ST 555: Statistical Programming I

RStudio part 1

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Outline

- Introduce to RStudio
- Install RStudio
- Change RStudio settings

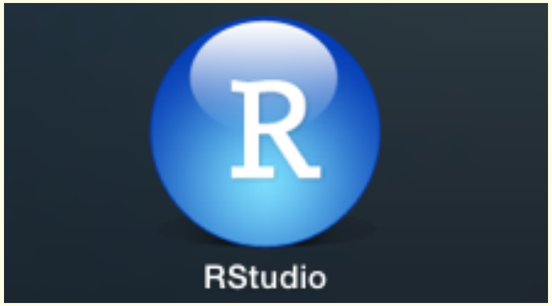
What is RStudio?

- RStudio is the premier integrated development environment (IDE) for R
- It is FREE!
- User-friendly, easy to learn
- Open source and free to write R packages
- Available in both open source and commercial editions on the desktop (Windows, Mac, and Linux)
- Includes powerful coding tools designed to enhance your productivity
- Supports R Markdown, R Sweave, R Presentation

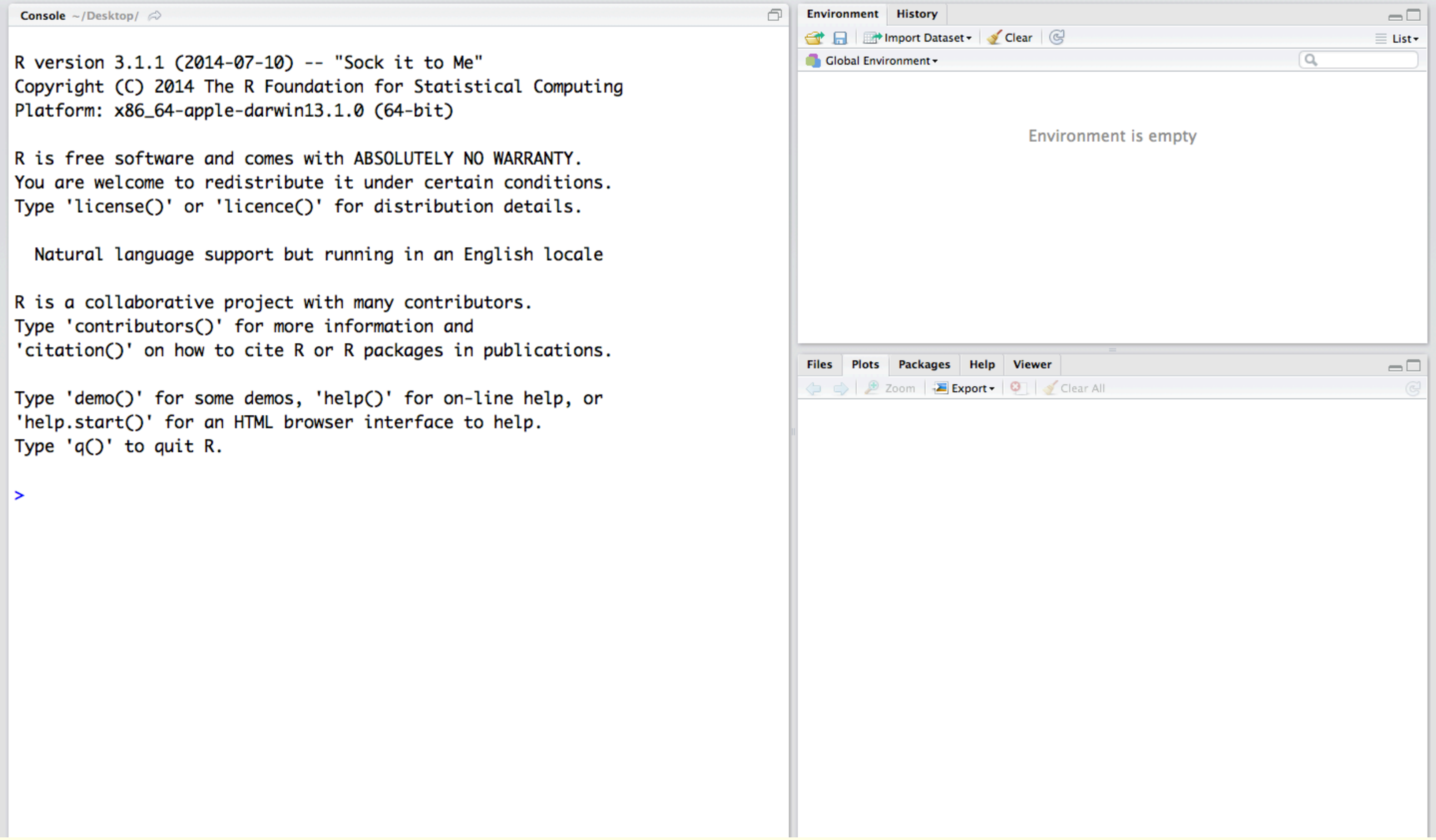
Installing RStudio

- Download regular release or preview version
- Regular release: http://www.rstudio.com/products/rstudio/
- Preview version:
  http://www.rstudio.com/products/rstudio/download/preview/

After installing, you could see this sign in your desktop

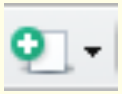
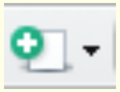
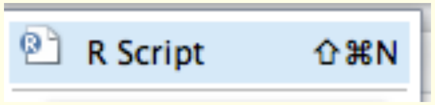


Installing RStudio

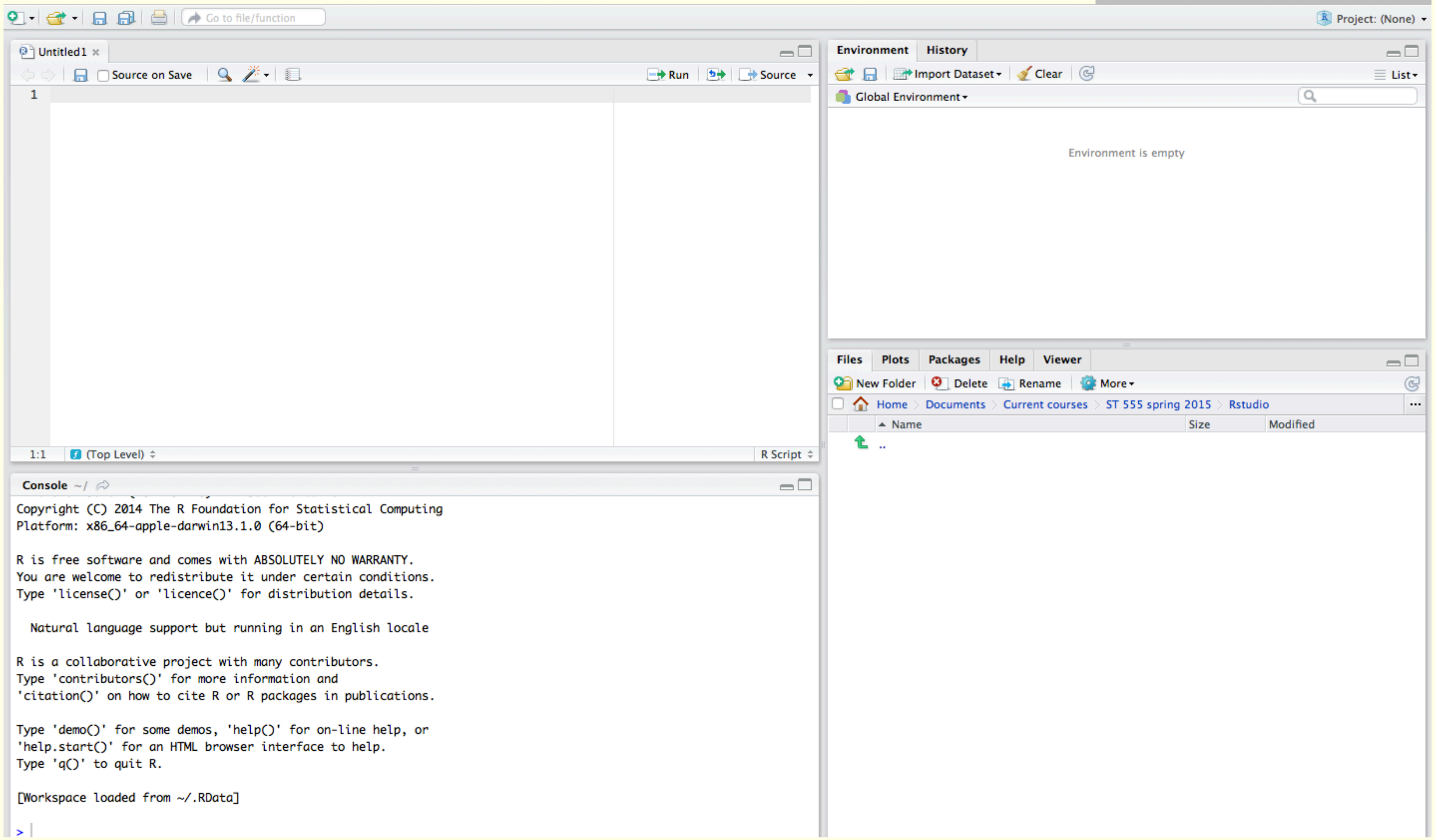


```
R version 3.1.1 (2014-07-10) -- "Sock it to Me"
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin13.1.0 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>
```

Add a new R Script

- Find out  button in the left upper side of RStudio.
- Click  , then click 

Add a new R Script



```
Copyright (C) 2014 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin13.1.0 (64-bit)

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Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[Workspace loaded from ~/.RData]

>
```
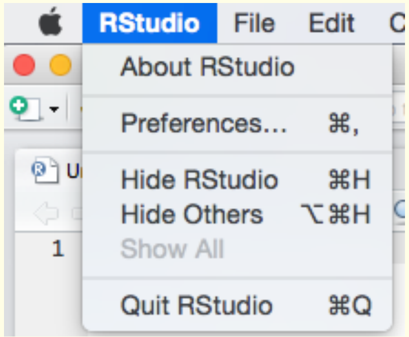
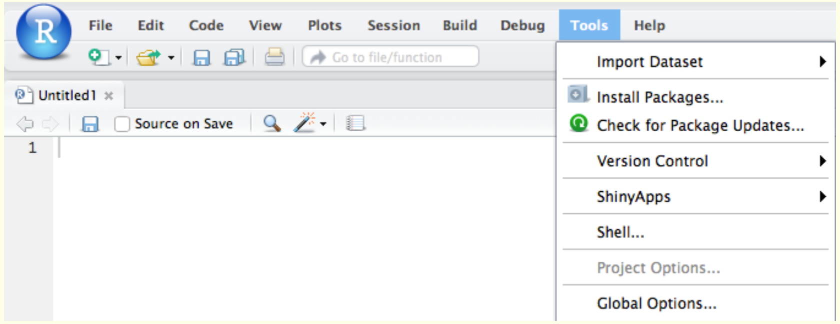

