Objects in R

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Objects in R

Learning Objectives

1. Define what an object is
2. Discuss why objects are important in R
3. Give examples of objects in R
4. Create objects in R
5. Define what a function is.
6. Identify the argument names and argument values of a function
7. Recognize the use of positional function arguments
8. Recognize the use of unlimited function arguments

Why are objects important?

- Everything in R is an object
- We need a way to *store* data in R so that we can *access* and *manipulate* the data for our needs.

3 problems to address:

Storage: how do we store data in a format that R recognizes

Access: how do we refer to and manage our data in a sensible manner

Manipulation: how to select and change slices of our data

- Storage problem is addressed partially and access problem is addressed fully in this section.
- Manipulation problem is addressed in the `Data Types and Data Structures` and `Data Management` section.

Names, values, and objects

value: something that can be manipulated by R. Most likely, numbers or text.

name: a reference to a value or object.

object: a value that is referenced by a name

- Objects address the **storage** problem*
- Names address the **access** problem
- Objects hold values (numbers, text)

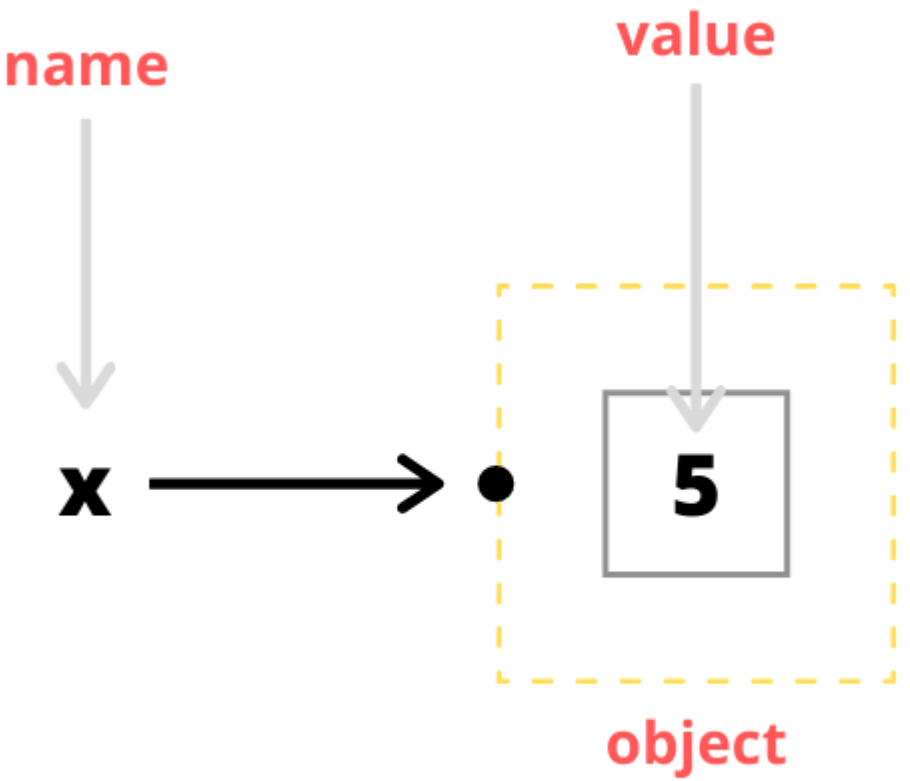
Object Analogy

Bank account: object

Money inside the bank account: value

Name + Account number: name

Object diagram



Assignment operator

- Now, how do we do associate an **object** with a **name**?
- We use the **assignment operator** ← (less than sign followed by hyphen) or = to "bind" an object to a name.
- *Binding links an object to a name*

Code Example

- In words: create an object of the value `3` and bind that object to the name `three`.

```
three ← 3
greeting ← "Hello world!"
# notice how we can use the name to reference the object
three
#> [1] 3
greeting
#> [1] "Hello world!"
```

Real world example

- Suppose we want to determine how much our business pays in corporate taxes.

```
corporate_tax_rate ← 8.8
gross_income ← 5000000

# 5,000,000 * (8.8 / 100) = 5,000,000 * 0.088
gross_income * (corporate_tax_rate / 100)
#> [1] 440000
```

- If there are many different tax rates and financial quantities, how to manage?
- Objects and names help us manage and organize our data

Bad Names

- There are some rules for creating names in R.
- Names can consist of letters, numbers, ., or _, but can't begin with _ or a digit.
- Also you can't use any reserved words in R (`if`, `function`, `FALSE`, `else`). See `?Reserved` or `help("Reserved")` for complete list of reserved words

```
_xyz ← 1
#> Error: <text>:1:1: unexpected input
#> 1: _
#>    ^
```

```
11_xyz ← 2
#> Error: <text>:1:3: unexpected input
#> 1: 11_
#>      ^
```

```
else ← 3
#> Error: <text>:1:1: unexpected 'else'
#> 1: else
#>    ^
```

Multiple names, same object

> **Multiple names can reference the same object**
>
> *Joint bank accounts: (Anthony####), (Peter####)*

```
x ← 3
y ← 3
x
#> [1] 3
y
#> [1] 3
```

- Practically, there are not many reasons to do the above
- To avoid confusion, the same object should be referenced by 1 name

