Intro to R

Winter 2019

Intro to R

- R is a language and environment that allows:
  - Data management
  - Graphs and tables
  - Statistical analyses
  - You will need: some basic statistics
    - We will discuss these
- R is open source and runs on Windows, Mac, Linux systems

R Environment

- R is an integrated software suite that includes:
  - Effective data handling
  - A suite of operators for array/matrix calculations
  - Intermediate tools for data analysis
  - Graphical facilities
  - Simple and effective programming language which includes conditionals, loops, functions, I/O

R

- Goals for this section of the course include:
  - Becoming familiar with Statistical Packages
  - Creating new Datasets
  - Importing & exporting Datasets
  - Manipulating data in a Dataset
  - Basic analysis of data (mainly descriptive statistics with some inferential statistics)
  - An overview of R's advanced features

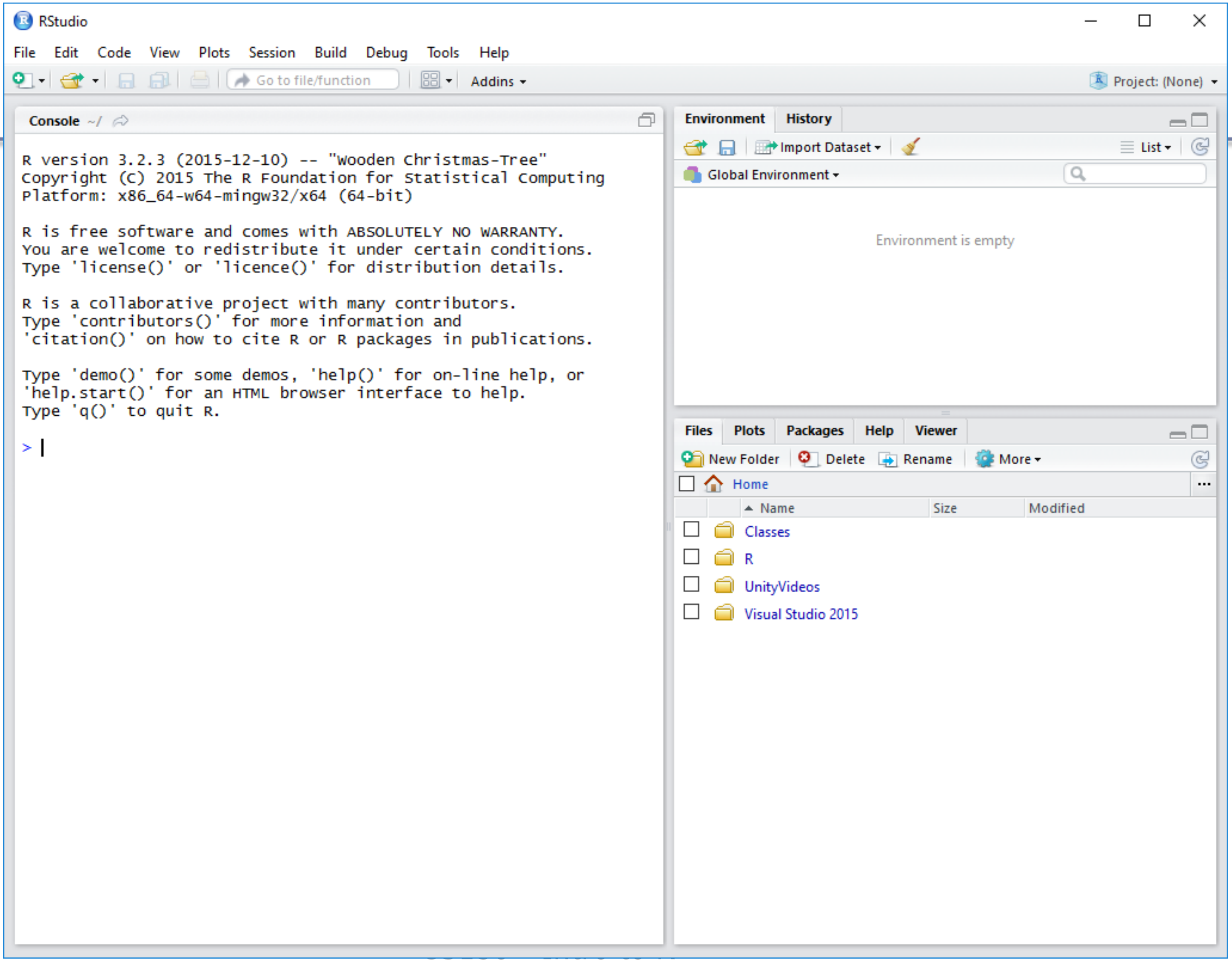
Note: This is not a statistics course such as Math 207. We will only concentrate on basic statistical concepts.

