Base R Data Structures: Vectors

Common Data Structures

A data scientist needs to deal with data! We need to have a firm foundation in the ways that we can store our data in R. This section goes through the most commonly used 'built-in' R objects that we'll use.

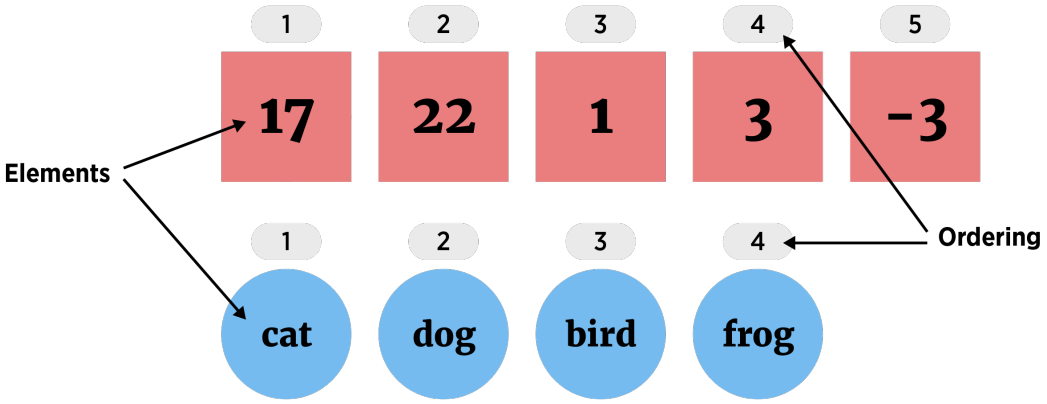
- There are five major data structures used in R

    1. Atomic Vector (1d)
    2. Matrix (2d)
    3. Array (nd)
    4. Data Frame (2d)
    5. List (1d)

Dimension	Homogeneous (elements all the same)	Heterogeneous (elements may differ)
1d	Atomic Vector	List
2d	Matrix	Data Frame
nd	Array	

(Atomic) Vector

(Atomic) Vector (1D group of elements with an ordering that starts at 1)



- **Elements** must be same the same 'type' (homogeneous). The most common types of data are:
    - logical, integer, double, and character

Creating a Vector

Many functions output a vector but the most common way to create one yourself is

to use the `c()` function.

- `c()` "combines" values together
  - Simply separate the values with a comma

```
#vectors (1 dimensional) objects
#all elements of the same 'type'
x <- c(1, 3, 10, -20, sqrt(2))
x
```

```
[1]   1.000000   3.000000  10.000000 -20.000000   1.414214
```

- Recall the `str()` function to investigate the structure of the object

```
str(x)
```

```
 num [1:5] 1 3 10 -20 1.41
```

- The `typeof()` function tells us which type of data is stored in the vector

```
typeof(x)
```

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

- Let's create another vector `y` with strings stored in it

```
y <- c("cat", "dog", "bird", "floor")
y
```

```
[1] "cat"   "dog"   "bird"  "floor"
```

```
str(y)
```

```
 chr [1:4] "cat" "dog" "bird" "floor"
```

```
typeof(y)
```

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

- We can combine two vectors together using `c()` as well!

```
z <- c(x, y)
z
```

```
[1] "1"                "3"                "10"               "-20"
[5] "1.4142135623731" "cat"              "dog"              "bird"
[9] "floor"
```

```
str(z)
```

```
 chr [1:9] "1" "3" "10" "-20" "1.4142135623731" "cat" "dog" "bird" "floor"
```

```
typeof(z)
```

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

Notice that R *coerces* the **elements** to the data type of the more flexible elements (character - R knows how to convert a number to a character string but doesn't know how to convert a character string to a number). No warning is produced or message!