Change preferences

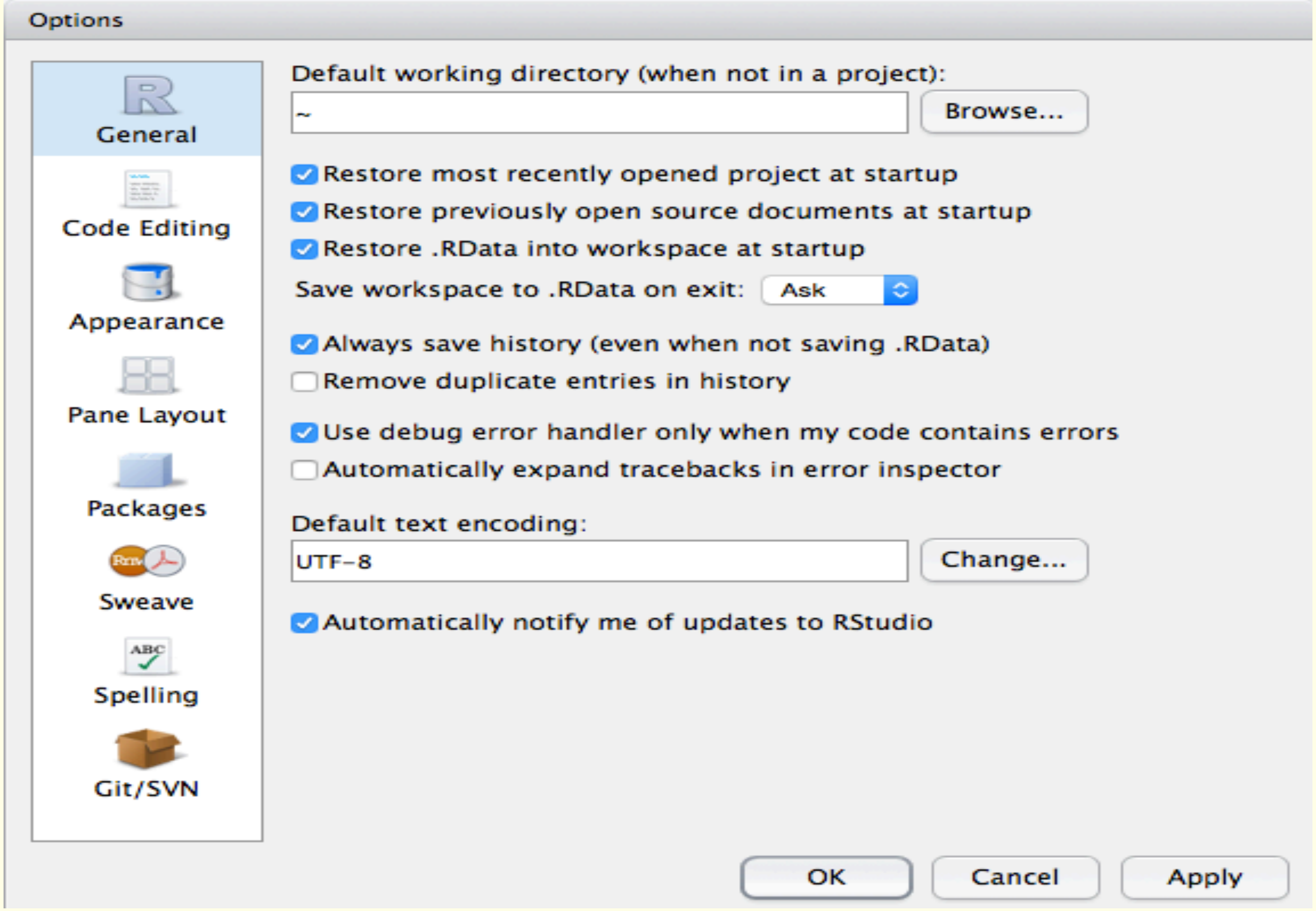
For mac user, click RStudio button, then click “Preferences”



For windows user, click Tools button, then click “Global Options”



Change preferences



Default working directory (when not in a project):

~

☑ Restore most recently opened project at startup

☑ Restore previously open source documents at startup

☑ Restore .RData into workspace at startup

Save workspace to .RData on exit: Ask

☑ Always save history (even when not saving .RData)

□ Remove duplicate entries in history

☑ Use debug error handler only when my code contains errors

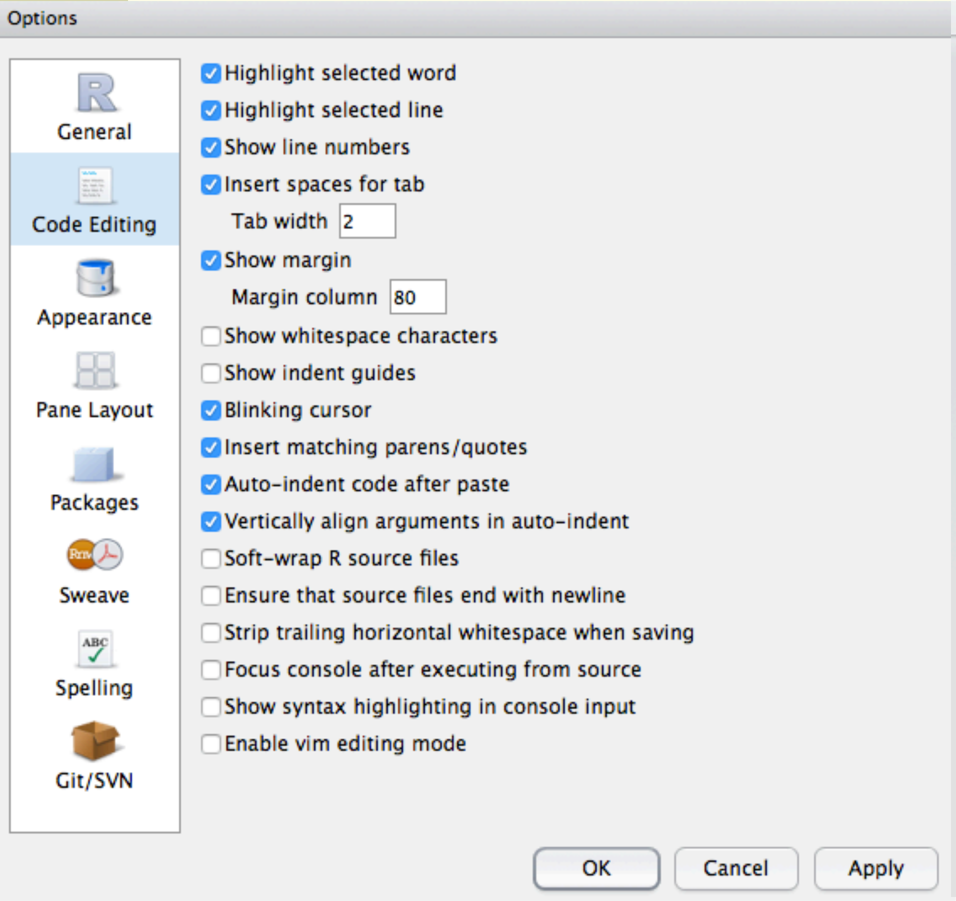
□ Automatically expand tracebacks in error inspector

Default text encoding:

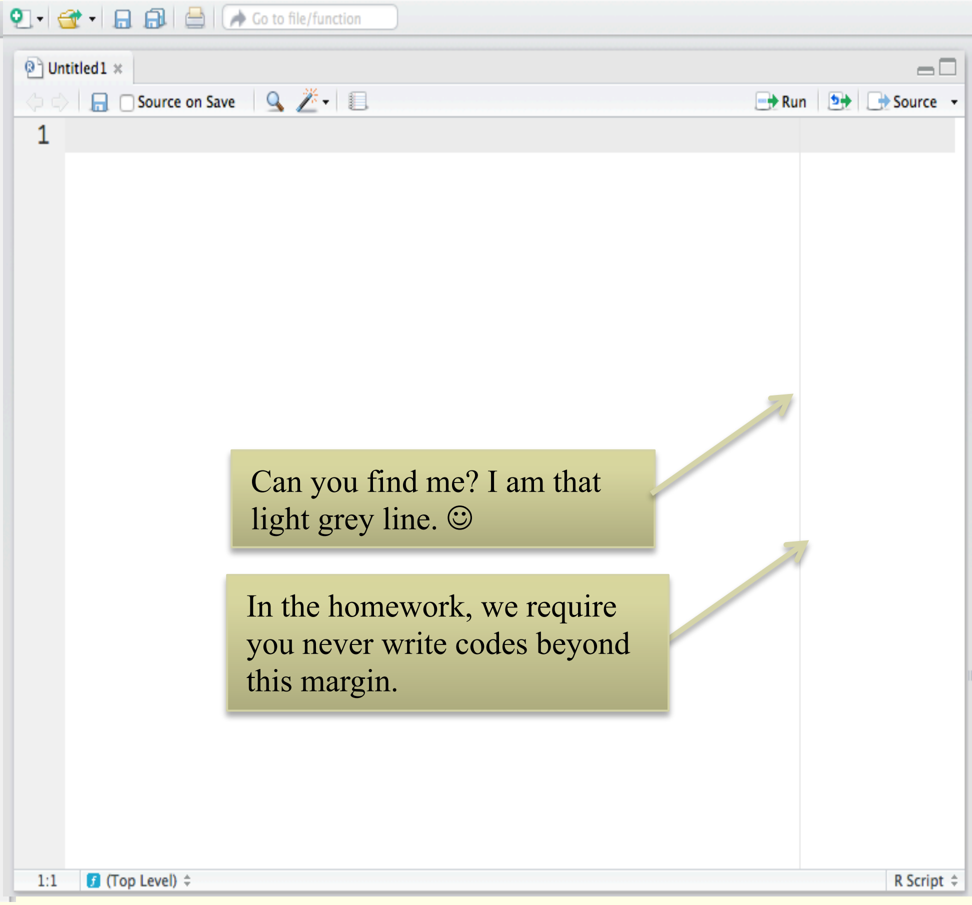
UTF-8

☑ Automatically notify me of updates to RStudio

Change preferences



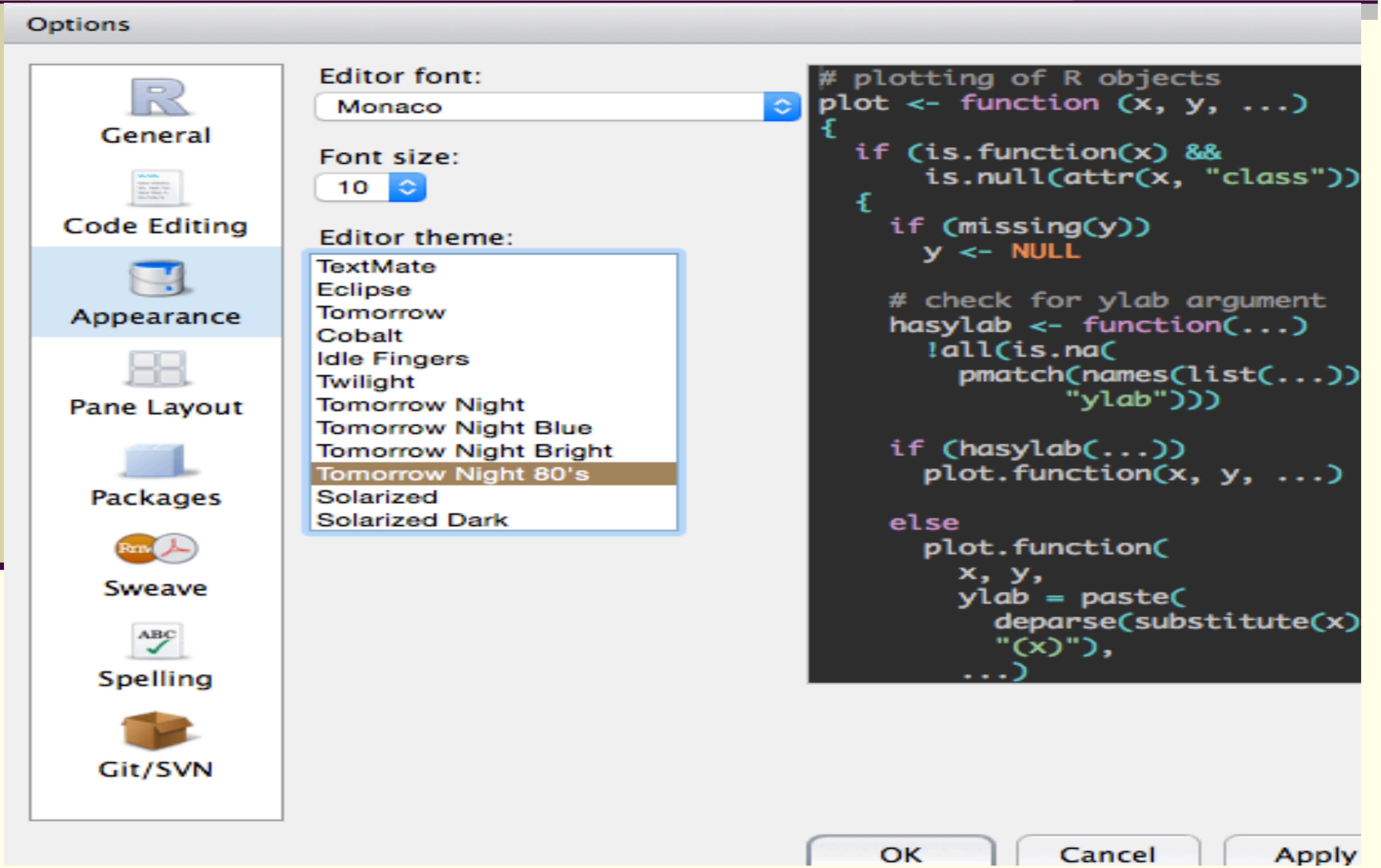
☑ Highlight selected word
☑ Highlight selected line
☑ Show line numbers
☑ Insert spaces for tab
Tab width 2
☑ Show margin
Margin column 80
□ Show whitespace characters
□ Show indent guides
☑ Blinking cursor
☑ Insert matching parens/quotes
☑ Auto-indent code after paste
☑ Vertically align arguments in auto-indent
□ Soft-wrap R source files
□ Ensure that source files end with newline
□ Strip trailing horizontal whitespace when saving
□ Focus console after executing from source
□ Show syntax highlighting in console input
□ Enable vim editing mode



Can you find me? I am that light grey line. ☺

In the homework, we require you never write codes beyond this margin.