R Resources

- Web site resources:
  - R console application only
    - https://cran.r-project.org/
  - Rstudio IDE
    - https://www.rstudio.com/products/rstudio/download/
    - https://cran.rstudio.com/
  - R documentation
    - http://www.tutorialspoint.com/r/index.htm
    - http://www.cyclismo.org/tutorial/R/index.html

https://cran.r-project.org/doc/contrib/Torfs+Brauer-Short-R-Intro.pdf

Open RStudio



```
R version 3.2.3 (2015-12-10) -- "Wooden Christmas-Tree"
Copyright (C) 2015 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (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.

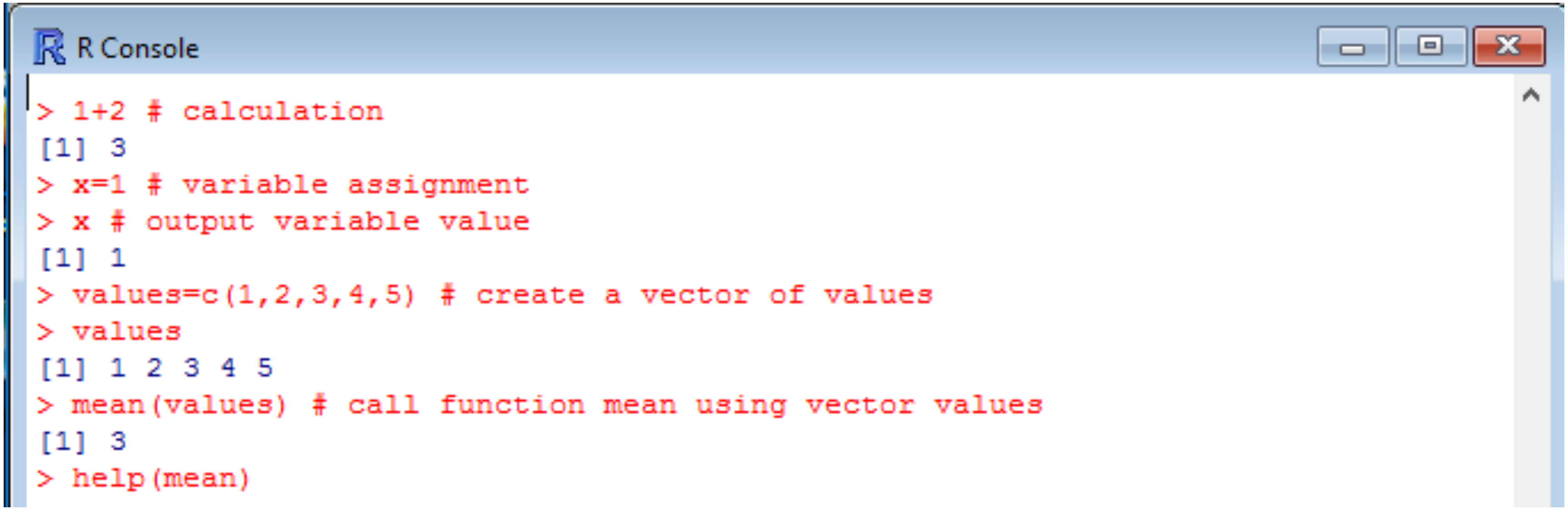
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

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.

> |
```

