Data Objects in R

Spring 23

March 30 2023

Object Oriented Programming in R

- *R uses object-oriented programming (OOP) principles*
- *Functions in R are designed to work with specific object classes and types*
- *Example: plot() function behaves differently based on the input object*

plot() Function Examples

Scatterplot with plot():

```
plot(y ~ x, data = mydata)  # If x and y are numeric, creates a scatterplot
```

Diagnostic plots with plot():

```
my_lm <- lm(y ~ x, data = mydata)  # Create a linear model
plot(my_lm)  # Produces diagnostic plots for the linear model
```

- The plot() function adapts its behavior based on the input object's class and type
- This allows for efficient and intuitive coding in R

Data structures and types in R

- R objects are based on vectors
- Two functions to examine objects:
    - typeof(): Returns the storage mode (data type) of an object
    - class(): Provides further description of an object
- NULL: Represents an empty object (vector of length 0)

Examples of Data Types and Functions

Numeric and integer data types:

```
x <- c(8, 2, 1, 3)
typeof(x)  # "double" (numeric)
[1] "double"

x_int <- c(8L, 2L, 1L, 3L)
typeof(x_int)  # "integer"
[1] "integer"
```

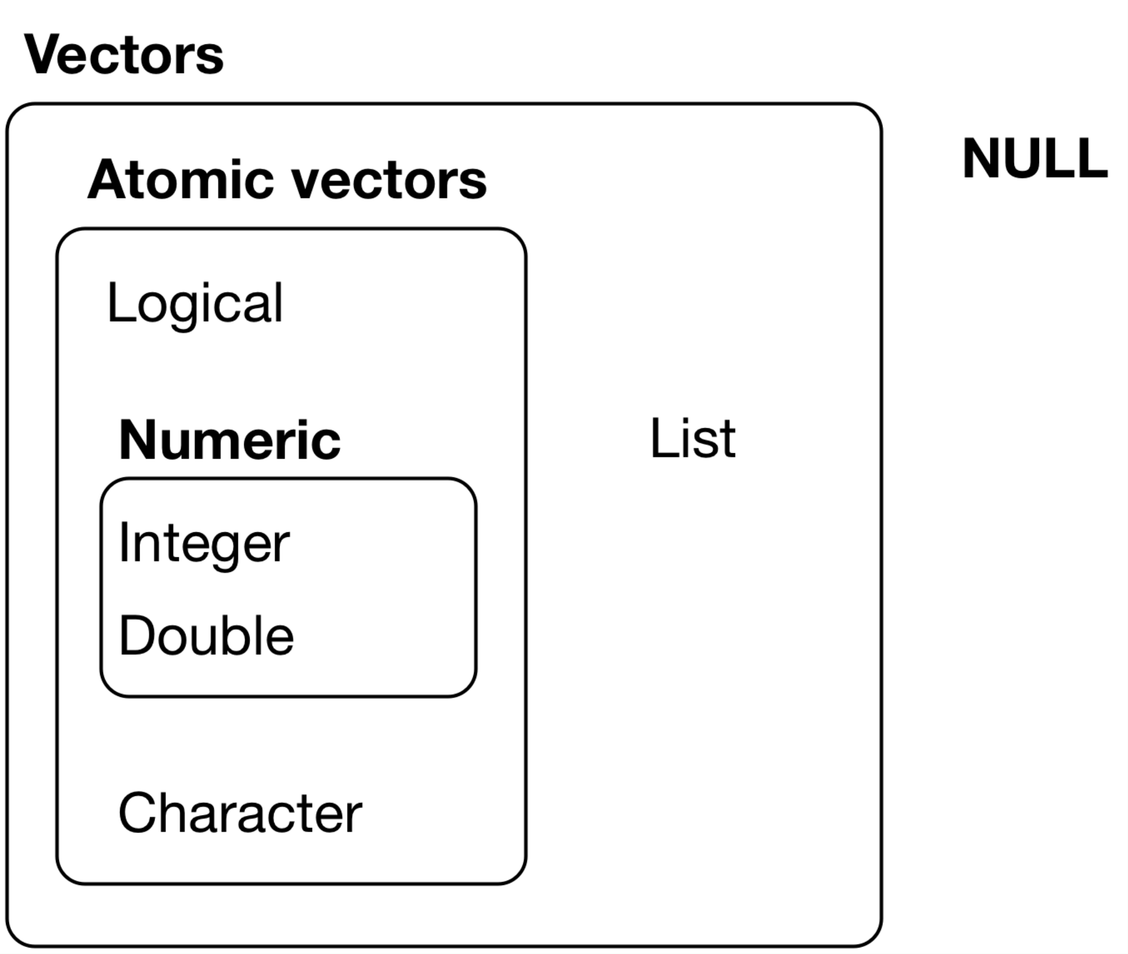
Logical data type and class:

```
x_is_one <- x == 1
typeof(x_is_one)  # "logical"
[1] "logical"

object_class <- class(x)
object_class  # "numeric"
[1] "numeric"
```

