An introduc

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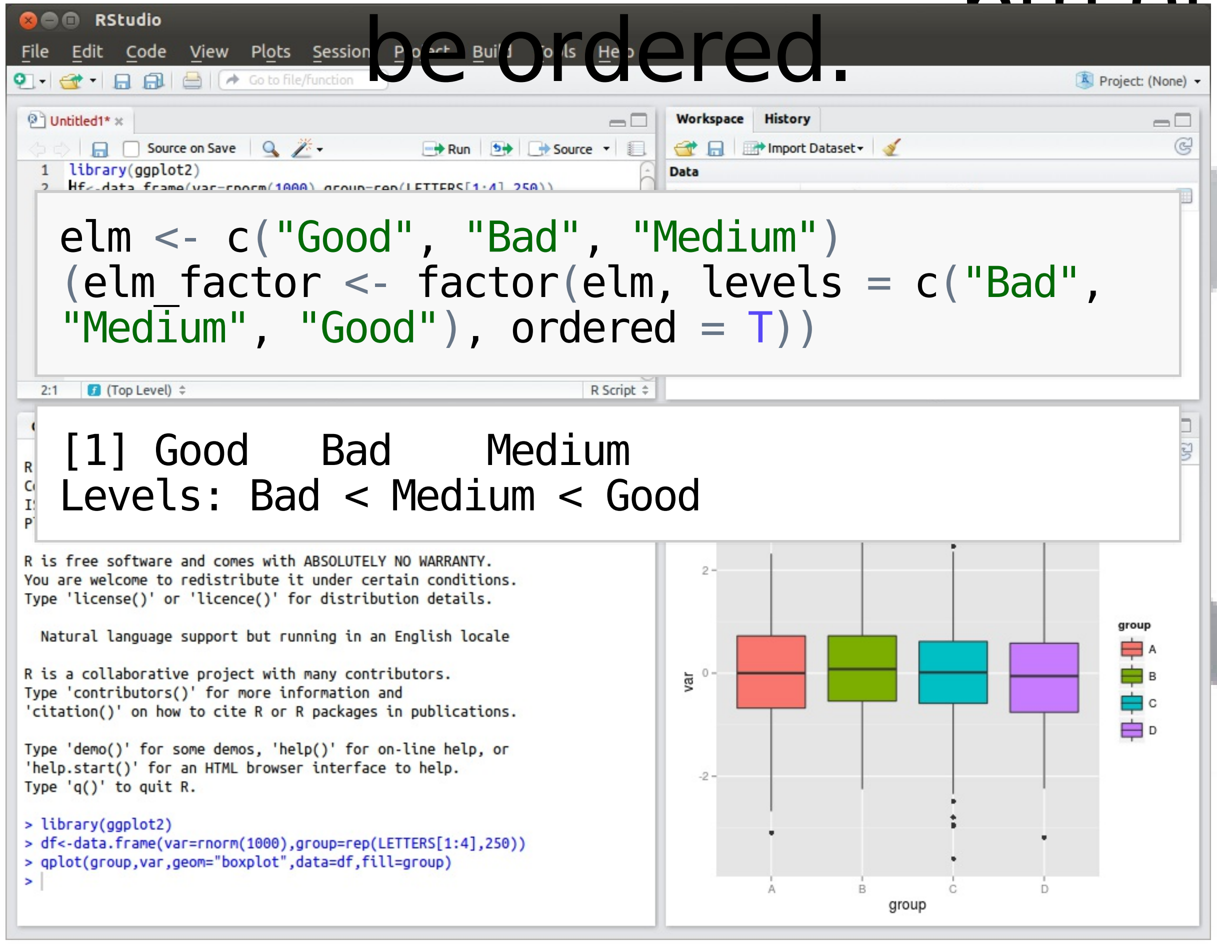
6th of July

Rstudio is just a software to run R!

A factor is just a way of saying that a variable has unique values! And they can be ordered.