Change Rstudio appearance



Editor font: Monaco

Font size: 10

Editor theme:

- TextMate
- Eclipse
- Tomorrow
- Cobalt
- Idle Fingers
- Twilight
- Tomorrow Night
- Tomorrow Night Blue
- Tomorrow Night Bright
- Tomorrow Night 80's
- Solarized
- Solarized Dark

```
# plotting of R objects
plot <- function (x, y, ...)
{
  if (is.function(x) &&
      is.null(attr(x, "class"))
  {
    if (missing(y))
      y <- NULL

    # check for ylab argument
    hasylab <- function(...)
      !all(is.na(
        pmatch(names(list(...))
              "ylab")))

    if (hasylab(...))
      plot.function(x, y, ...)

    else
      plot.function(
        x, y,
        ylab = paste(
          deparse(substitute(x)
          "(x)"),
        ...)
```

Exercises: makes changes in RStudio

- 1. Create a new R script
- 2. In the “Preferences” or “Global options” do the following:

  i. Find out the following options and click them

  “Highlight selected word”

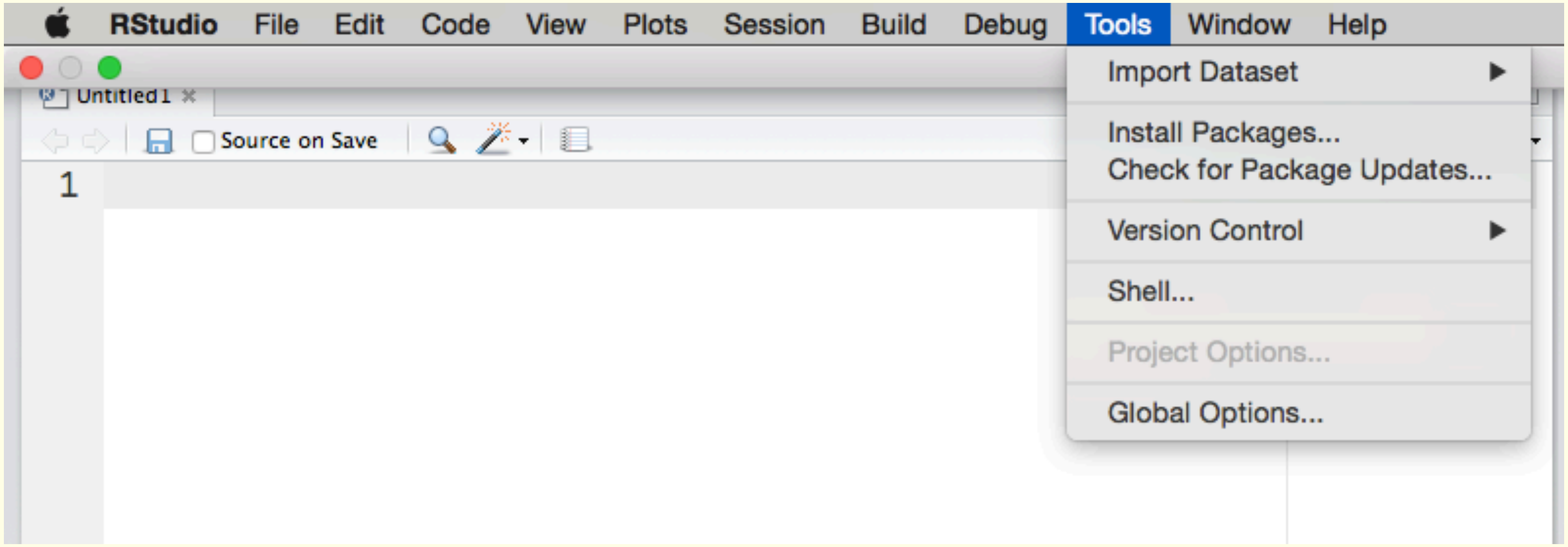
  “Highlight selected line”

  “Show line numbers”

  ii. Change your RStudio`s appearance

Install packages

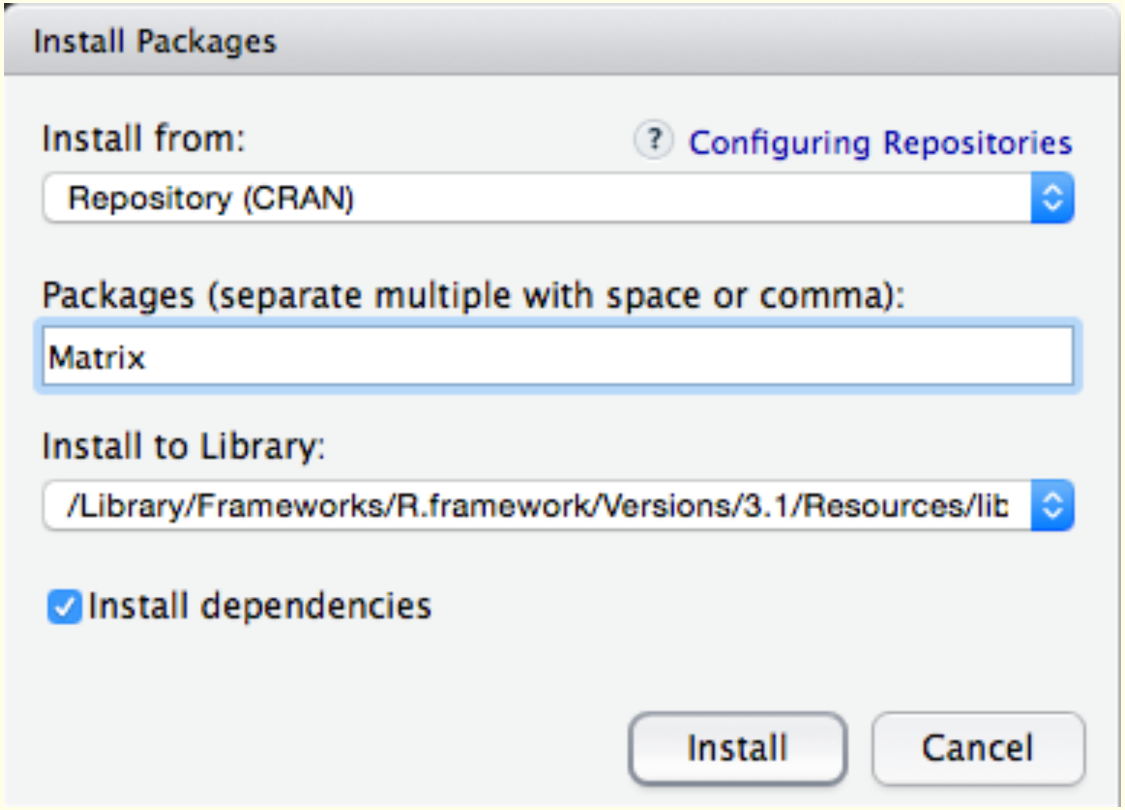
Click “Tools”, then click “Install Packages…”



Install packages

For example, to install “Matrix” packages.

Choose Install from to Repository (CRAN), in the Packages, type package`s name “Matrix”, click Install.



Install Packages

Install from: Repository (CRAN)

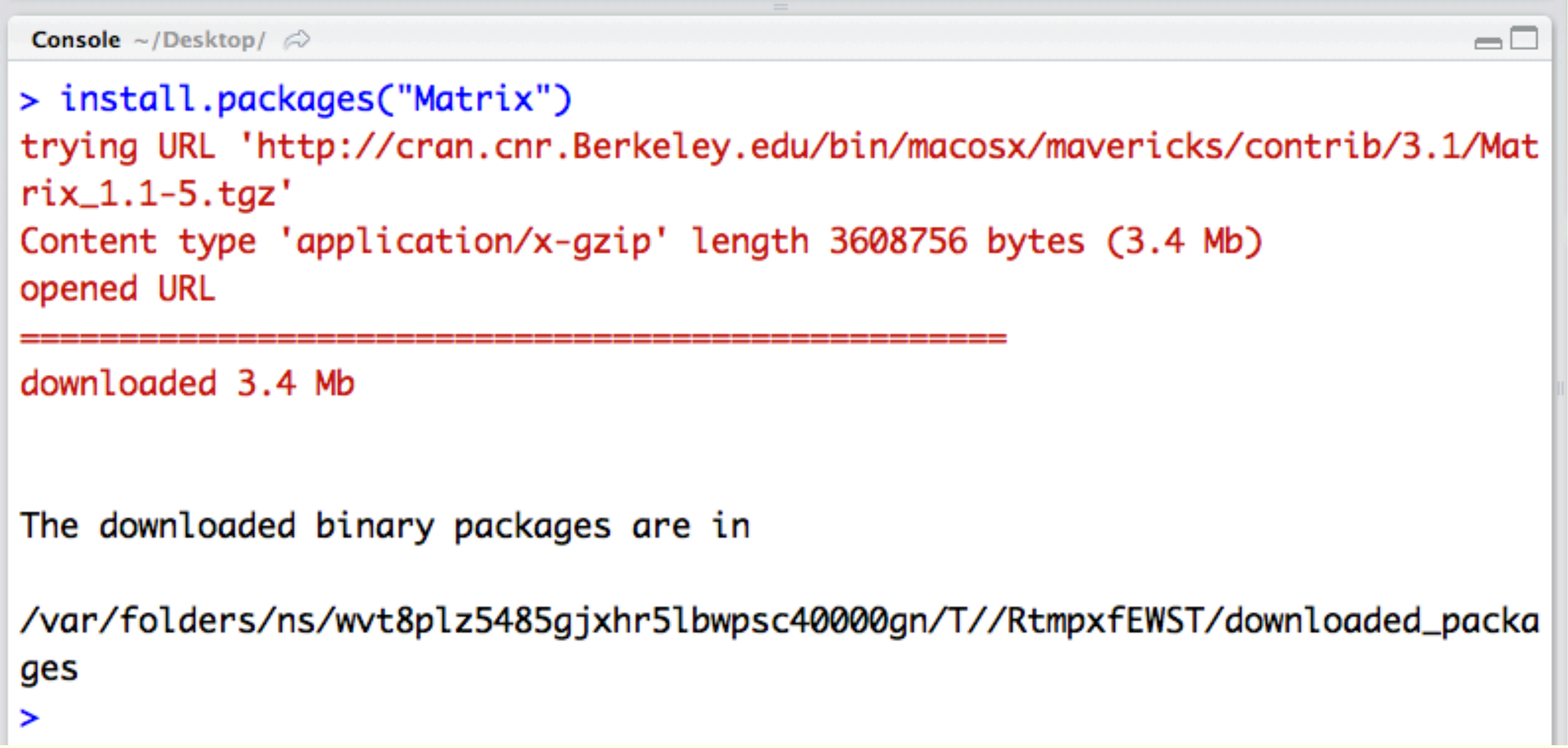
Packages (separate multiple with space or comma): Matrix

Install to Library: /Library/Frameworks/R.framework/Versions/3.1/Resources/lib

☑ Install dependencies

Install packages

- In Console, you can find out if the package was installed or not.



```
> install.packages("Matrix")
trying URL 'http://cran.cnr.Berkeley.edu/bin/macosx/mavericks/contrib/3.1/Mat
rix_1.1-5.tgz'
Content type 'application/x-gzip' length 3608756 bytes (3.4 Mb)
opened URL
==================================================
downloaded 3.4 Mb


The downloaded binary packages are in

/var/folders/ns/wvt8plz5485gjxhr5lbwpsc40000gn/T//RtmpxfEWST/downloaded_packa
ges
>
```

Install packages

Another way to install packages in RStudio is to type

```
> install.packages("Matrix")
```

in the Script or Console.

Note the package`s name is case sensitive.

