

Week 1: R Overview

POP88162 Introduction to Quantitative Research Methods

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Topics for Today

- History of R
- R operators and operations
- R objects and assignment
- Scripts and R Markdown

R Background



- *S* (for statistics) is a programming language for statistical analysis developed in 1976 in AT&T Bell Labs.
- Original *S* language and its extension *S-PLUS* were closed source.
- In 1991 **R**oss Ihaka and **R**obert Gentleman began developing *R*, an open-source alternative to *S*.

R Basics

- R is an *free* and *open-source* programming language
- With a focus on statistical analysis
- R is often used for interactive data analysis (one command at a time)
- But it also permits to execute entire scripts in *batch* mode
- Example R code:

```
1 2 + 3
```

```
[1] 5
```

Operators

Key **operators** in R are:

- Arithmetic (+, -, *, ^, /, %/%, %% , %*%)
- Boolean (&, &&, |, ||, !)
- Relational (==, !=, >, >=, <, <=)
- Assignment (<-, <<-, =)
- Membership (%in%)

Mathematical Operations

Arithmetic operations in R:

```
1 1 + 1
```

```
[1] 2
```

```
1 5 - 3
```

```
[1] 2
```

```
1 6 / 2
```

```
[1] 3
```

```
1 4 * 4
```

```
[1] 16
```

Scientific Notation

$$5^2 = 5 \times 5 = 25$$

```
1 5 ^ 2
```

```
[1] 25
```

$$5^{-2} = \frac{1}{5^2} = \frac{1}{5 \times 5} = \frac{1}{25} = 0.04$$

```
1 5 ^ -2
```

```
[1] 0.04
```

$$5 \times 10^{-2} = 5 \times \frac{1}{10^2} = 5 \times \frac{1}{100} = \frac{5}{100} = 0.05$$

```
1 5 * 10 ^ -2
```

```
[1] 0.05
```

$$5 \times 10^{-3} = \frac{5}{1000} = 0.005$$

```
1 5 * 10 ^ -3
```

```
[1] 0.005
```

$$5 \times 10^{-4} = \frac{5}{10000} = 0.0005$$

```
1 5 * 10 ^ -4
```

```
[1] 5e-04
```

Logical Operations

```
1 3 != 1 # Not equal
```

[1] TRUE

```
1 3 > 3 # Greater than
```

[1] FALSE

```
1 # True if either first OR second operand is True, False otherwise
2 FALSE | TRUE
```

[1] TRUE

```
1 # R also treats F and T as Boolean, but
2 # it is not recommended due to poor legibility
3 F | T
```

[1] TRUE

```
1 # True if both first AND second operand are True, False otherwise
2 FALSE & TRUE
```

[1] FALSE

```
1 # Combining 3 Boolean expressions
2 3 > 3 | 3 >= 3
```

[1] TRUE

R Objects

Everything that exists in R is an object.

John Chambers

- Fundamentally, everything you are dealing with in R is an **object**.
- That includes individual variables, datasets, functions and many other classes of objects.
- The key reference to an object is its **name**.
- Typically, the reference is established through assignment operation.

Assignment Operations

- `<-` is the standard assignment operator in R.
- While `=` is also supported it is not recommended.

```
1 x <- 3
```

```
1 x
```

```
[1] 3
```

```
1 census <- read.csv("../data/census.csv")
```