This has consequences

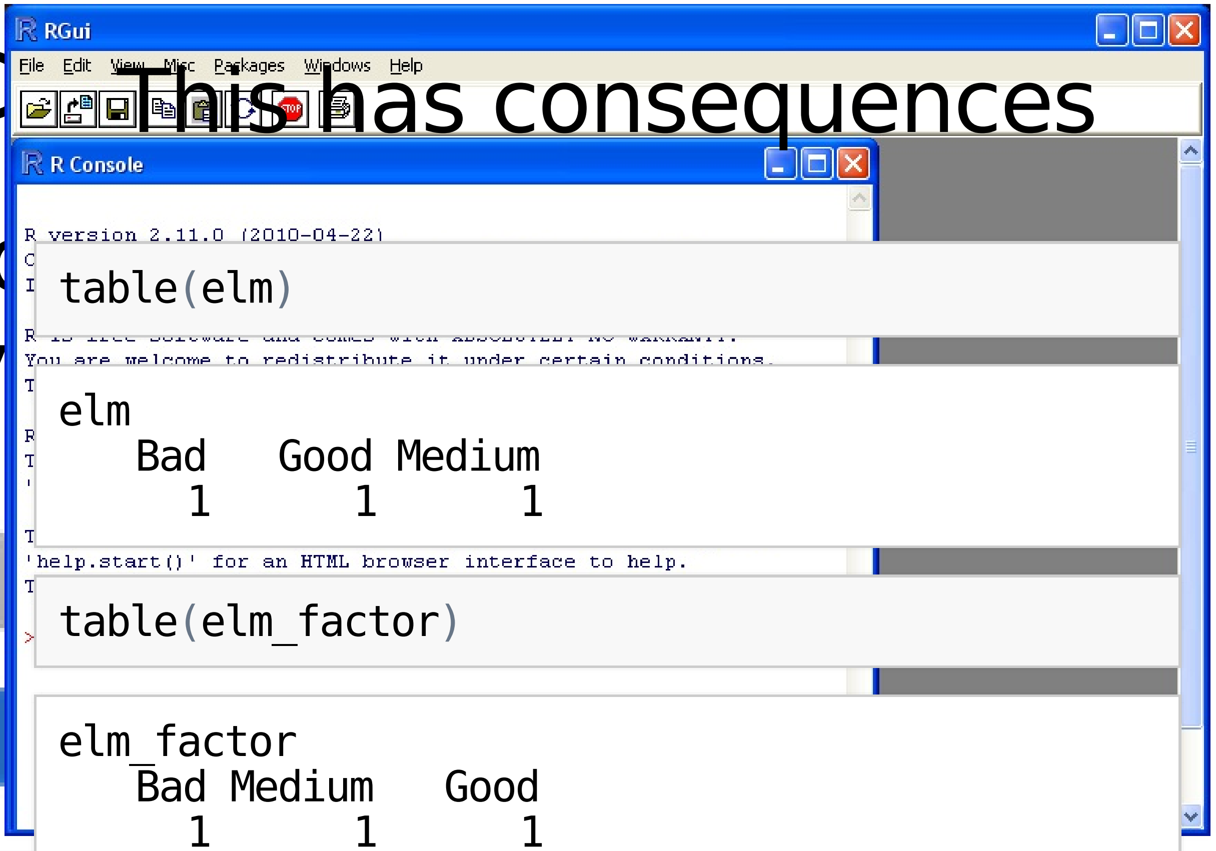


```
library(ggplot2)
df<-data.frame(var=rnorm(1000),group=rep(LETTERS[1:4],250))
```

```
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.

> library(ggplot2)
> df<-data.frame(var=rnorm(1000),group=rep(LETTERS[1:4],250))
> qplot(group,var,geom="boxplot",data=df,fill=group)
> |
```

```
elm <- c("Good", "Bad", "Medium")
(elm_factor <- factor(elm, levels = c("Bad",
"Medium", "Good"), ordered = T))
```

```
[1] Good   Bad    Medium
Levels: Bad < Medium < Good
```



```
R version 2.11.0 (2010-04-22)
You are welcome to redistribute it under certain conditions.
'help.start()' for an HTML browser interface to help.
```

```
table(elm)
```

```
elm
   Bad   Good Medium
     1      1      1
```

```
table(elm_factor)
```

```
elm_factor
   Bad Medium   Good
     1      1      1
```

How to install R?