Atomic Vectors and lists

- R uses two types of vectors to store info
  - atomic vectors: all entries have the same data type
  - lists: entries can contain other objects that can differ in data type



Examples of Vector Types

Atomic vector (numeric):

```
atomic_vector <- c(1, 2, 3, 4)
class(atomic_vector)  # "numeric"
[1] "numeric"
```

List with multiple data types:

```
my_list <- list(name = "John", age = 30, salary = 50000)
class(my_list)  # "list"
[1] "list"
```

Atomic Vectors: Matrices

- You can add attributes, such as dimension, to vectors
- A matrix is a 2-dimensional vector containing entries of the same type

Creating a matrix with dimensions:

```
my_matrix <- matrix(1:9, nrow = 3, ncol = 3)
class(my_matrix)  # "matrix"
[1] "matrix" "array"
my_matrix
     [,1] [,2] [,3]
[1,]    1    4    7
[2,]    2    5    8
[3,]    3    6    9
typeof(my_matrix)
[1] "integer"
```

Adding dimensions to a vector:

```
my_vector <- c(1, 2, 3, 4, 5, 6)
dim(my_vector) <- c(2, 3)
my_vector
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
class(my_vector)
[1] "matrix" "array"
typeof(my_vector)
[1] "double"
```

Creating Matrices Using Vector Binding

- Bind vectors of the same length to create columns or rows
- Use `cbind()` for column binding and `rbind()` for row binding

Column binding with `cbind()`:

```
x <- c(1, 2, 3, 4)
x_col <- cbind(x = x, y = 2 * x)
x_col
     x y
[1,] 1 2
[2,] 2 4
[3,] 3 6
[4,] 4 8
```

Row binding with `rbind()`:

```
x_row <- rbind(x1 = x, x2 = x * 2)
x_row
   [,1] [,2] [,3] [,4]
x1    1    2    3    4
x2    2    4    6    8
```

Implicit and Explicit Coercion in R

Implicit Coercion

- R defaults to the most complex data type if more than one type is given

```
y <- c(1, 2, "a", NULL, TRUE)
typeof(y)
[1] "character"
class(y)
[1] "character"
y
[1] "1"    "2"    "a"    "TRUE"
```

Explicit coercion

Intentionally force a different data type from the "default" type

```
y <- as.character(c(1, 2, "a", NULL, TRUE))
typeof(y)
[1] "character"
class(y)
[1] "character"
y
[1] "1"    "2"    "a"    "TRUE"
```

Logical Vectors coercion

> ***Logical values coerced into 0 for FALSE and 1 for TRUE when applying math functions***

```
x <- c(8, 2, 1, 3)
x >= 5  # which entries >= 5?
[1]  TRUE FALSE FALSE FALSE
sum(x >= 5)  # how many >= 5?
[1] 1
```