Exercises: Install packages

1. Try to install the following packages in R studio
   Matrix
   base
   ggplot2

2. Now, let`s try to install R packages in another way. Some R packages are not in "Repository (CRAN)", we need to download from website and install from "Package Archive File"
   Download the "glmnet" package from
   http://cran.r-project.org/web/packages/glmnet/index.html
   Try to install from Package Archive File.

ST 555: Statistical Programming I

RStudio part 2

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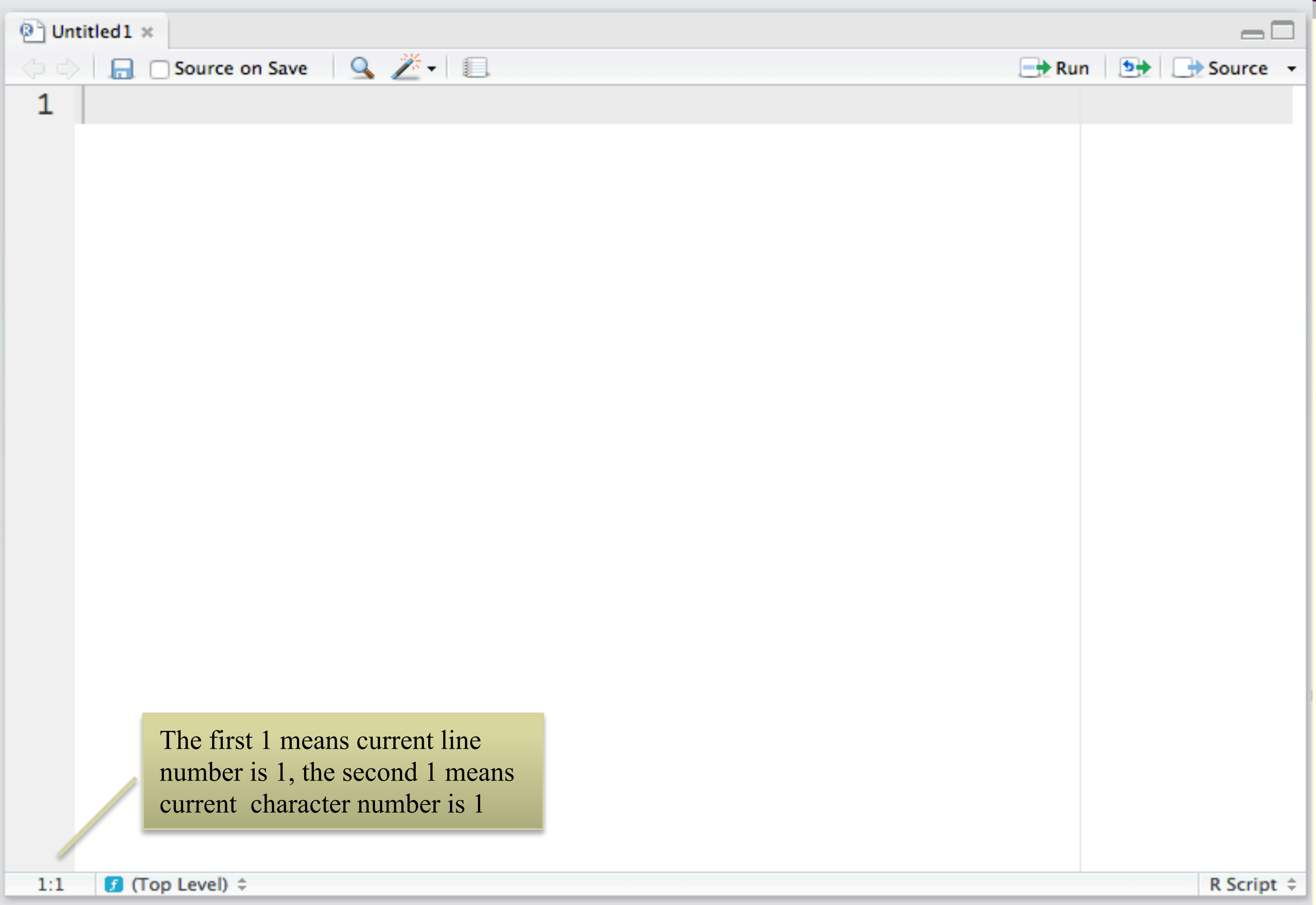
Outline

- Running R programs
- R programming standards
- Useful R programming resources

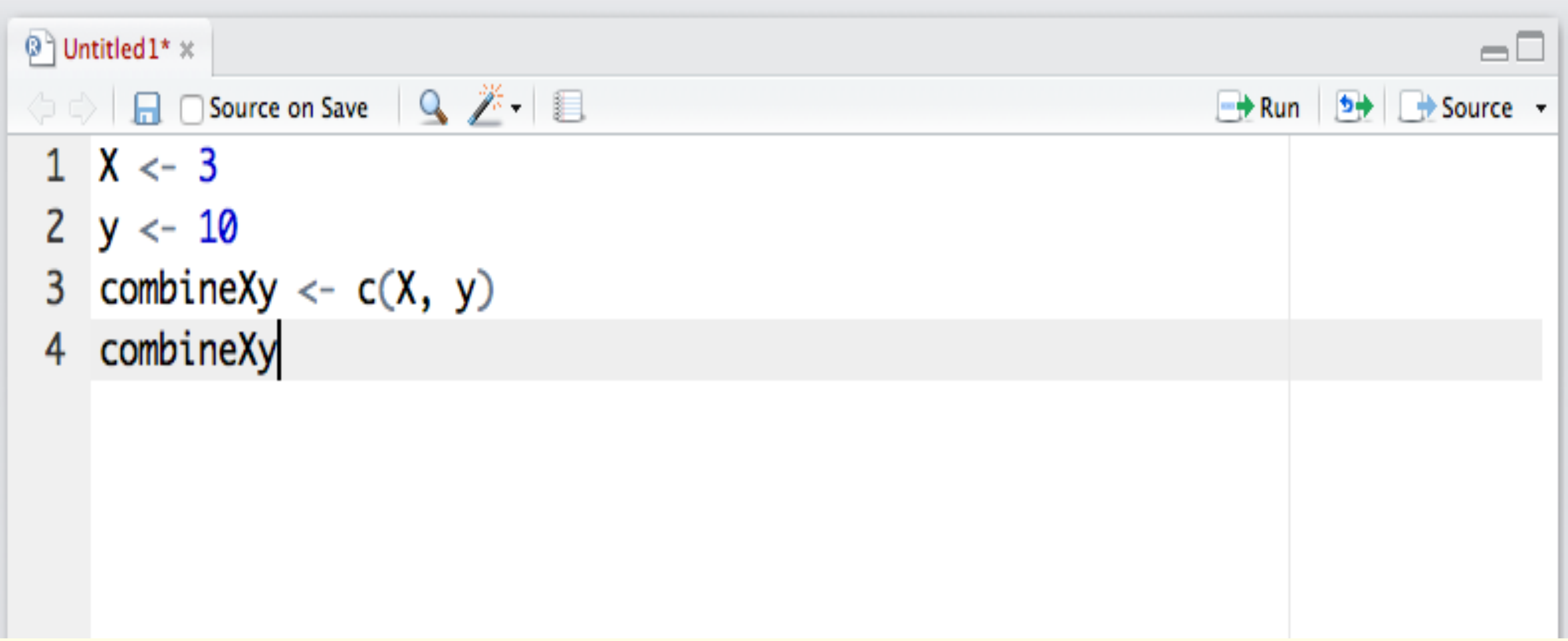
Running R Programs using RStudio



The first 1 means current line number is 1, the second 1 means current character number is 1

Running R Programs using RStudio

Writing in the Script

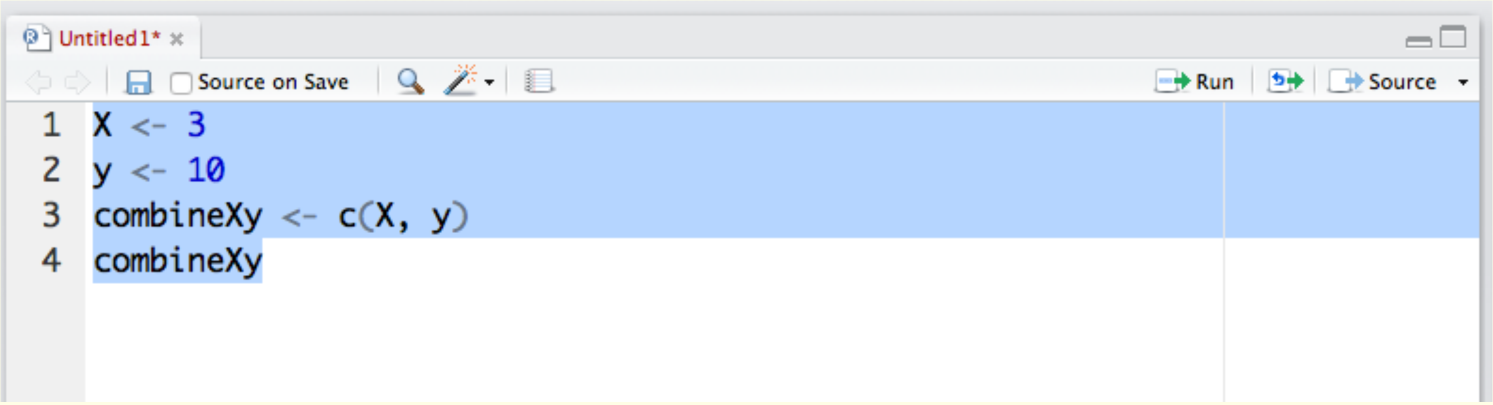


```r
X <- 3
y <- 10
combineXy <- c(X, y)
combineXy
```

Running R Programs using RStudio

- Two other ways to run the code:
- 1. Copy the code and paste it in the console;
- 2. Use keyboard shortcuts.

  First, highlight the code, then for mac user, use “Command + Return”; for windows user, use “Ctrl + Enter”



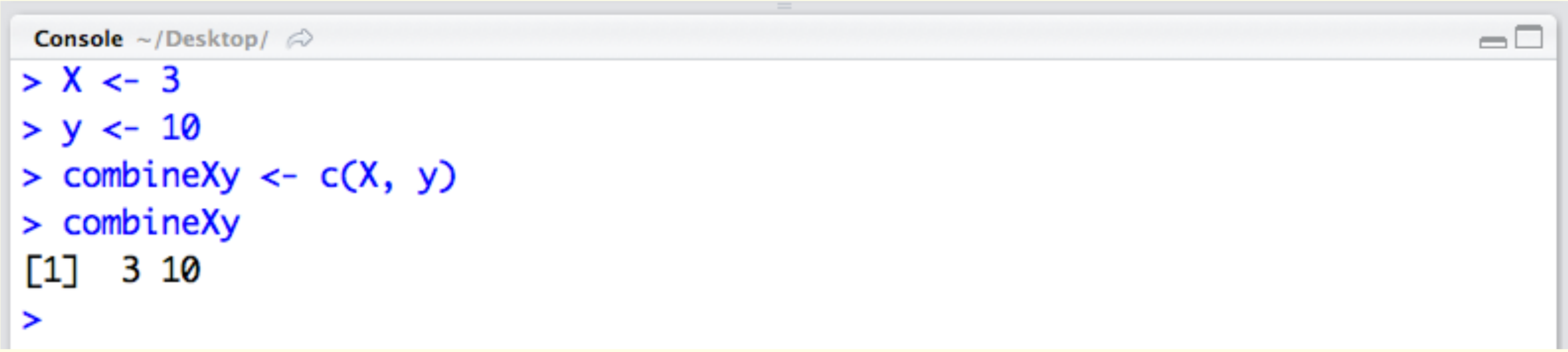
```
X <- 3
y <- 10
combineXy <- c(X, y)
combineXy
```