Luckily, you guys have R and Rstudio installed, so you don't have to worry about this!

But if you want to install it at home, please follow **this guide**

That guide can help you install

- R
- Rstudio
- And `swirl`, a package in which you could do a bunch of exercises as homework!

What is R?

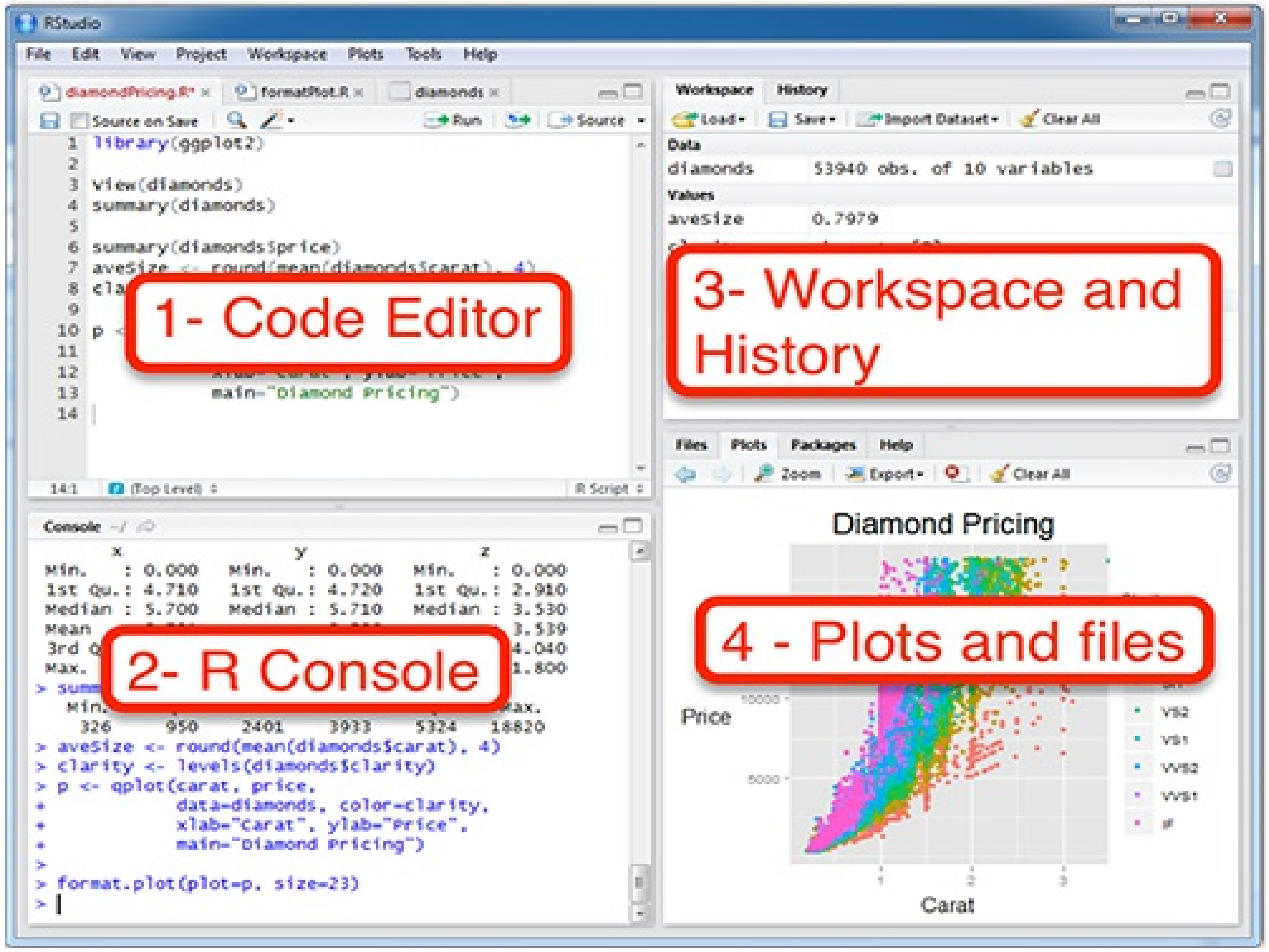
R is a programming language designed to do data analysis, usually interactive.