- Mean of a Logical Vector

```
mean(x >= 5)
[1] 0.25
```

Examples: Coercion of Logical Values

Sum of Logical Values

```r
grades <- c(80, 60, 95, 70, 85)
passing_grades <- grades >= 65
sum(passing_grades)  # count of passing grades
[1] 4
```

Mean of Logical Values

```r
rainfall <- c(1.2, 0, 2.5, 0.8, 0, 0)
rainy_days <- rainfall > 0
mean(rainy_days)  # proportion of rainy days
[1] 0.5
```

Data types: factors

- Factors are a class of data that are stored as integers

```
x_fct <- as.factor(c("yes", "no", "no"))
class(x_fct)
[1] "factor"
typeof(x_fct)
[1] "integer"
```

The attribute `levels` is a character vector of possible values

- Values are stored as the integers (1=first `level`, 2=second `level`, etc.)
- Levels are ordered alphabetically/numerically (unless specified otherwise)

```
str(x_fct)
 Factor w/ 2 levels "no","yes": 2 1 1
levels(x_fct)
[1] "no"  "yes"
```

Subsetting: Atomic Vector and Matrices

- subset with [] by referencing index value (from 1 to vector length):

```
x
[1] 8 2 1 3
x[c(4, 2)]  # get 4th and 2nd entries
[1] 3 2
```

- subset by omitting entries

```
x[-c(4, 2)]  # omit 4th and 2nd entries
[1] 8 1
```

- subset with a logical vector

```
# get 1st and 3rd entries
x[c(TRUE, FALSE, TRUE, FALSE)]
[1] 8 1
```

Subsetting: Matrices

- Access entries using subsetting [row,column]

```
x_col
     x y
[1,] 1 2
[2,] 2 4
[3,] 3 6
[4,] 4 8
```

```
x_col[, 1] # first column
[1] 1 2 3 4
```

```
x_col[1:2, 1] # first 2 rows of first column
[1] 1 2
```

R Doesn't Always Preserve Class

```
# one row (or col) is no longer a matrix (1D)
class(x_col[1,])
[1] "numeric"
```

Subsetting: Atomic Vector and Matrices

- You can access entries like a matrix:

```
x_df <- data.frame(x = x, double_x = x*2)
x_df
  x double_x
1 8       16
2 2        4
3 1        2
4 3        6
```

```
x_df[, 1]  # first column, all rows
[1] 8 2 1 3
```

or access columns with $

```
x_df$x  # get variable x column
[1] 8 2 1 3
```

```
# first column is no longer a dataframe
class(x_df[, 1])
[1] "numeric"
```

Data frames or Tibbles

Tibbles

- are a new modern data frame
- never changes the input data types
- can have columns that are lists
- can have non-standard variable names
    - can start with a number or contain spaces

Subsetting data frames

- Can also use column names to subset:

```
library(babynames)
# get 2 rows of Name and Sex
babynames[1:2, c("name", "sex")]
# A tibble: 2 × 2
  name  sex  
  <chr> <chr>
1 Mary  F    
2 Anna  F    
```

Lists in R

Lists: Flexible Data Containers

- List is a vector with entries that can be different object types

```
my_list <- list(myVec = x,
                myDf = x_df,
                myString = c("hi", "bye"))
my_list
$myVec
[1] 8 2 1 3

$myDf
  x double_x
1 8       16
2 2        4
3 1        2
4 3        6

$myString
[1] "hi"  "bye"
```

Accessing List Elements

- Like a data frame, use the $ to access named objects stored in the list

```
my_list$myDf
  x double_x
1 8       16
2 2        4
3 1        2
4 3        6
```

```
class(my_list$myDf)
[1] "data.frame"
```