R Session

- Start an RStudio session
- We will use the console window of RStudio



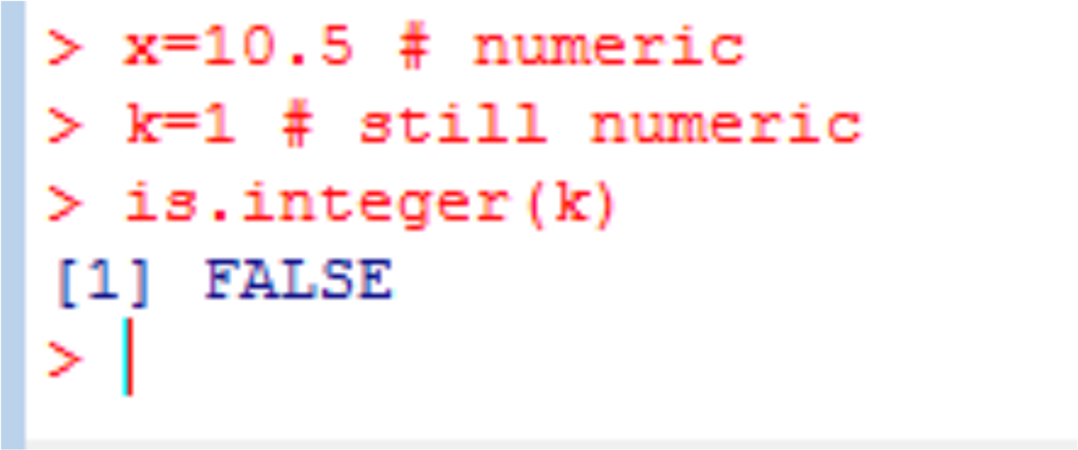
```
> 1+2 # calculation
[1] 3
> x=1 # variable assignment
> x # output variable value
[1] 1
> values=c(1,2,3,4,5) # create a vector of values
> values
[1] 1 2 3 4 5
> mean(values) # call function mean using vector values
[1] 3
> help(mean)
```

Basic Datatypes

- There are four basic datatypes in R:
  - **Numeric:** numbers with decimal points
  - **Logical:** binary – true or false
  - **Character:** any text
  - **Integer:** whole numbers only

Basic Datatypes
Numeric

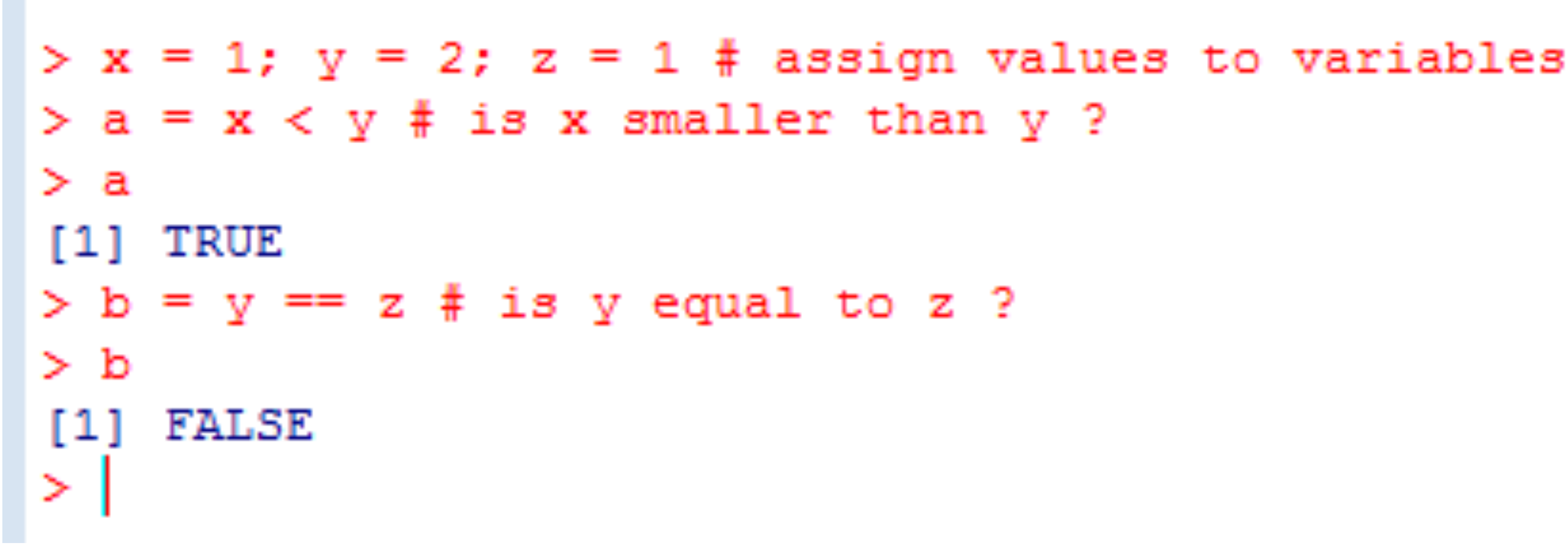
- Numeric – the default datatype for numbers
  - Contains a decimal point



```
> x=10.5 # numeric
> k=1 # still numeric
> is.integer(k)
[1] FALSE
> 
```