R is helpful for..

- Getting that darn excel/stata file into R (importing)
- Turning that very ugly dataset into something to work with (data cleaning)
- Automating your weekly reports (automating tasks)
- Analyzing data (modeling)
- Creating nicely formatted documents (communicating results)
- Building your own commands to do specific things (functions)
- Building very creative graphics
- Among many things…

And so.. what is Rstudio?

And so.. what is Rstudio?



1- Code Editor

```
library(ggplot2)

view(diamonds)
summary(diamonds)

summary(diamonds$price)
aveSize <- round(mean(diamonds$carat), 4)
cla

p <

             main="Diamond Pricing")
```

2- R Console

```
         x                 y                 z
 Min.   : 0.000   Min.   : 0.000   Min.   : 0.000
 1st Qu.: 4.710   1st Qu.: 4.720   1st Qu.: 2.910
 Median : 5.700   Median : 5.710   Median : 3.530
 Mean                                          3.539
 3rd Q                                         4.040
 Max.                                          1.800
> summ
   Min.                                     Max.
    326      950     2401     3933     5324    18820
> aveSize <- round(mean(diamonds$carat), 4)
> clarity <- levels(diamonds$clarity)
> p <- qplot(carat, price,
+            data=diamonds, color=clarity,
+            xlab="Carat", ylab="Price",
+            main="Diamond Pricing")
>
> format.plot(plot=p, size=23)
> |
```

3- Workspace and History

```
Data
diamonds       53940 obs. of 10 variables
Values
aveSize        0.7979
```

4 - Plots and files

Let's get to it then!

R is an interactive language. That means that if you type a number, you will get a number.

```
#Input
10
```

```
[1] 10
```

```
#Input
5
```

```
[1] 5
```

R is also a calculator

Try typing these operations in R:

- `5 + 5`
- `10 - 5`
- `10 * 5`
- `20 / 10`
- `(10 * 20) - 5 / 2 + 2`
- `2 ^ 3`

Before we continue, what type of operations are these?

Answers in next slide!

Introduction to R objects

- Addition
- Subtraction
- Multiplication
- Division
- A combination of all
- Exponentiation

Numbers in R are called `numerics`.

For example:

```
is.numeric(10)
is.numeric(10 + 20)
is.numeric(10 / 2)
```

Introduction to R objects

Having single numbers, like 10, is not very useful.

We want something similar to a column of a dataset, like age or income.

We can do that with `c()`, which stands for `concatenate`.

```r
c(32, 34, 18, 22, 65)
```

```
[1] 32 34 18 22 65
```

Read this expression as: concatenate these numbers into a single object.

Introduction to R objects

We can also give it a name, like age.

```
age <- c(32, 34, 18, 22, 65)
```

- Why didn't the result get printed?
- Where is this age object at?
- What is formally the age object?

Introduction to R objects

We just created our first variable! The typical SAS/Excel/Stata column.

In R, these objects are called '**vectors**'.

Vectors can have several flavours:

- Numerics (we just saw one)
- Logicals
- Characters
- Factors

Introduction to R objects

Suppose these ages belong to certain people. We can create a character vector with their names.

Following this guideline, create it yourself.

- Create a character vector with `c()`
- Include the names Paul, Maria, Andres, Roberto and Alicia inside
- wrap every name in quotes like this “Paul”, “Maria”, etc… This will make R understand that input as characters.

Introduction to R objects

Answer:

```r
c("Paul", "Maria", "Andres", "Robert", "Alicia")
```

```
[1] "Paul"   "Maria"  "Andres" "Robert" "Alicia"
```

We can also give it a name, like participants.

```r
participants <- c("Paul", "Maria", "Andres", "Robert", "Alicia")
```

Introduction to R objects

Character vectors are filled by strings, like “Paul” or “Maria”.

Can we do operations with strings?

```r
"Paul" + "Maria"
```

```
Error in "Paul" + "Maria": non-numeric argument to binary operator
```

Makes sense.. we can't add any letters.