Subsetting Lists with Single Brackets

- One [] operator gives you the object at the given location but preserves the list type
- my_list[2] returns a list of length one with entry myDf

```
my_list[2]
$myDf
  x double_x
1 8       16
2 2        4
3 1        2
4 3        6
```

```
str(my_list[2])
List of 1
 $ myDf:'data.frame':	4 obs. of  2 variables:
  ..$ x       : num [1:4] 8 2 1 3
  ..$ double_x: num [1:4] 16 4 2 6
```

Subsetting Lists with Double Brackets

- The double `[[]]` operator gives you the object stored at that location (equivalent to using $)
- `my_list[[2]]` or `my_list[["myDf"]]` return the data frame `myDf`

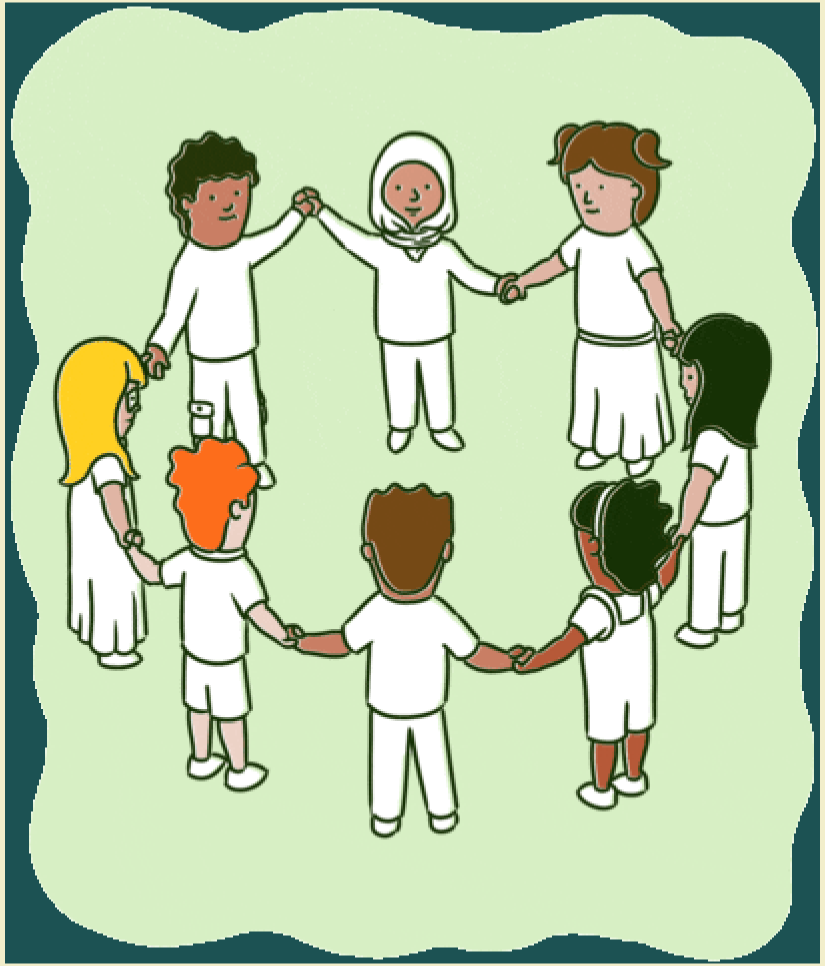
```
my_list[[2]]
  x double_x
1 8       16
2 2        4
3 1        2
4 3        6
str(my_list[[2]])
'data.frame':	4 obs. of  2 variables:
 $ x       : num  8 2 1 3
 $ double_x: num  16 4 2 6
```

List Subsetting Recap

- *Single brackets `[]` preserve the list type*
- *Double brackets `[[]]` return the object stored at the location*
- *Use `$` to access named objects in a list*

Group Activity 1

10:00



- Let's go over to maize server/ local Rstudio and our class moodle
- Get the class activity 3 file
- Please work on the problems
- Talk to your neighbor or ask me questions