Basic Datatypes
Logical

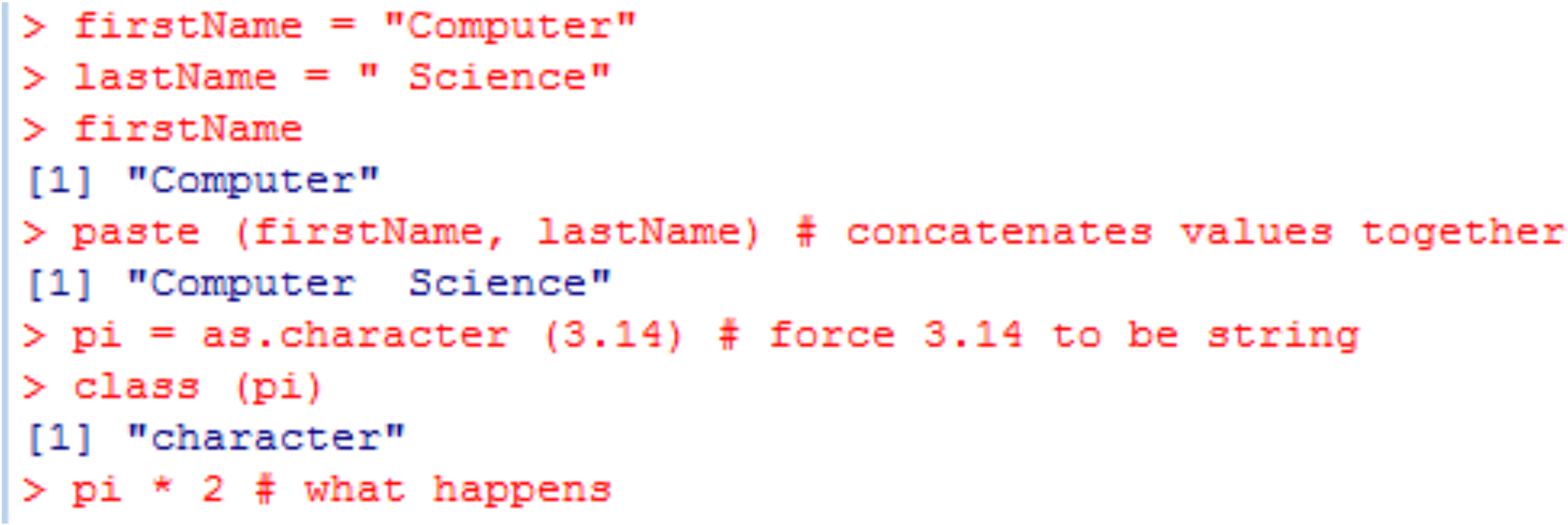
- Logical – is either TRUE or FALSE



```
> x = 1; y = 2; z = 1 # assign values to variables
> a = x < y # is x smaller than y ?
> a
[1] TRUE
> b = y == z # is y equal to z ?
> b
[1] FALSE
> 
```

Basic Datatypes
Character

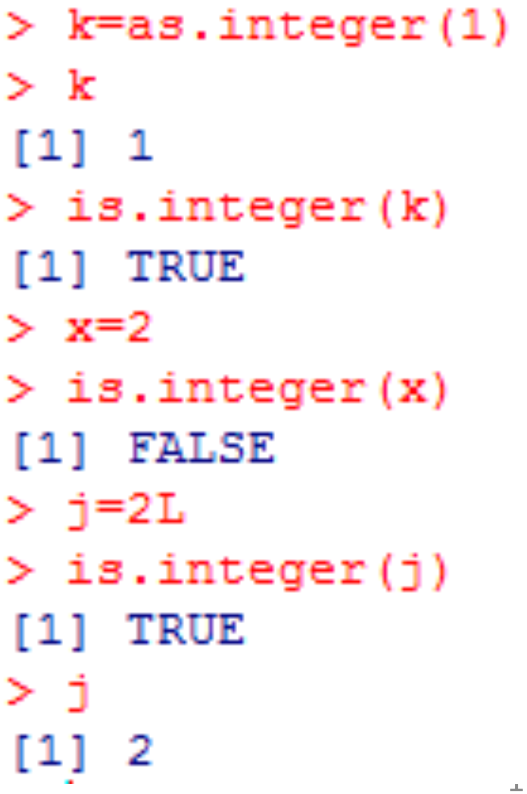
- Character – is used to represent **text** values



```
> firstName = "Computer"
> lastName = " Science"
> firstName
[1] "Computer"
> paste (firstName, lastName) # concatenates values together
[1] "Computer  Science"
> pi = as.character (3.14) # force 3.14 to be string
> class (pi)
[1] "character"
> pi * 2 # what happens
```