For more shortcuts check out this webpage:

https://support.rstudio.com/hc/en-us/articles/200711853-Keyboard-Shortcuts

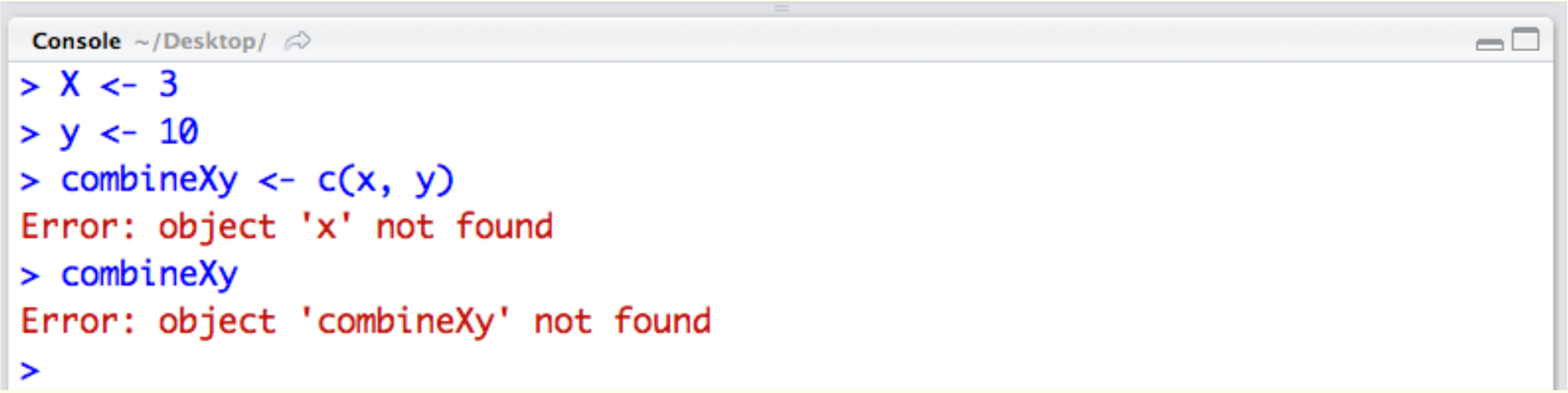
Running R Programs using RStudio

- In the RStudio console, you could see the result.



```
> X <- 3
> y <- 10
> combineXy <- c(X, y)
> combineXy
[1]  3 10
>
```

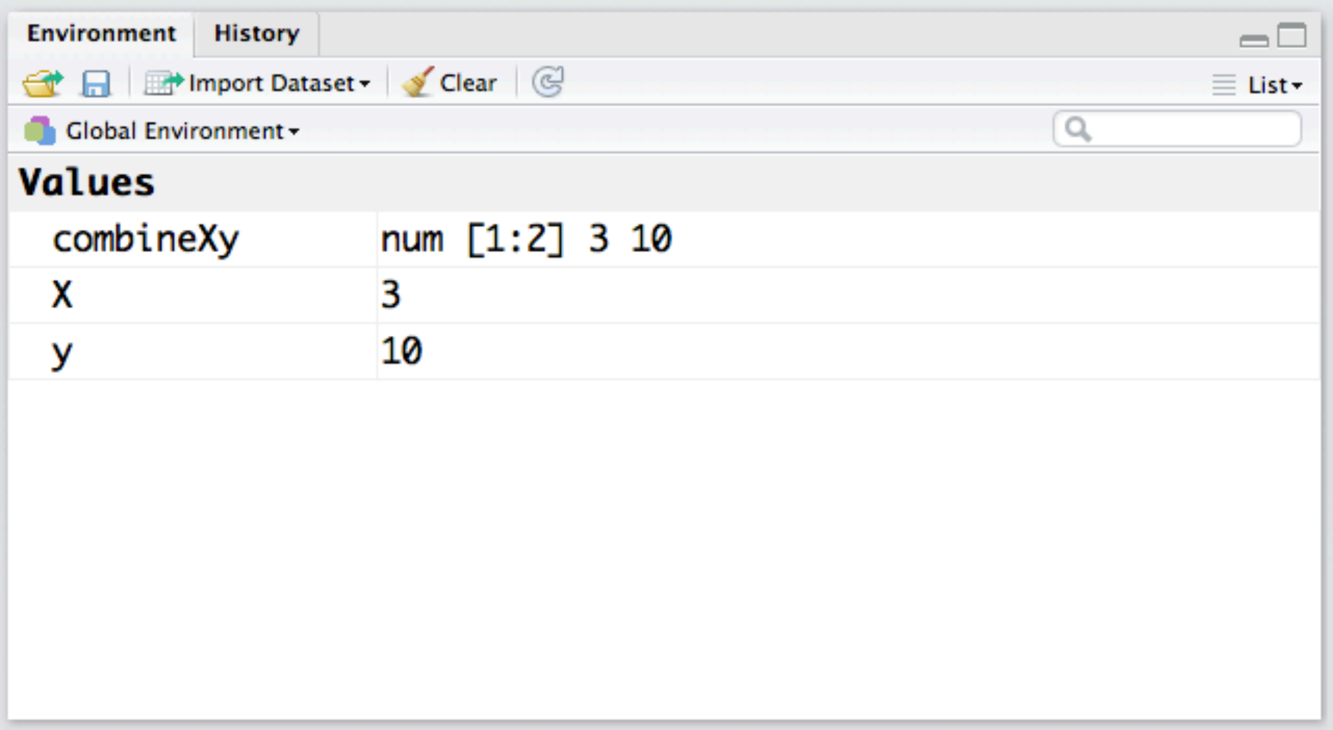
- If your code is wrong, RStudio will give you warning massages.
- For example, input “X” as “x”, then



```
> X <- 3
> y <- 10
> combineXy <- c(x, y)
Error: object 'x' not found
> combineXy
Error: object 'combineXy' not found
>
```

Running R Programs using RStudio

- Furthermore, RStudio saves variables name in “Environment” dialogue box, which is in the upper right corner of RStudio.



Values

combineXy	num [1:2] 3 10
x	3
y	10

R programming standards

1. All programs should be well organized and easy to follow.
2. There should be no errors or warnings in the console when the code is run.
3. Student should follow all specifications in the assignment.
4. Program and output should be correct.
5. Student should complete all the tasks in the assignment.

R programming standards, continued

6. Programs should have a complete header comment, including students name, date, assignment name, goal of program, and data files used.

7. Comments should be used throughout the program to identify and explain the rational for each section of code

8. Variables assignment should use “<-” not “=”

9. Always add “rm(list = ls())” at the top and at the bottom of your program. [Be sure to save first]

R programming standards, more

10. Each line, the character length should not exceed 80

11. Always add space before and after math operations such as “+”, “-”, “*”, “/”, always add space after “,”.

12. Name variables consistently.

    Here are some options for naming variables (by Yiwen Zhang)

    all lower case: searchpaths …

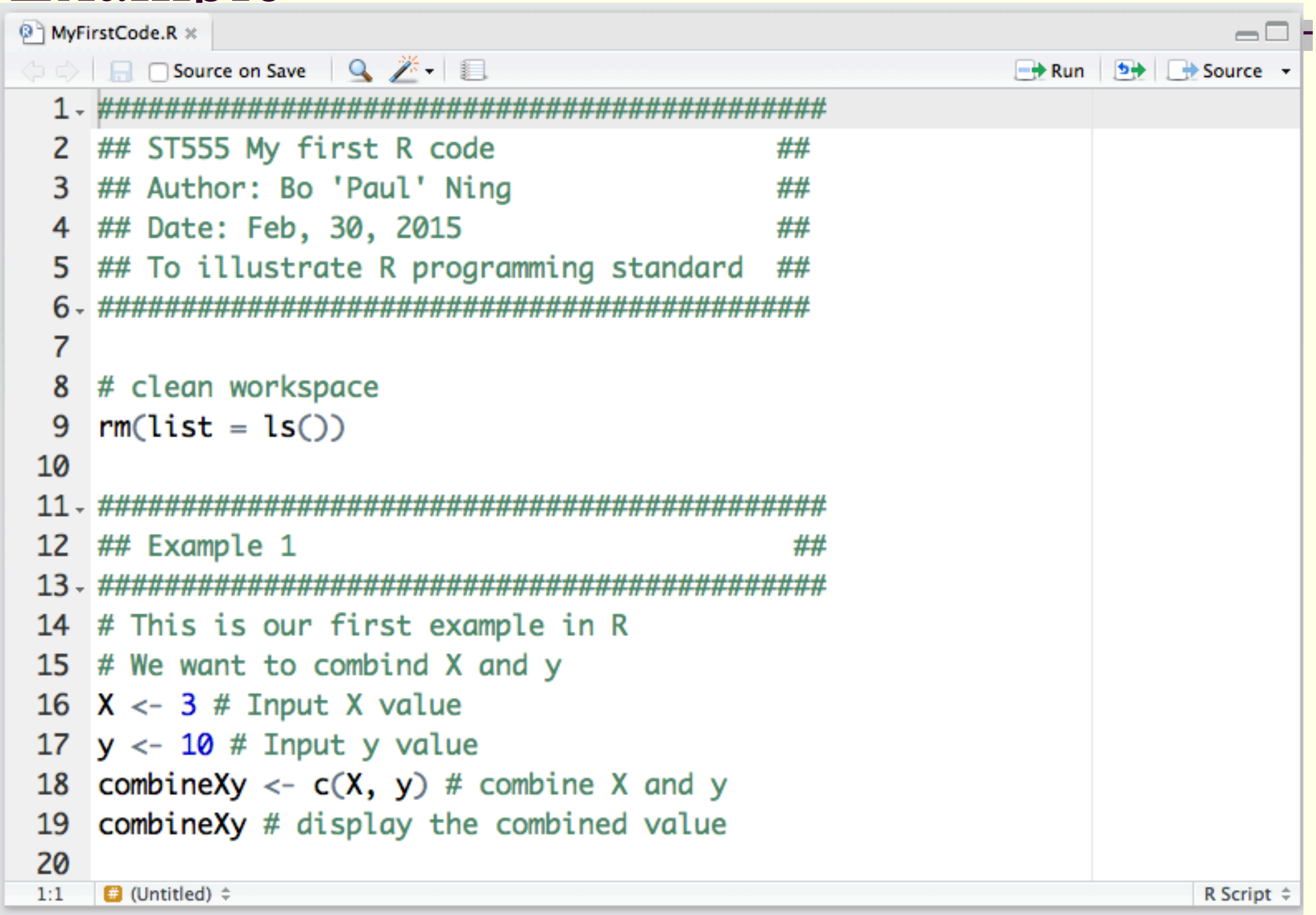
    period separated: as.numeric, read.table …

    underscore separated: package_version …

    lower camel case (suggested): colSums, sessionInfo …

    upper camel case: Vectorize, NextMethod …

R proramming standards Example



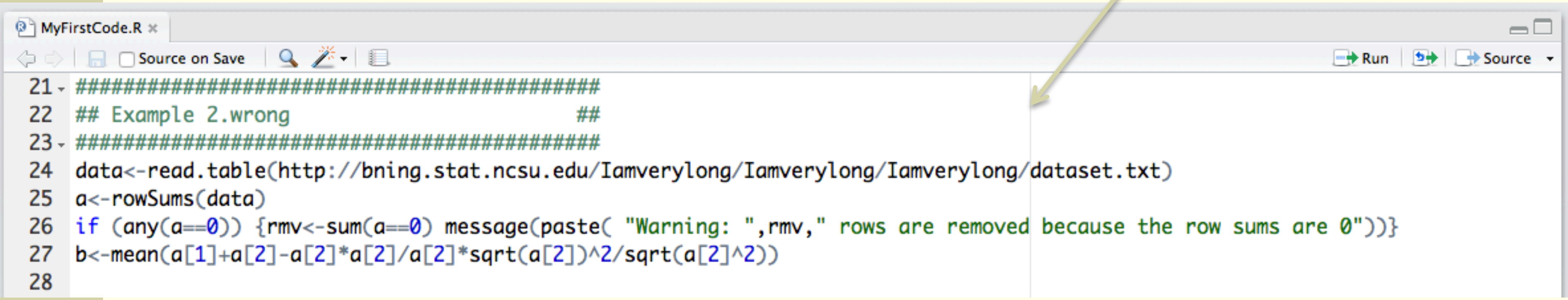
```
############################################
## ST555 My first R code                 ##
## Author: Bo 'Paul' Ning                ##
## Date: Feb, 30, 2015                   ##
## To illustrate R programming standard  ##
###########################################

# clean workspace
rm(list = ls())

############################################
## Example 1                              ##
############################################
# This is our first example in R
# We want to combind X and y
X <- 3 # Input X value
y <- 10 # Input y value
combineXy <- c(X, y) # combine X and y
combineXy # display the combined value

```

R programming standards

Look at the following two examples, which one do your prefer?