Single name, multiple objects

> **A unique name can reference only one object**
>
> *A name + account number cannot reference multiple bank accounts*

```
# first, x references 1
x ← 1
# now, x references 2
x ← 2
x
#> [1] 2
```

- Order of assignment matters - the most recent assignment is the current binding

Single name, multiple objects

- Practically, you do this when you care about the final object and not the intermediate object

```
# the following is fake-code

# read in some data

my_data ← read.csv(file = "my_data.csv")

# these three lines clean the raw data
# we want the data to be cleaned but not necessarily want
# to store the intermediate data in our environment

my_data ← rename_columns(my_data)
my_data ← create_new_column(my_data)
my_data ← convert_missing_values(my_data)

# only interested in storing the data after it has
# been cleaned up, so that I can use analyze or visualize it

my_data
```

Benefits of objects

- **Organization**: many values (data) to store and manage, we need systematic way to refer to data
- **Reusability**: Names allow us to reference and use objects in multiple locations
- **Readability**: Objects are associated with informative names

Functions

- Functions are objects that run some R code when we refer to them by their name
- Functions can be distinguished from other objects if we see a set of parentheses after the function name
- Functions can have arguments (inputs) in the form of `argument_name = argument_value`.
- Each argument is separated by commas

```
# argument names are not surrounded in "" or ''
# use an equal sign = to relate each argument name and value pair
make_salad(cucumber = 0.5,
           bell_pepper = 0.5,
           tomato = 1,
           onions = 0.2,
           spinach = 2)
```

Function example

```r
# vector: a sequence of values (values in an Excel column)

# 1. create an object, a vector of 5 numerical values
# 2. assign the name, numbers, to reference this object
numbers ← c(0, 1, 2, 3, 4)
numbers
#> [1] 0 1 2 3 4

mean(x = numbers)
#> [1] 2

# note that numbers is a reference to the vector c(2,2,2,2,2)
# so, we can use the actual vector itself in lieu of numbers
mean(x = c(0, 1, 2, 3, 4))
#> [1] 2
```

```r
print(x = "Hello World!")
#> [1] "Hello World!"
```

Common Functions

Function	Description
print()	Print output to the console
mean()	Compute the mean
sum()	Compute the sum
sd()	Compute the standard deviation
max()	Get the maximum value
min()	Get the minimum value
unique()	Get the unique values

Parts of a function

- There are three parts to a function: name, arguments, and body
- The **name** of the function is how you can refer to the function for usage
- The **arguments** are the inputs to the function that can change its behavior
- The **body** of the function contains R code that is executed when you use your function

Creating a function

- Let's create a function named greeting that prints out a greeting given a name

```
# Notice the function reserved keyword
# The brackets {} enclose the body of the function
# We use the assignment operator to give a function its name
greeting ← function(name){
  print(paste("Hello", name))
}

greeting("Anthony")
#> [1] "Hello Anthony"
```

Returning values with a function

- In the body of our function, we can use the `return` function to "return" *something*
- This *something* is the **return value** of the function. Think of the **return value** as the output of the function
- We can save the return value of a function to a new object and use it in subsequent code

Example - returning values with a function

- Let's create a function named `lbs_to_kg` that converts units from pounds to kilograms

```
# Good practice to choose descriptive function names and arguments
# Notice how we can do assignment in a function
# and use the newly created object in subsequent lines
lbs_to_kg ← function(lbs){
  kg ← lbs / 2.205
  return(kg)
}

lbs_to_kg(6)
#> [1] 2.721088
```

Positional function arguments

- It's not always necessary to specify function arguments in the form of `argument_name = argument_value`
- R can infer the argument name based on the order you provide the arguments without specifying the argument name
- Often, this is done for brevity and out of habit
- This is something to look out for when reading documentation, examples, code "in the wild"

Positional function arguments

- Let's take a look at the built-in mean function `mean()`

```
# with argument name x
mean(x = c(0,1,2,3,4))
#> [1] 2

# without argument name x
mean(c(0,1,2,3,4))
#> [1] 2
```

Unlimited function arguments

- R also has an option to specify unlimited arguments with `...` (triple dots)
- This is useful for functions which intuitively work with unlimited arguments

```
# look at function definition
# sum( ... , na.rm = FALSE)

sum(1, 4, 5, 6, 7, 8, 4, 3, 2, 1, 2, 3, 4, 3, 2)
#> [1] 55
```

Checkpoint question 1

Consider the following R code. Which of the following is **not** a valid name?

```
first_name ← "Anthony"
2020_lab_date ← "2020-03-16"
corporate_tax.rate ← 8.8
its_FALSE ← "It's actually true"
```

A. first_name

B. 2020_lab_date

C. corporate_tax.rate

D. its_FALSE

Checkpoint question 2

Consider the following R code. What is `x + y`?

```
x ← 1
x ← x + 1
y ← 2
x + y
```

A. 1

B. 2

C. 3

D. 4

Checkpoint question 3

Consider the following R code. What is `x`?

```
x ← 2
y ← 3

x ← x + y
y ← 1

x
```

A. 1

B. 2

C. 3

D. 5

Checkpoint question 4

Which of the following options is **not** an argument name to the function `make_smoothie()`?

```
milk_type ← "almond"
make_smoothie(
  blueberry = 10,
  banana = 1/2,
  strawberry = 5,
  size = "Medium",
  milk = milk_type
)
```

A. milk

B. banana

C. size

D. milk_type