Basic Datatypes
Integer

- Integer – created using as.integer () function or suffix L as in 2L
  - No decimal point
  - Only use integer in interface with another software package or to save space (memory)



```
> k=as.integer(1)
> k
[1] 1
> is.integer(k)
[1] TRUE
> x=2
> is.integer(x)
[1] FALSE
> j=2L
> is.integer(j)
[1] TRUE
> j
[1] 2
```

Data Structures

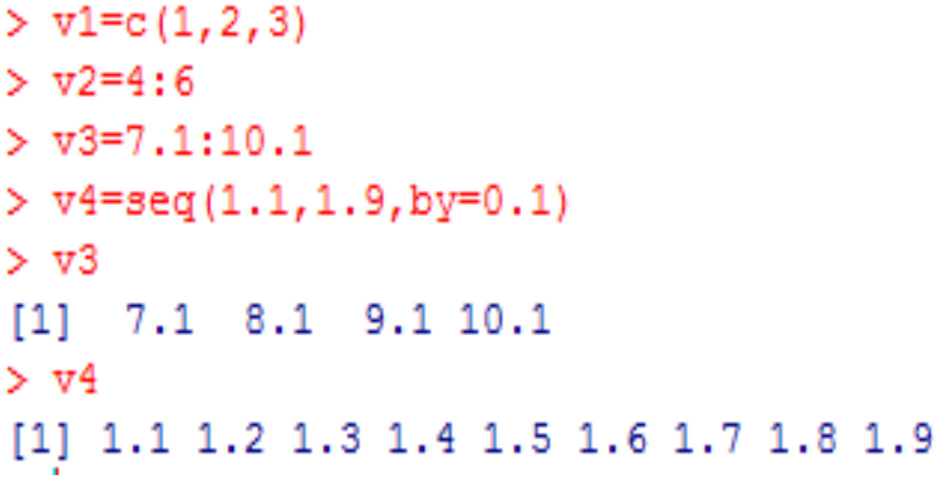
http://adv-r.had.co.nz/Data-structures.html

- Combine multiple pieces of data into one variable
- Atomic Vector – often just called *vector*
  - Sequence of data of the same type (1, 2, 3, 9)
- Generic Vector/Lists
  - Sequence of data of many types (100, 200, “oak”)
- Matrix
  - Grid of data of the same type $\begin{bmatrix} 1 & 9 \\ 2 & 3 \end{bmatrix}$
- Data Frame
  - Grid of data of many types

$$\begin{bmatrix} 100 & 200 & "oak" \\ 32 & 40 & "maple" \end{bmatrix}$$

Vector

- A sequence of data of the same type
- Six types of atomic vectors
  1. Logical
  2. Integer
  3. Double (Numeric
  4. Character
  5. Complex
  6. Raw



```
> v1=c(1,2,3)
> v2=4:6
> v3=7.1:10.1
> v4=seq(1.1,1.9,by=0.1)
> v3
[1]  7.1  8.1  9.1 10.1
> v4
[1] 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9
```

- For now we will concern ourselves with 1-4.

Measures of Central Tendency

- Used to describe the center of a distribution
- Define each of the following:
  - Mean
  - Median
  - Mode

Problems

- 1) Create a vector of ages in a variable called age with the following integer values: 18, 19, 18, 21, 22, 23, 19, 18

- 2) Compute the mean and median of the age values

- 3) Compute the mean of the first 1000 natural numbers

Problem

- Given the following dataset, find the mean, median, and mode of the Age variable using R

Breed	Age	Weight
Collie	2	23.2
Collie	3	35.7
Setter	5	45.4
Shepard	1	65.9
Setter	2	72.2

An R Solution

- First of all, what do we expect the answers to be?

- Let’s use R to check expected results:

1. Create a vector **age** with the Age values
2. Call function mean
3. Call function median
4. Call function mode

Did we get our expected results?

Data Frame

- A data frame is a two-dimensional (2D) structure where
  - column data refers to a variable
  - row data refers to an observation or a case
- Column names are to be unique non-empty.
- Row names are optional but should be unique.
- Allowable types of variable info: numeric, factor or character type.