Example A:

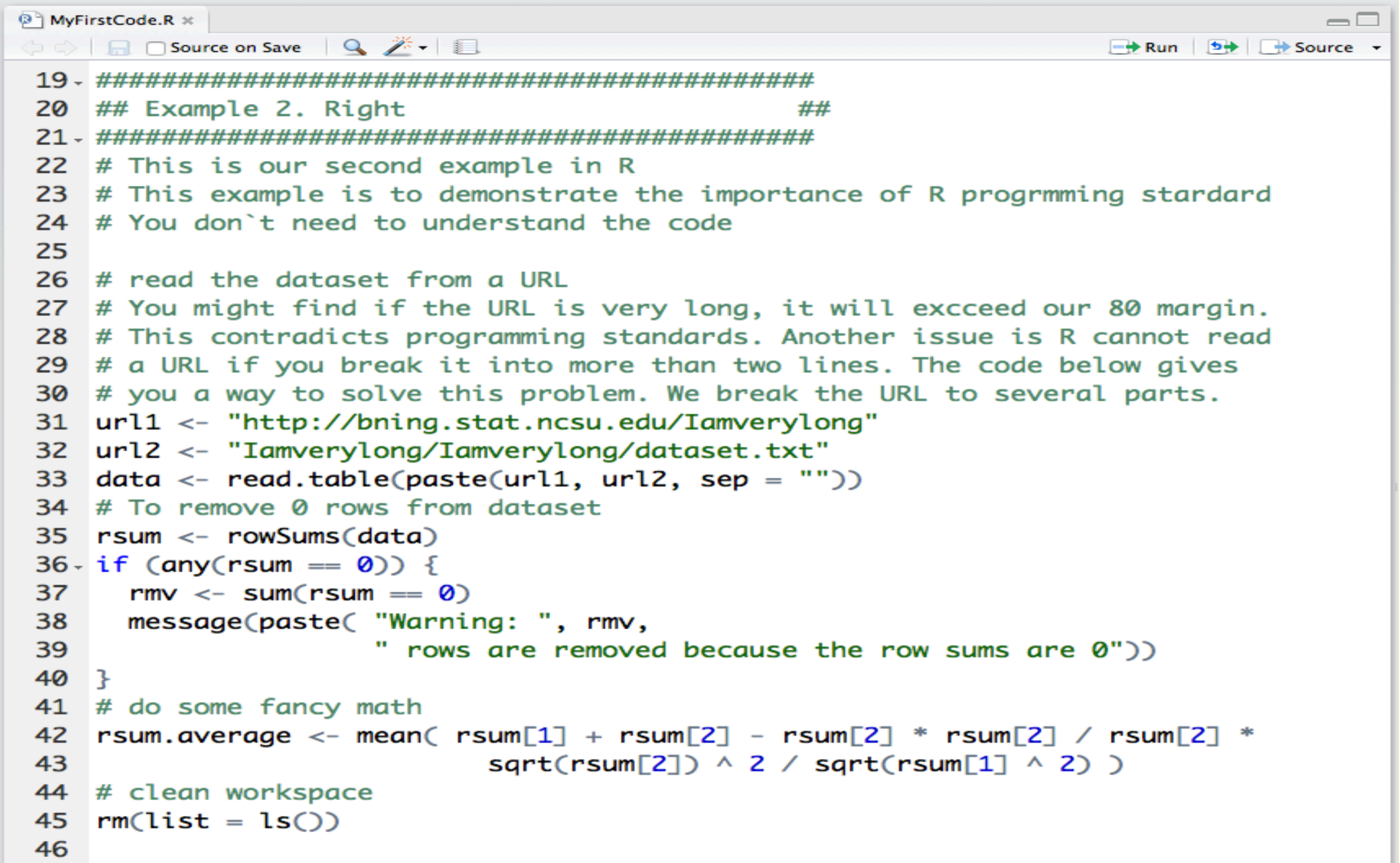
I am that light grey line again!



```
############################################
## Example 2.wrong                        ##
############################################
data<-read.table(http://bning.stat.ncsu.edu/Iamverylong/Iamverylong/Iamverylong/dataset.txt)
a<-rowSums(data)
if (any(a==0)) {rmv<-sum(a==0) message(paste( "Warning: ",rmv," rows are removed because the row sums are 0"))}
b<-mean(a[1]+a[2]-a[2]*a[2]/a[2]*sqrt(a[2])^2/sqrt(a[2]^2))

```

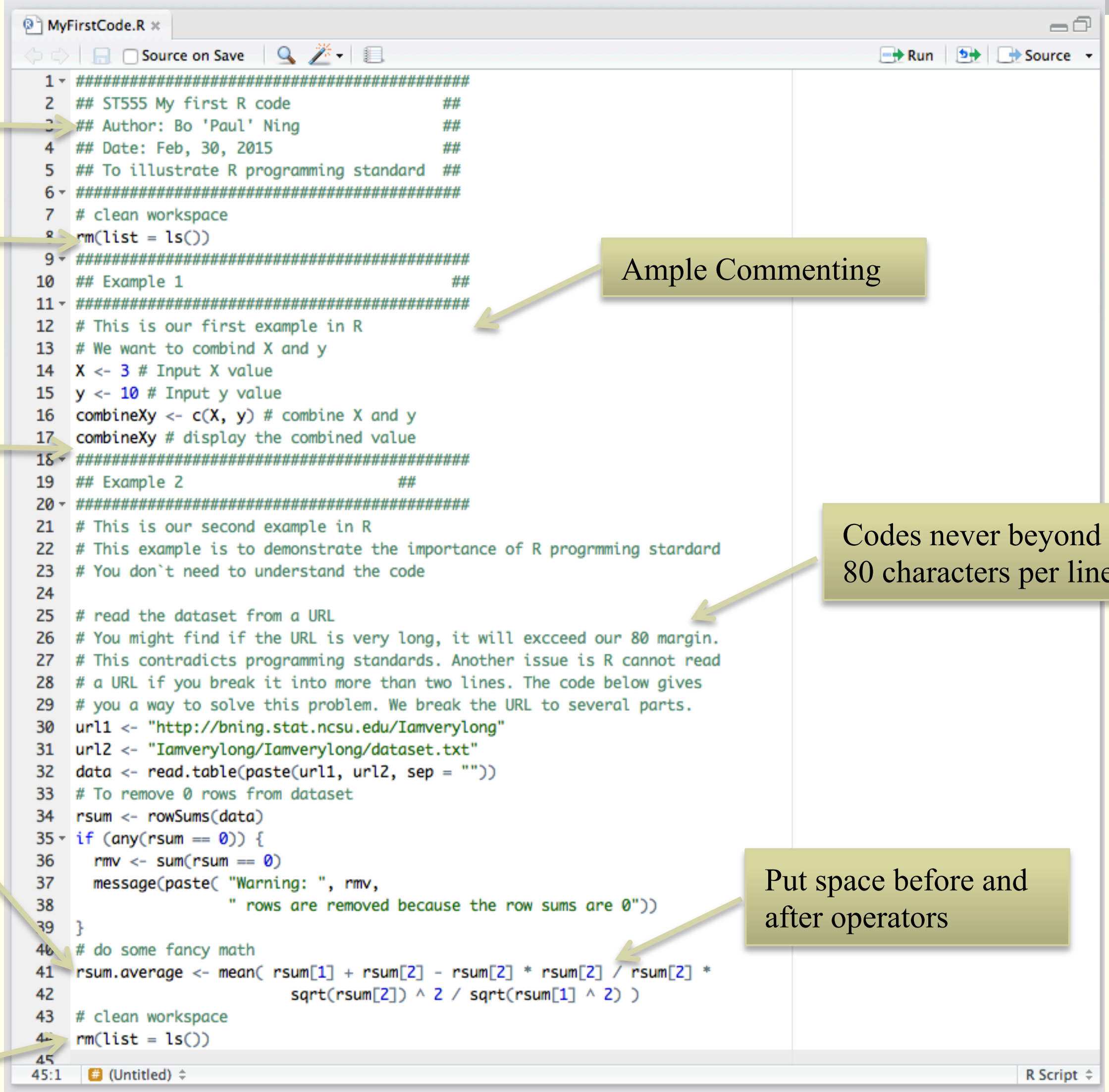
R programming standards

Example B:



```
############################################
## Example 2. Right                       ##
############################################
# This is our second example in R
# This example is to demonstrate the importance of R progrmming stardard
# You don`t need to understand the code

# read the dataset from a URL
# You might find if the URL is very long, it will excceed our 80 margin.
# This contradicts programming standards. Another issue is R cannot read
# a URL if you break it into more than two lines. The code below gives
# you a way to solve this problem. We break the URL to several parts.
url1 <- "http://bning.stat.ncsu.edu/Iamverylong"
url2 <- "Iamverylong/Iamverylong/dataset.txt"
data <- read.table(paste(url1, url2, sep = ""))
# To remove 0 rows from dataset
rsum <- rowSums(data)
if (any(rsum == 0)) {
  rmv <- sum(rsum == 0)
  message(paste( "Warning: ", rmv,
                 " rows are removed because the row sums are 0"))
}
# do some fancy math
rsum.average <- mean( rsum[1] + rsum[2] - rsum[2] * rsum[2] / rsum[2] *
                        sqrt(rsum[2]) ^ 2 / sqrt(rsum[1] ^ 2) )
# clean workspace
rm(list = ls())

```

R programming standards



```r
############################################
## ST555 My first R code                 ##
## Author: Bo 'Paul' Ning                ##
## Date: Feb, 30, 2015                   ##
## To illustrate R programming standard  ##
###########################################
# clean workspace
rm(list = ls())
############################################
## Example 1                              ##
############################################
# This is our first example in R
# We want to combind X and y
X <- 3 # Input X value
y <- 10 # Input y value
combineXy <- c(X, y) # combine X and y
combineXy # display the combined value
############################################
## Example 2                        ##
############################################
# This is our second example in R
# This example is to demonstrate the importance of R progrmming stardard
# You don`t need to understand the code

# read the dataset from a URL
# You might find if the URL is very long, it will excceed our 80 margin.
# This contradicts programming standards. Another issue is R cannot read
# a URL if you break it into more than two lines. The code below gives
# you a way to solve this problem. We break the URL to several parts.
url1 <- "http://bning.stat.ncsu.edu/Iamverylong"
url2 <- "Iamverylong/Iamverylong/dataset.txt"
data <- read.table(paste(url1, url2, sep = ""))
# To remove 0 rows from dataset
rsum <- rowSums(data)
if (any(rsum == 0)) {
  rmv <- sum(rsum == 0)
  message(paste( "Warning: ", rmv,
                 " rows are removed because the row sums are 0"))
}
# do some fancy math
rsum.average <- mean( rsum[1] + rsum[2] - rsum[2] * rsum[2] / rsum[2] *
                        sqrt(rsum[2]) ^ 2 / sqrt(rsum[1] ^ 2) )
# clean workspace
rm(list = ls())
```

Complete header

Add rm(list = ls()) at the beginning

Ample Commenting

Use "<-" to assign values to variables

Codes never beyond 80 characters per line

Variable name is consistent and understandable

Put space before and after operators

Add rm(list = ls()) at the end

R programming standards

- Good references for R programming Standards (Compliments of Dr. Hua Zhou)

http://google-styleguide.googlecode.com/svn/trunk/cppguide.xml

https://sites.google.com/site/matlabstyleguidelines/home

Useful R programming resources

Here are resources for R programming

1. Advanced R by Hadley Wickham: http://adv-r.had.co.nz/
2. Dr. John Monahan's class (2013 fall) on R: http://www.stat.ncsu.edu/people/monahan/courses/ST610/
3. Online tutorial: http://tryr.codeschool.com/levels/1/challenges/1

Taken from Dr. Hua Zhou`s ST 758: computation for statistical research lecture notes.

