An introduction to

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

This has consequences

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

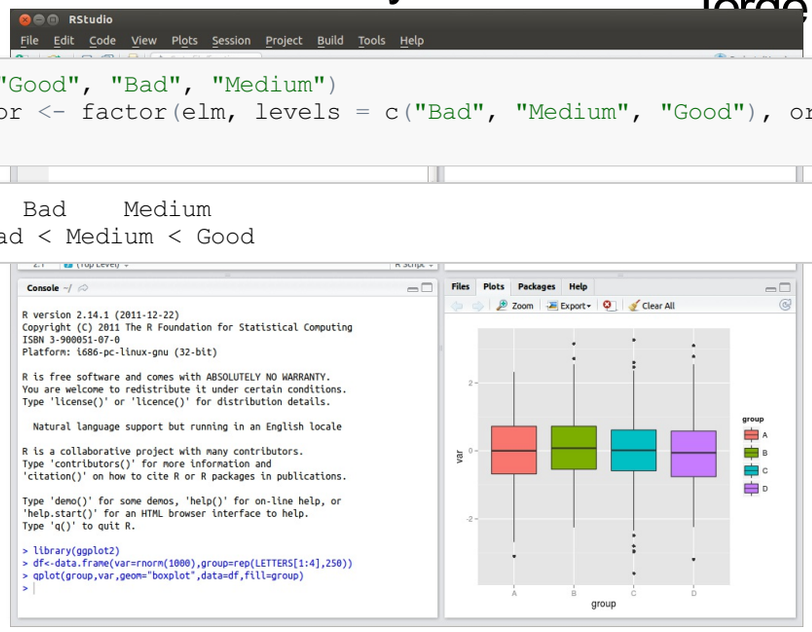
```
[1] Good   Bad    Medium
Levels: Bad < Medium < Good
```

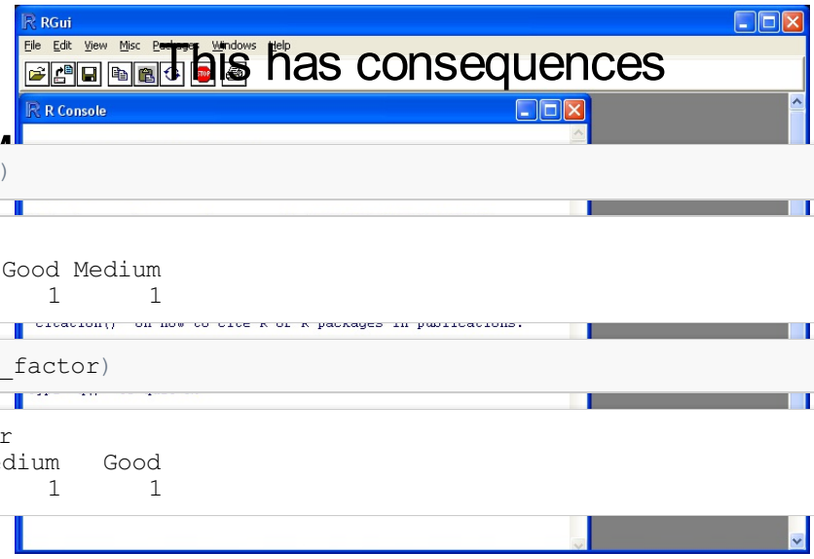
```
table(elm)
```

```
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?

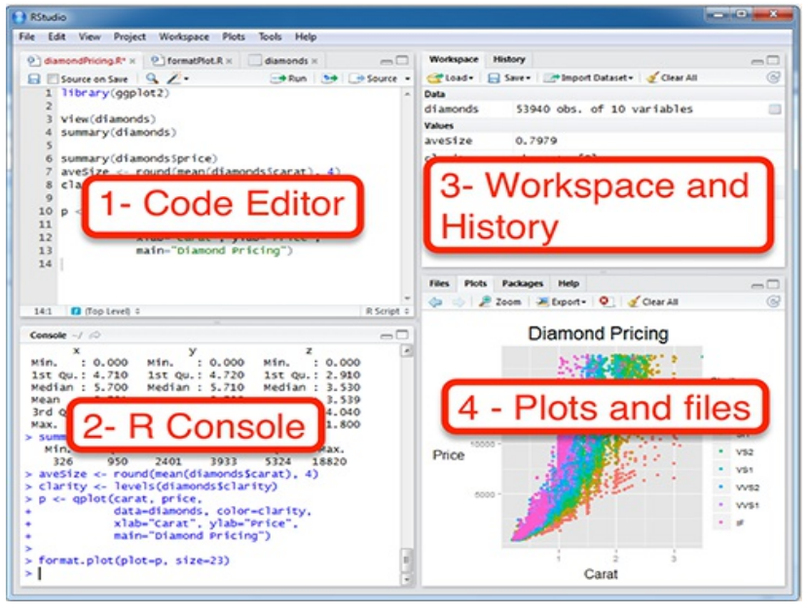
R is a programming language designed to do data analysis, usually interactive.

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?



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)
```

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`.

```
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?

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

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.

Answer:

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

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

We can also give it a name, like participants.

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

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

Can we do operations with strings?

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

```
Error in "Paul" + "Maria": argumento no-numérico para operador binario
```

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"  "Andres"
 [9] "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.

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

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

```
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`?

```
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”.)

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

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

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

```
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
```

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

We used some logical evaluations on those previous slides (*Is age greater than 20?*). But what is the list of operators available?

Logical evaluations (generally) work like arithmetic ones, that is, the evaluation is executed element-wise:

```
age > 0 # Is each value greater than zero?
age == 22   # Are corresponding values equivalent?
age != 22   # Are corresponding values not equivalent?
```

However, other logical evaluations take the whole object as the element to evaluate:

```
"z" %in% letters # Is "z" present in the list letters?
```

```
[1] TRUE
```

Introduction to R objects

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

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

Categories such as:

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

```
gender <- c("Male", "Female", "Male", "Male", "Female")

# Can be turned into

gender <- factor(gender)
```

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!

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"       "lgl"
[6] "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
```

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.

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

Lists

Introduction to R objects

Think of lists as a bag that can store anything.

```
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!

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

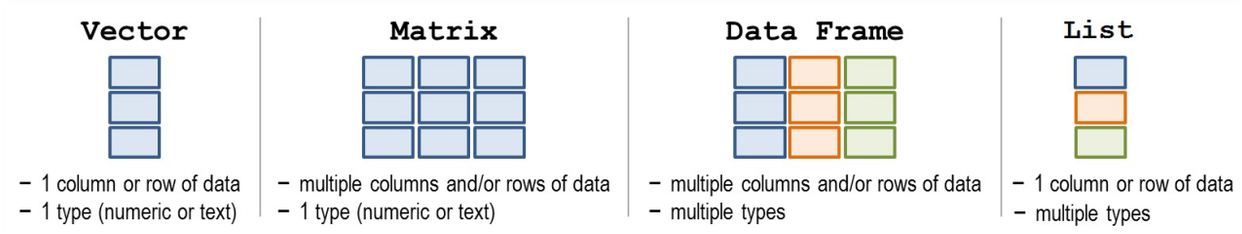
```
$df
    name age gender age_60
1   Paul  32   Male   TRUE
2  Maria  34 Female   TRUE
3 Andres  18   Male   TRUE

$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.



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….