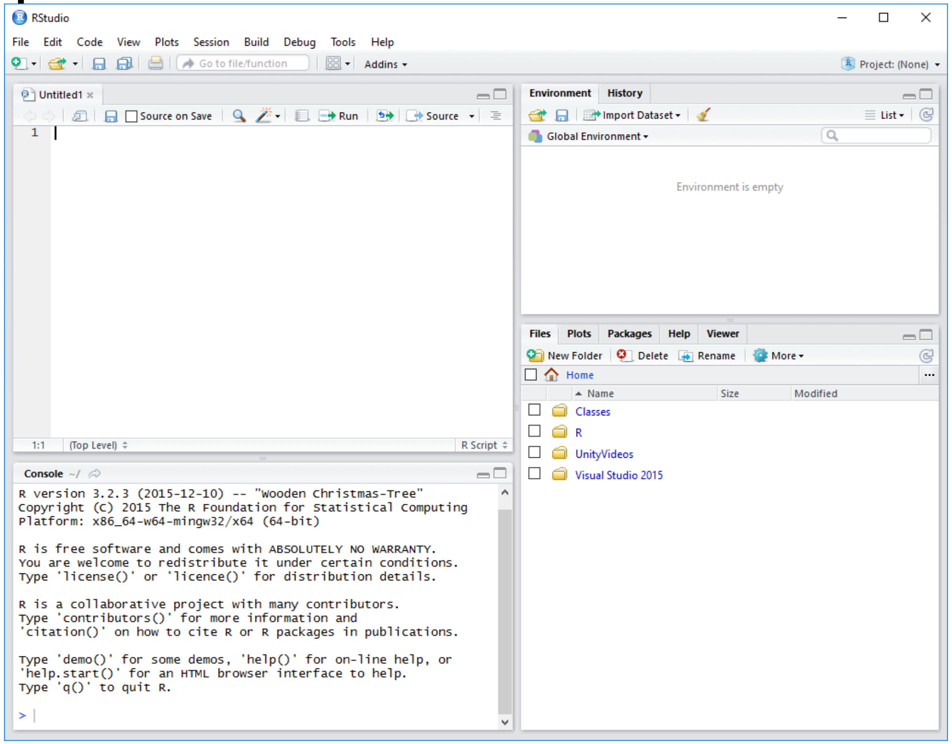
Dog Data Frame Example

- What type is Breed?
  Age?
  Weight?

Breed	**Age**	**Weight**
Collie	2	23.2
Collie	3	35.7
Setter	5	45.4
Shepard	1	65.9
Setter	2	72.2