ST 555: Statistical Programming I

R Markdown

Bo “Paul” Ning

Dr. Reneé H. Moore

RStudio

Outline

- What is R Markdown?
- Why use R Markdown?
- Use R Markdown to generate report

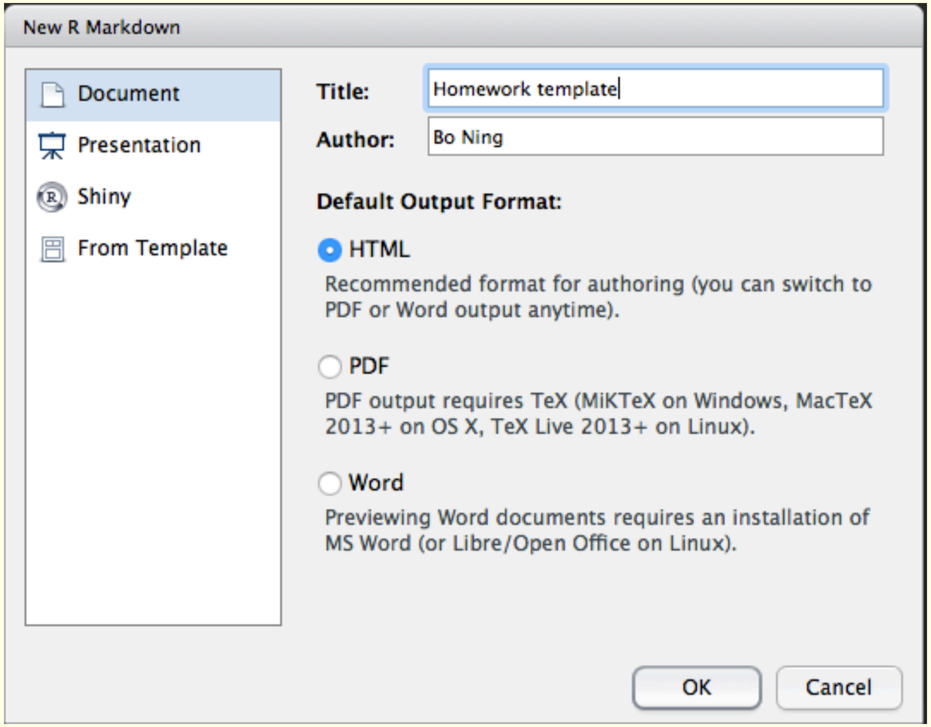
What is R Markdown? Why Use?

- R Markdown is a dynamic document for R
- It combines the core syntax of markdown (an easy-to-write plain text format) with embedded R code chunks that are run so their output can be included in the final document.

  (from http://rmarkdown.rstudio.com)
- New technology, widely used
- Integrate texts, R code and output together in one document in a nice looking way
- Automatically generate dynamic report for R programming

Open R Markdown

- Find out button in the left upper side of RStudio.
- Click , then click R Markdown...
- Choose “Document”, “Title”, “Author”, “Format Type”, Then click “OK”.



New R Markdown

Title: Homework template

Author: Bo Ning

Default Output Format:

● HTML

Recommended format for authoring (you can switch to PDF or Word output anytime).

○ PDF

PDF output requires TeX (MiKTeX on Windows, MacTeX 2013+ on OS X, TeX Live 2013+ on Linux).

○ Word

Previewing Word documents requires an installation of MS Word (or Libre/Open Office on Linux).

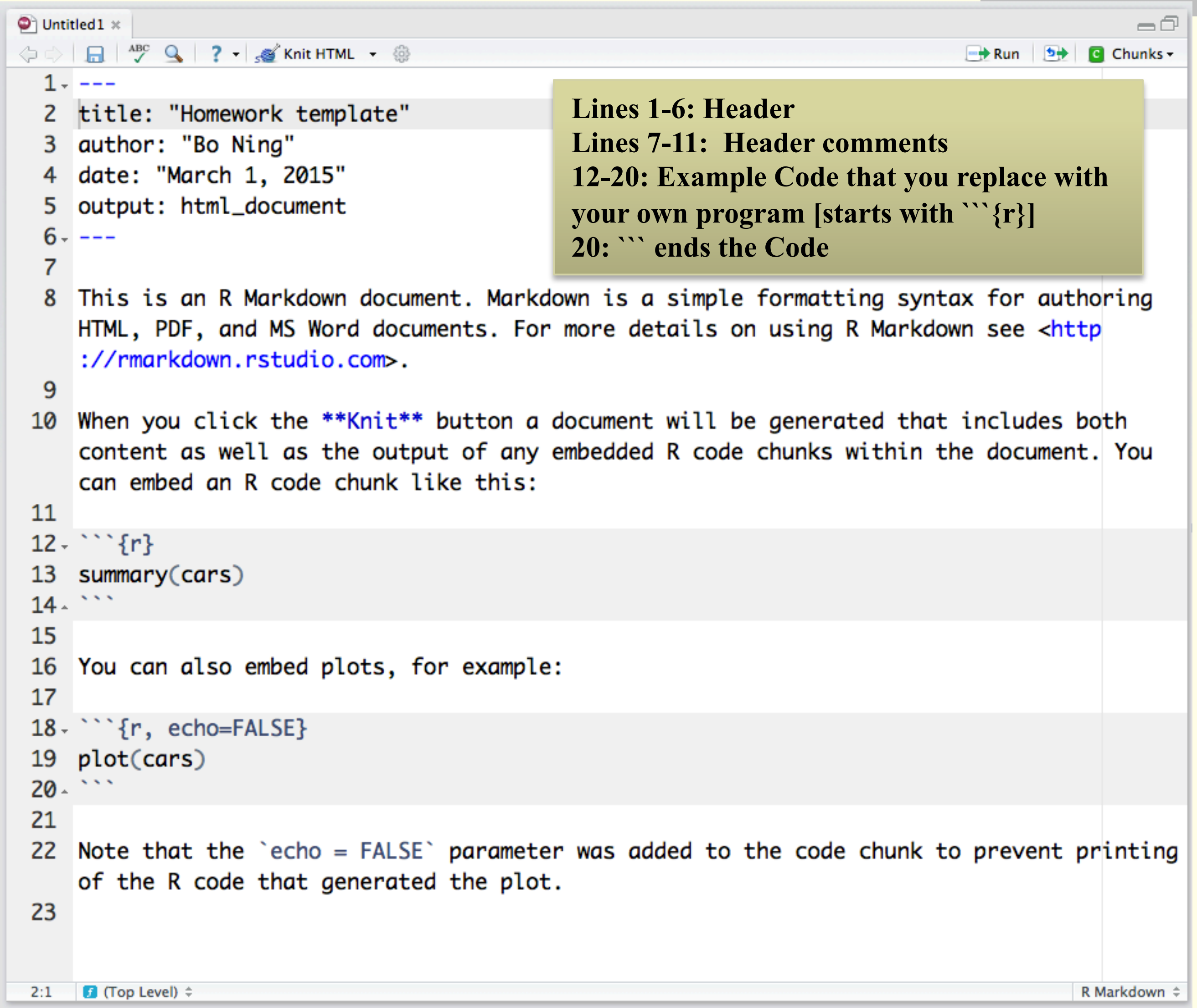
A Few Comments before Generating RMarkdown Report

- Make sure you have the lastest version of RStudio
- Yes to install 3 packages

- Where are you files saving?
- >getwd()

- Ways to change directory
- >setwd("C:/My Documents")
- From File Menu Save your Script in preferred directory
- Bottom Right Window, choose Files and then find preferred directory

Open R Markdown

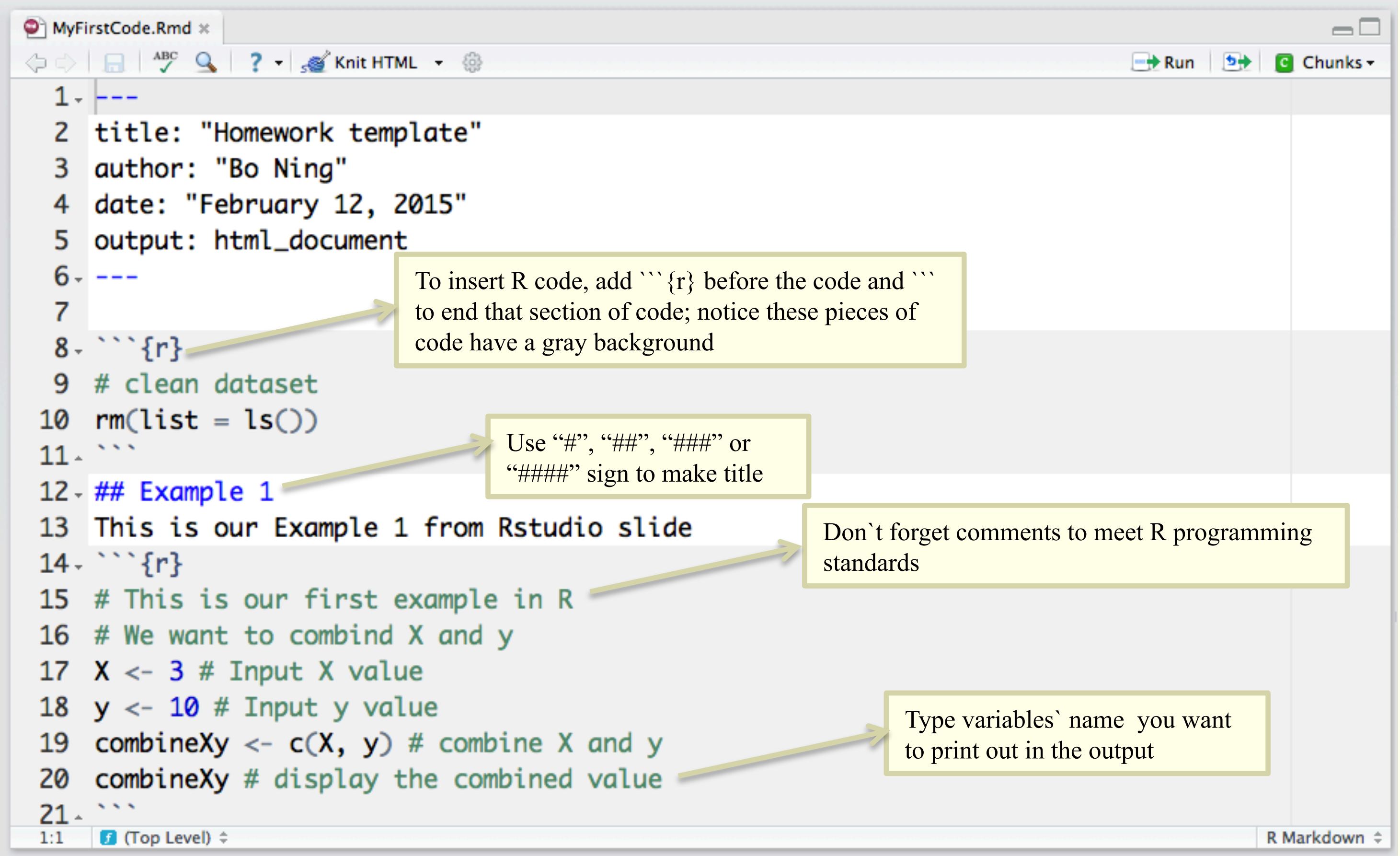


```
1  ---
2  title: "Homework template"
3  author: "Bo Ning"
4  date: "March 1, 2015"
5  output: html_document
6  ---
7
8  This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.
9
10 When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:
11
12 ```{r}
13 summary(cars)
14 ```
15
16 You can also embed plots, for example:
17
18 ```{r, echo=FALSE}
19 plot(cars)
20 ```
21
22 Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.
23
```

Lines 1-6: Header
Lines 7-11: Header comments
12-20: Example Code that you replace with your own program [starts with ```{r}]
20: ``` ends the Code

Write code in R Markdown

- Let`s start to write our first R Markdown file
- Includes title (question number) and “rm(list = ls())”



~~~
---
title: "Homework template"
author: "Bo Ning"
date: "February 12, 2015"
output: html_document
---

```{r}
# clean dataset
rm(list = ls())
```
## Example 1
This is our Example 1 from Rstudio slide
```{r}
# This is our first example in R
# We want to combind X and y
X <- 3 # Input X value
y <- 10 # Input y value
combineXy <- c(X, y) # combine X and y
combineXy # display the combined value
```
~~~

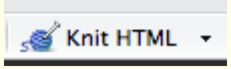
To insert R code, add ```{r} before the code and ``` to end that section of code; notice these pieces of code have a gray background