Alright, we're set. Concatenate the numeric vector age and `participants`.

Introduction to R objects

```
c(age, participants)
```

```
 [1] "32"     "34"     "18"     "22"     "65"     "Paul"   "Maria" 
 [8] "Andres" "Robert" "Alicia"
```

- What's the problem with this result?

This breaks an R law!

We joined a `numeric` vector and a `character` vector.

Vectors can *ONLY* be of one class.

```r
c(1, "one") # forces to character vector
```

```
[1] "1"   "one"
```

```r
c(1, "1") # note that the first one is a numeric, while the second is a character
```

```
[1] "1" "1"
```

Now, which of these people has an age above `20`?

```r
age > 20
```

```
[1]  TRUE  TRUE FALSE  TRUE  TRUE
```

- That's a logical vector.

Contrary to `character` and `numeric` vectors, `logical` vectors can only have three values:

- TRUE
- FALSE
- NA (which stands for “Not available”.)

Introduction to R objects

`logicals` can be created manually or with a `logical` statement.

```r
c(TRUE, FALSE, TRUE, TRUE)
```

```
[1]  TRUE FALSE  TRUE  TRUE
```

```r
age < 60
```

```
[1]  TRUE  TRUE  TRUE  TRUE FALSE
```

The above expression tests for the logical statement.

For example,

```
   32    34    18    22    65
 TRUE  TRUE  TRUE  TRUE FALSE
```

Introduction to R objects

You can also write T or F as short abbreviations of TRUE and FALSE.

```
c(T, T, F, T) == c(TRUE, TRUE, FALSE, TRUE)
```

```
[1] TRUE TRUE TRUE TRUE
```

Which is comparing:

```
 TRUE  TRUE FALSE  TRUE
  "T"   "T"   "F"   "T"
```

But behind the scenes, TRUE and T are just a 1 and F and FALSE are just a `0`.

What is the result of this?

```
T + 5
TRUE - 5
FALSE + TRUE
T + T - FALSE
```

Now that you know that.. what would be the class of the following vectors?

```
c(5, TRUE)
c(5, "FALSE")
c(FALSE, TRUE)
c(1, FALSE)
```

- numeric: TRUE is coerced to 1
- character: “FALSE” is a string, can't be turned to a number
- logical: both elements are logical!
- numeric: FALSE is coerced to 0

What do we know so far?

- Numeric vectors
- Character vectors
- Logical vectors
- How to assign a name to these vectors
- Vectors can contain only *one* class of data

What's missing?

Factors

Introduction to R objects

Factors are R's way of storing **categorical variables**.

Categories such as:

- 'Male' and 'Female' or 'Married' and 'Divorced'
- 'Good', 'Middle' and 'High'

```r
gender <- c("Male", "Female", "Male", "Male", "Female")
# Can be turned into
gender <- factor(gender)
```

Introduction to R objects

Introduction to R objects

Factors are useful for some specific operations like:

- Changing order of levels for terms in modelling
- Changing order of axis labels in plots
- Among other things..

In many cases you can use characters to do what you would want with factors!

Introduction to R objects

Now, have you noticed that we've been assigning names to things?

```
age
```

```
[1] 32 34 18 22 65
```

The name age holds all these elements inside. How do we know where all the variables we've created are?

Let's ask R what objects can be listed from our workspace or environment.

```
ls()
```

```
[1] "age"          "elm"          "elm_factor"   "gender"
[5] "lgl"          "participants"
```

Introduction to R objects

So far, we have a bunch of variables scattered around our workspace. This is usually no the way to go!

We want to group similar things in the same place.

```
our_df <- data.frame(name = participants, age = age, gender = gender, age_60 = lgl)
our_df
```

```
    name age gender age_60
1   Paul  32   Male   TRUE
2  Maria  34 Female   TRUE
3 Andres  18   Male   TRUE
4 Robert  22   Male   TRUE
5 Alicia  65 Female  FALSE
```

A data frame is usually the primary structure of analysis in R

It's important that you understand the thing that defines a data frame.