Dog Data Frame

- We are going to start creating scripts in Rstudio
- File->New File->R Script



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'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>
```

Dog Data Frame

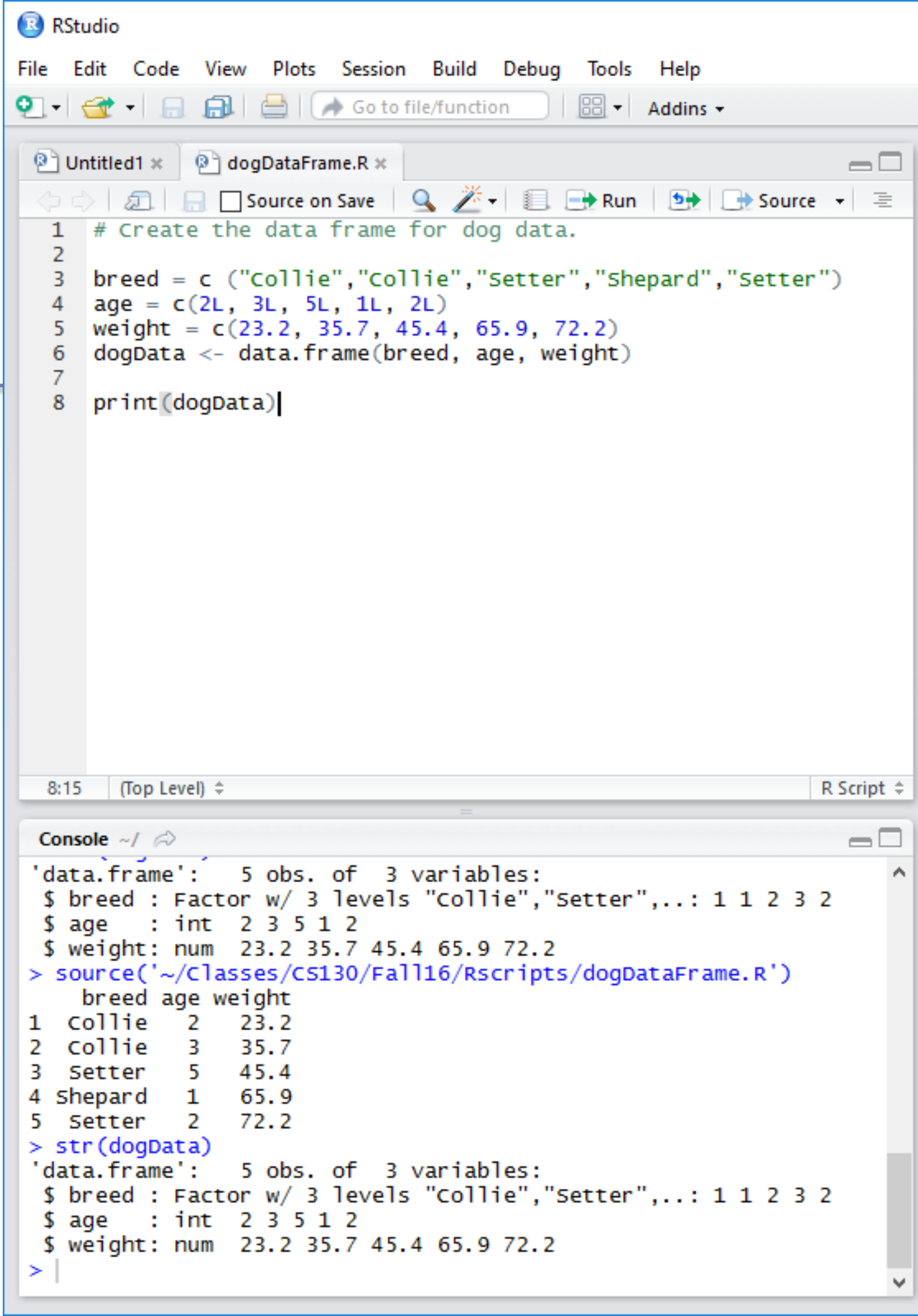
- In the Untitled script window, type the following R script

```
# Create the data frame for dog data.

breed = c("Collie","Collie","Setter","Shepard","Setter")
age = c(2L, 3L, 5L, 1L, 2L)
weight = c(23.2, 35.7, 45.4, 65.9, 72.2)
dogData <- data.frame(breed, age, weight)

print(dogData)
```

Execute the script



```
# Create the data frame for dog data.

breed = c ("Collie","Collie","Setter","Shepard","Setter")
age = c(2L, 3L, 5L, 1L, 2L)
weight = c(23.2, 35.7, 45.4, 65.9, 72.2)
dogData <- data.frame(breed, age, weight)

print(dogData)
```

```
'data.frame':   5 obs. of  3 variables:
 $ breed : Factor w/ 3 levels "Collie","Setter",..: 1 1 2 3 2
 $ age   : int  2 3 5 1 2
 $ weight: num  23.2 35.7 45.4 65.9 72.2
> source('~/Classes/CS130/Fall16/Rscripts/dogDataFrame.R')
    breed age weight
1  Collie   2   23.2
2  Collie   3   35.7
3  Setter   5   45.4
4 Shepard   1   65.9
5  Setter   2   72.2
> str(dogData)
'data.frame':   5 obs. of  3 variables:
 $ breed : Factor w/ 3 levels "Collie","Setter",..: 1 1 2 3 2
 $ age   : int  2 3 5 1 2
 $ weight: num  23.2 35.7 45.4 65.9 72.2
> 
```

Problems

- Find the mean and median of the age and weight variables. Use the console window to do this.

  Hint: Variables of a Data Frame can be specified as dataframe$variable (e.g. dogData$age)

Variables in R

- Let’s define the following terms
- Variable
  - Categorical (or Qualitative) Variable
    - Nominal
    - Ordinal
  - Quantitative Variables
    - Numeric
      - Discrete
      - Continuous

Qualitative vs. Quantitative

- Qualitative: classify individuals into categories
- Quantitative: tell how much or how many of something there is

- Which are qualitative and which are quantitative?
  - Person’s Age
  - Person’s Gender
  - Mileage (in miles per gallon) of a car
  - Color of a car

Qualitative: Ordinal vs. Nominal

- Ordinal variables:
  - One whose categories have a natural ordering
  - Example: grades

- Nominal variables:
  - One whose categories have no natural ordering
  - Example: state of residence

Factor

- Factors are used to represent categorical data.
- Can be:
  - Ordered – use ordered()
  - Unordered – use factor()

- Factors are stored as integers, and have labels associated with these unique integers

- Once created, factors can only contain a pre-defined set of values, known as levels. By default, R sorts levels in alphabetical order

Create Ordinal Values

http://www.statmethods.net/input/valuelabels.html