Use “#”, “##”, “###” or “####” sign to make title

Don`t forget comments to meet R programming standards

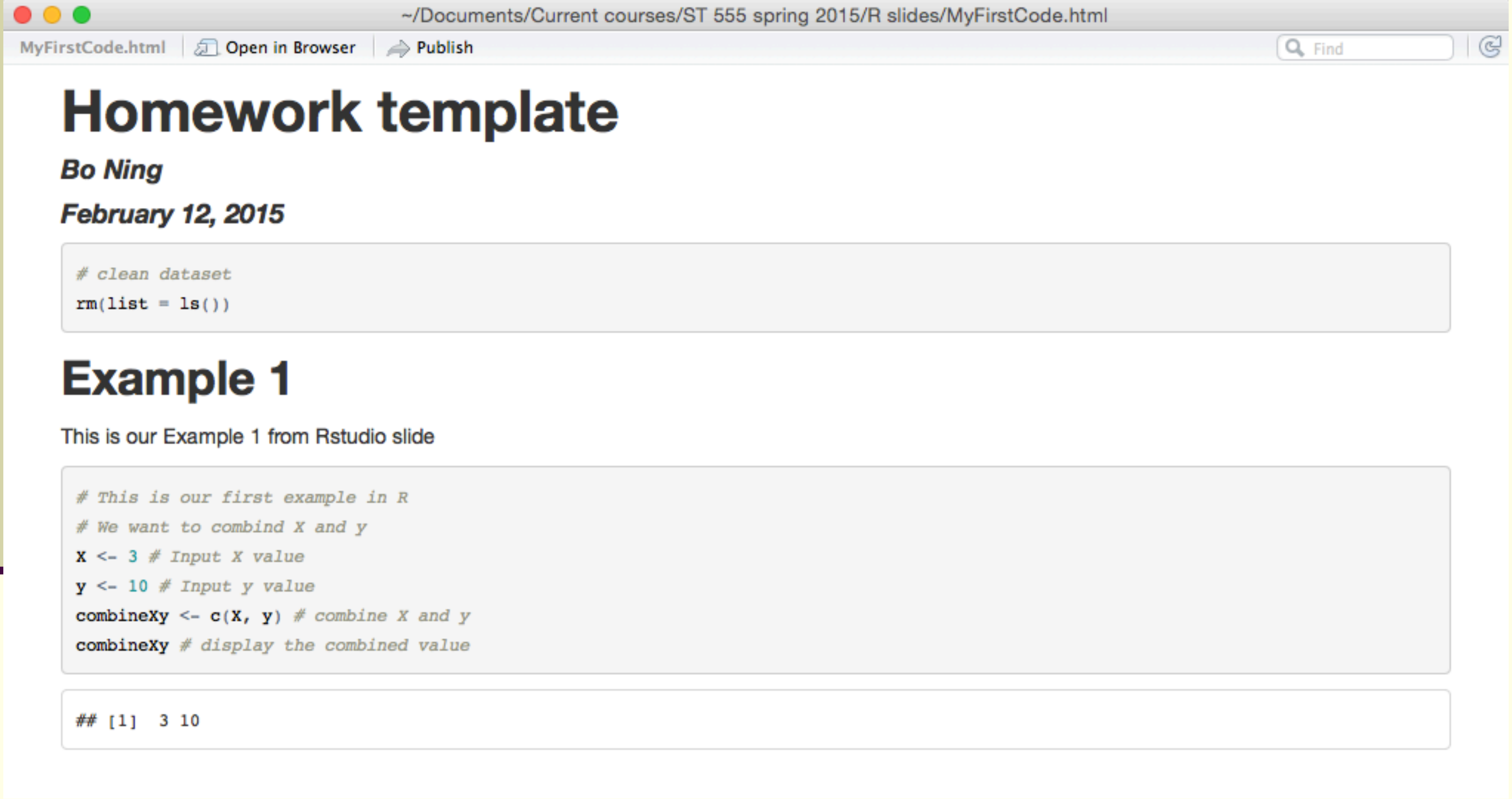
Type variables` name you want to print out in the output

Generate report

- To generate a report, in the editor window, find out  .

- There are three formats for reports.
- Knit HTML gives you a .html format report;
- Knit PDF, gives you a .pdf format report;
- Knit Word (.doc/.docx)
- Knit PDF may require you to install LaTeX, which you could download from the website: http://latex-project.org
- If you don`t wish to install LaTeX, Knit HTML and Knit Word are the options for you.

Generate report


~/Documents/Current courses/ST 555 spring 2015/R slides/MyFirstCode.html
MyFirstCode.html
Open in Browser
Publish
Find

Homework template

Bo Ning

February 12, 2015

```
# clean dataset
rm(list = ls())
```

Example 1

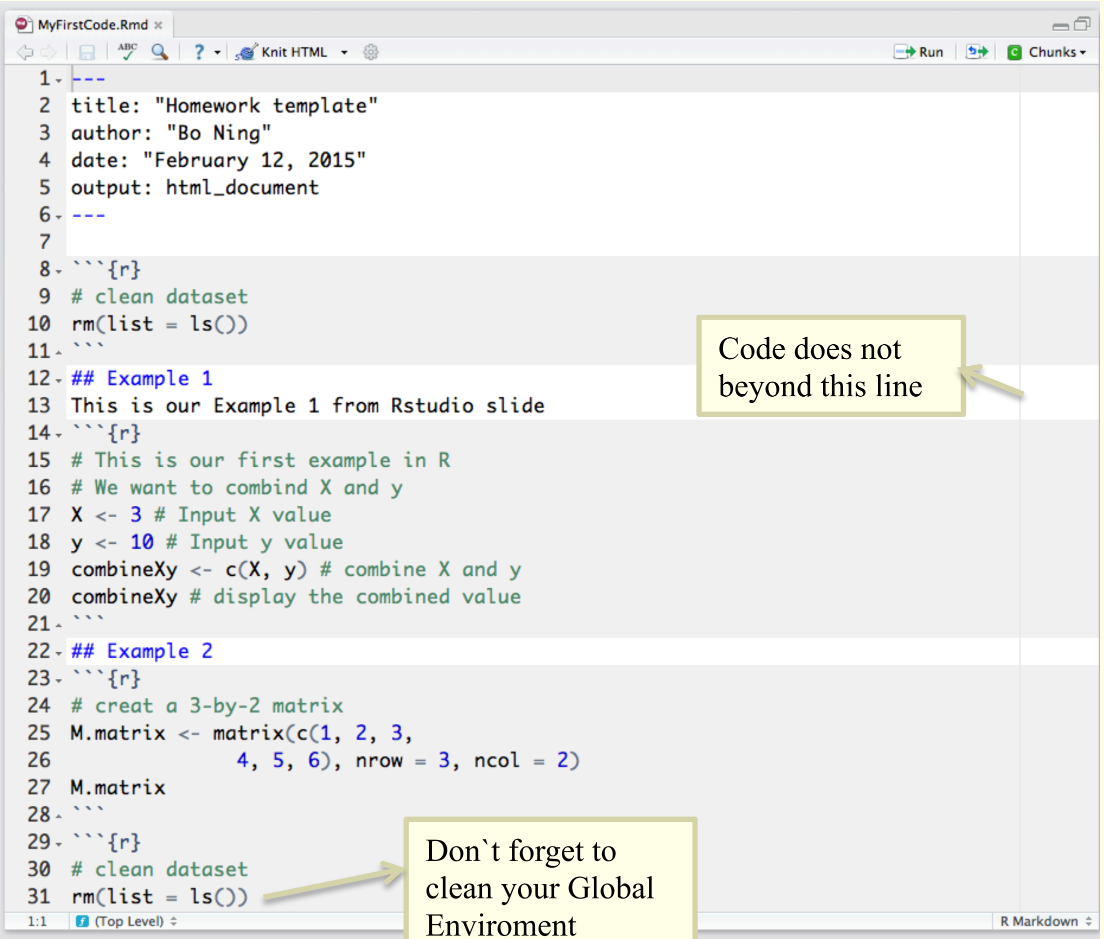
This is our Example 1 from Rstudio slide

```
# This is our first example in R
# We want to combind X and y
X <- 3 # Input X value
y <- 10 # Input y value
combineXy <- c(X, y) # combine X and y
combineXy # display the combined value
```

```
## [1]  3 10
```

Generate report

- Suppose our homework template has 2 examples, here is the final version of the code.



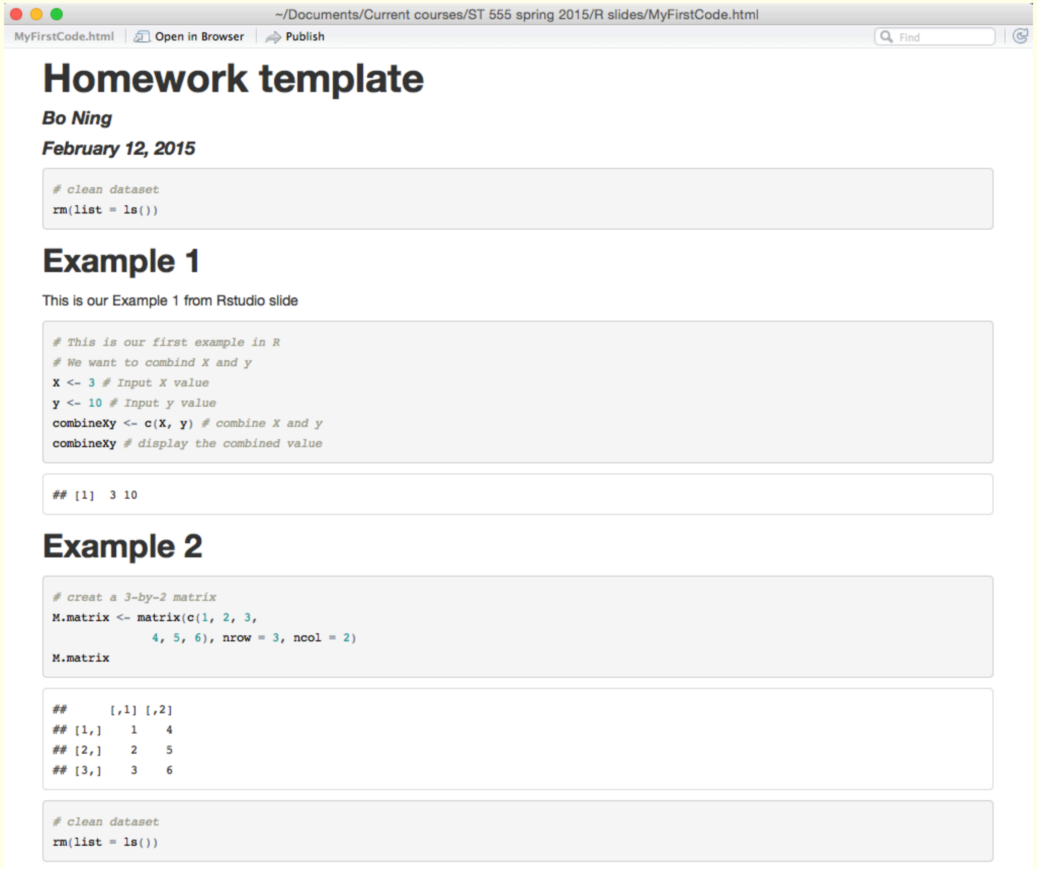
~~~
---
title: "Homework template"
author: "Bo Ning"
date: "February 12, 2015"
output: html_document
---

```{r}
# clean dataset
rm(list = ls())
~~~
Example 1
This is our Example 1 from Rstudio slide
```{r}
# This is our first example in R
# We want to combind X and y
X <- 3 # Input X value
y <- 10 # Input y value
combineXy <- c(X, y) # combine X and y
combineXy # display the combined value
```
Example 2
```{r}
# creat a 3-by-2 matrix
M.matrix <- matrix(c(1, 2, 3,
              4, 5, 6), nrow = 3, ncol = 2)
M.matrix
```
```{r}
# clean dataset
rm(list = ls())
```

Code does not beyond this line

Don`t forget to clean your Global Enviroment

Generate report

- Let`s Knit HTML again.


~/Documents/Current courses/ST 555 spring 2015/R slides/MyFirstCode.html
MyFirstCode.html
Open in Browser
Publish
Find

Homework template

Bo Ning

February 12, 2015

```
# clean dataset
rm(list = ls())
```

Example 1

This is our Example 1 from Rstudio slide

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# This is our first example in R
# We want to combind X and y
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```
## [1]  3 10
```

Example 2

```
# creat a 3-by-2 matrix
M.matrix <- matrix(c(1, 2, 3,
              4, 5, 6), nrow = 3, ncol = 2)
M.matrix
```

```
##      [,1] [,2]
## [1,]    1    4
## [2,]    2    5
## [3,]    3    6
```

```
# clean dataset
rm(list = ls())
```

R Markdown supplements

- An advantage for R Markdown is that it incorporates LaTeX.

- If you want to know more about how to incorporates LaTeX code in R Markdown, please google it, or go to Yihui Xie`s blog (http://yihui.name)

- For each homework, please submit a R Markdown file (.Rmd file) and the corresponding output file (.html file, .pdf file or a word file).