- A data frame has *rows* and *columns*, more technically called *dimensions*.
- Data frames have two dimensions.

```
dim(our_df)
```

```
[1] 5 4
```

```
nrow(our_df)
```

```
[1] 5
```

```
ncol(our_df)
```

```
[1] 4
```

Introduction to R objects

Data frames are very distinctive because they can hold any type of vector.

Matrices cannot!

```
our_matrix <- matrix(1:20, ncol = 4, nrow = 5)
our_matrix
```

```
     [,1] [,2] [,3] [,4]
[1,]    1    6   11   16
[2,]    2    7   12   17
[3,]    3    8   13   18
[4,]    4    9   14   19
[5,]    5   10   15   20
```

- Matrices are very similar to data frames.
- They have same number of dimensions.
- You can choose rows/columns in similar ways.

Introduction to R objects

Finally, we're missing the secret ingridient the differentiates both matrices and data frames.

Lists

Introduction to R objects

Think of lists as a bag that can store anything.

```r
our_list <- list(names = participants, gender = gender, age = age)
our_list
```

```
$names
[1] "Paul"   "Maria"  "Andres" "Robert" "Alicia"

$gender
[1] Male   Female Male   Male   Female
Levels: Female Male

$age
[1] 32 34 18 22 65
```

This is a bag that has 3 objects.

- A charachter
- A factor
- A numeric

Introduction to R objects

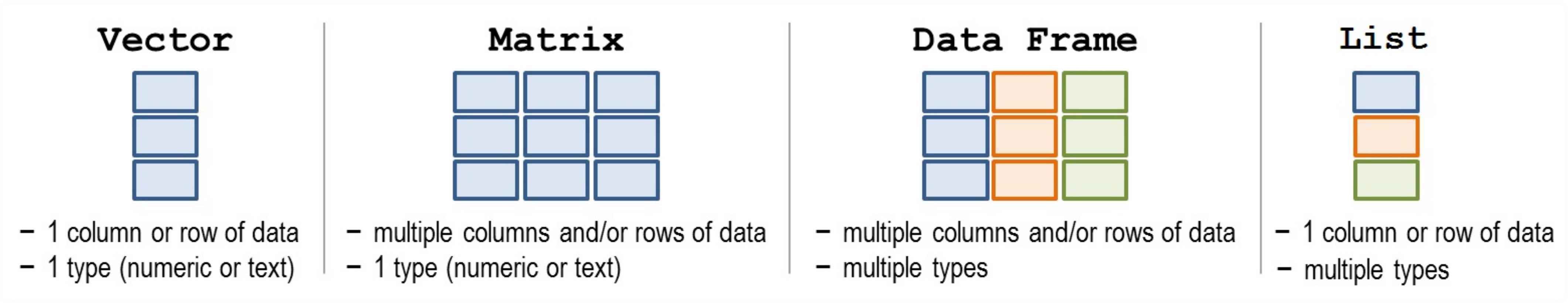
Think outside the box… when I say anything, I mean ANYTHING!

```r
complex_list <- list(df = our_df[1:3, ], matrix = our_df[1:3, ], avg_age = mean(age))
complex_list
```

```
$df
    name age gender age_60
1   Paul  32   Male   TRUE
2  Maria  34 Female   TRUE
3 Andres  18   Male   TRUE

$matrix
    name age gender age_60
1   Paul  32   Male   TRUE
2  Maria  34 Female   TRUE
3 Andres  18   Male   TRUE

$avg_age
[1] 34.2
```

Introduction to R objects

To sum up, these are the 4 types of data structures available in R.



Vector

- 1 column or row of data
- 1 type (numeric or text)

Matrix

- multiple columns and/or rows of data
- 1 type (numeric or text)

Data Frame

- multiple columns and/or rows of data
- multiple types

List

- 1 column or row of data
- multiple types

Introduction to R objects

Now I'm gonna rock your world...

A data frame is a list (because it can have any class) with a row and column dimensions.

```
data.frame(our_list)
```

```
   names gender age
1   Paul   Male  32
2  Maria Female  34
3 Andres   Male  18
4 Robert   Male  22
5 Alicia Female  65
```

To be continued….