```
classRank=c(1, 1, 2, 1, 3)

classRankOrdinal = ordered(classRank,
levels=c(1,2,3,4),
labels=c(“Fr”, “So”, “Jr”, “Sr”) )

print(classRankOrdinal)

barplot(summary(classRankOrdinal))
```

Why do we want ordinal values?

```
classRankNotOrdinal=(“Fr”, “Fr”, “So”, “Fr”, “Jr”)

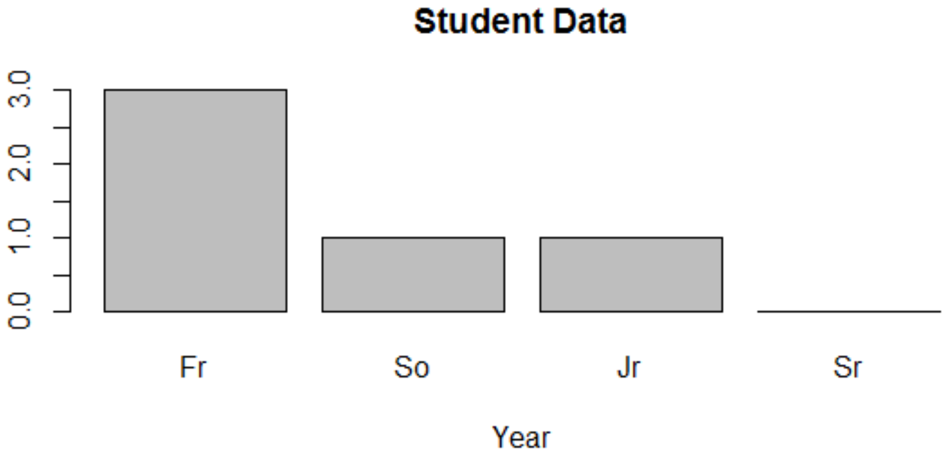
barplot(table(classRankNotOrdinal))
```

Bar Chart

http://statmethods.net/graphs/bar.html

- A **bar chart** or **bar graph** is a chart that presents grouped data with rectangular bars with lengths proportional to the values that they represent.
- function table returns a vector of frequency data

```
> barplot(table(classRankOrdinal ),
main = “Student Data",
xlab = “Year")
```



Quantitative

- Discrete variables: Variables whose possible values can be listed
  - Example: number of children

- Continuous variables: Variables that can take any value in an interval
  - Example: height of a person

Problem

- Using the command str(dogData), identify:
    - variable name
    - quantitative or qualitative
    - discrete, continuous, neither
    - nominal, ordinal, neither
- A specific variable can be selected and passed to the class function. Pass the variable age of dogData to class. What does the result tell us?

Importing Data into R

- getwd()
- data = read.table(“filename.txt”, header=FALSE)

- Copy testData.txt from CS130 Public to the location provided by getwd()
- Open testData.txt in a text editor

- testData =read.table(“testData.txt”, header=TRUE)
- print(testData)
- str(testData)

Candy Dataset Example

http://zeus.cs.pacificu.edu/chadd/cs130w17/candy.txt
This file contains a header

Brand	Name	ServingPerPkg	OzPerPkg	Calories	TotalFatInGrams	SatFatInGrams
M&M/Mars	Snickers Peanut Butter	1.0	2.00	310	20.0	7.0
Hershey	Cookies 'n Mint	1.0	1.55	230	12.0	6.0
Hershey	Cadbury Dairy Milk	3.5	5.00	220	12.0	8.0
M&M/Mars	Snickers	3.0	3.70	170	8.0	3.0
Charms	Sugar Daddy	1.0	1.70	200	2.5	2.5

Write dataframe to file

```
write.table( dataframe, “file.txt”)
getwd()

write.table(candy, “candy.txt”)
```

Go to Documents and open candy.txt in a text editor

Problem

- Identify each of the following for Total Fat in Grams:
  - Minimum:
  - Maximum:
  - Mean:
  - Standard Deviation:

Use the help feature!