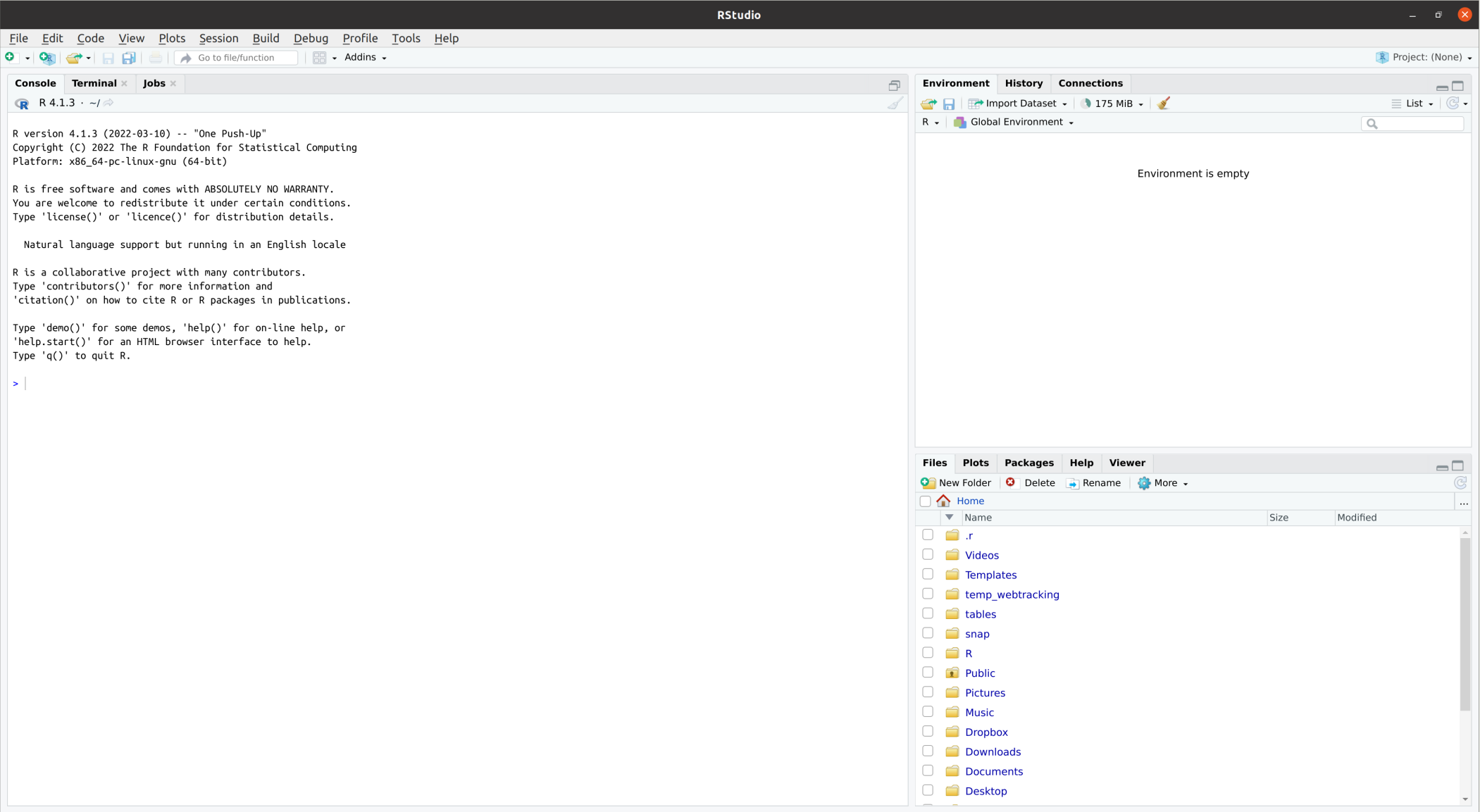
Extra

R Documentation on Assignment

R and Development Environments

- There is some choice of integrated development environments (IDEs) for R (StatET, ESS, R Commander).
- However, over the last decade RStudio became the de factor standard IDE for working in R.
- You can also find R extensions for your favourite text editor (Sublime Text, Visual Studio Code, Vim).

RStudio



R Script

- Usually you want to have a record of what analysis was done and how you did it.
- So, instead of writing all your R commands in the interactive console,
- You can create an R script, write them there and run them together or one at a time.
- R script is a file with `.R` extension and contains a collection of valid R commands.

R Markdown

- Markdown:
 - Easy-to-read and easy-to-write plain text format;
 - Separates content from its appearance (rendition);
 - Widely used across industry sectors and academic fields;
 - `.md` file extension.
- RMarkdown:
 - Allows combining of R commands with regular text;
 - Compiles into PDF/DOC/HTML and other formats;
 - Can be converted into slide deck or even website!
 - `.Rmd` file extension
- All R assignments must be submitted in PDF/DOC files compiled from R Markdown!

 Extra

Ch 27: R Markdown in Wickham & Grolemund 2017

Markdown Formatting Basics

- Use `_` or `*` for emphasis (single - italic, double - bold, triple - bold and italic)
 - `*one*` becomes *one*, `__two__` - **two** and `***three***` - ***three***
- Headers or decreasing levels follow `#`, `##`, `###`, `####` and so on
- (Unordered) Lists follow marker `-`, `+` or `*`
 - Start at the left-most position for top-level
 - Indent four space and use another marker for nesting like here
- (Numbered) Lists use `1.` (counter is auto-incremented)
- Links have syntax of `[some text here](url_here)`
- Images similarly: `![alt text](url or path to image)`

R Markdown Example

R Markdown

```
### Title
```

Some text in *italic* and **bold**

Simple list:

- A
- B

Ordered list:

1. A
1. B

Example, where $Y_i = 5 + X_i + \epsilon$

```
```{r}
x_i <- 3
epsilon <- rnorm(1)
y_i <- 5 + x_i + epsilon
`
```

## Rendering

### Title

Some text in *italic* and **bold**

Simple list:

- A
- B

Ordered list:

1. A
2. B

Example, where  $Y_i = 5 + X_i + \epsilon$

```
1 x_i <- 3
2 epsilon <- rnorm(1)
3 y_i <- 5 + x_i + epsilon
4 y_i
```

```
[1] 6.775524
```



# Next

- Tutorial:
  - Getting started with R
- Next week:
  - Data Structures