You'll need to get used to how R does these kinds of things implicitly. Check out how R does coercion on some other types of data.

```
c(TRUE, "hat", 3)
```

```
[1] "TRUE" "hat"  "3"
```

```
c(c(TRUE, 3), "hat")
```

```
[1] "1"   "3"   "hat"
```

Notice that the order of operations above is important to understand! In the first line, R coerces the three elements together (character as it is the most flexible). In the second line, R first coerces `TRUE` and `3` together. `TRUE` values are treated as 1 (`FALSE` values as 0). Then the values of `1` and `3` are coerced to character strings to create the final vector.

- One really useful function that creates a vector is the `seq()` (or sequence) function

```
seq(from = 1, to = 10, by = 2)
```

```
[1] 1 3 5 7 9
```

```
seq(1, 10, 1)
```

```
 [1]  1  2  3  4  5  6  7  8  9 10
```

```
seq(1, 10, length = 5)
```

```
[1]  1.00  3.25  5.50  7.75 10.00
```

- A shorthand for the `seq()` function is to use a `:`

```
1:10
```

```
 [1]  1  2  3  4  5  6  7  8  9 10
```

- This can easily be modified to get other sequences.

```
20:30/2
```

```
 [1] 10.0 10.5 11.0 11.5 12.0 12.5 13.0 13.5 14.0 14.5 15.0
```

```
1:15*3
```

```
 [1]  3  6  9 12 15 18 21 24 27 30 33 36 39 42 45
```

Note that R is doing **element-wise** math. This is the default behavior of doing math on our common data structures (not just vectors!)

- Another function that creates a vector is the `runif()` (random uniform number generator) function.

```
runif(4, min = 0, max = 1)
```

```
[1] 0.6042025 0.8143031 0.4596253 0.1859617
```

```
runif(10)
```

```
 [1] 0.974910209 0.296446608 0.134271371 0.323132982 0.002682698
0.174034442
 [7] 0.358704976 0.986762458 0.622212187 0.937527729
```

```
runif(5, 20, 30)
```

```
[1] 20.07139 20.90222 27.99191 24.15232 29.33368
```

We'll find this function really useful when we simulate different quantities!

You might find the different ways to call a function confusing right now! We'll talk about how to use the help files to understand function calls shortly!

Vector Attributes

R objects can have attributes associated with them. The main attribute that a vector might have associated with it are **names** for the elements.

```
u <- c("a" = 1, "b" = 2, "c" = 3)
u
```

```
a b c
1 2 3
```

```
attributes(u)
```

```
$names
[1] "a" "b" "c"
```

There is a special function for getting at the names of an R object. It is the `names()` function (nice choice there).

```
        names(u)
```

```
[1] "a" "b" "c"
```

```
        names(u)[1]
```

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

Names can be useful when it comes to subsetting and matching observations.

Accessing Elements of a Vector

When thinking about accessing (or subsetting) a vector's elements, remember that vectors are 1D. We can place the numbers corresponding to the positions of the elements we want inside of `[]` at the end of the vector to return them.

- Return vector elements using square brackets `[]` at the end of a vector.

```
        letters #built-in vector
```

```
 [1] "a" "b" "c" "d" "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q"
"r" "s"
[20] "t" "u" "v" "w" "x" "y" "z"
```

```
        letters[1] #R starts counting at 1!
```

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

```
        letters[26]
```

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

- Can 'feed' in a vector of indices to `[]`

```
        letters[1:4]
```

```
[1] "a" "b" "c" "d"
```

```
        letters[c(5, 10, 15, 20, 25)]
```

```
[1] "e" "j" "o" "t" "y"
```

```
        x <- c(1, 2, 5)
        letters[x]
```

```
[1] "a" "b" "e"
```

We'd call `x` above an *indexing vector*

- Use negative indices to return a vector without certain elements

```
        letters[-(1:4)]
```

```
 [1] "e" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q" "r" "s" "t" "u"
"v" "w"
[20] "x" "y" "z"
```

```
        x <- c(1, 2, 5)
        letters[-x]
```

```
 [1] "c" "d" "f" "g" "h" "i" "j" "k" "l" "m" "n" "o" "p" "q" "r" "s" "t"
"u" "v"
[20] "w" "x" "y" "z"
```

- If we have a names attribute associated, we can use names to access elements.

```
        u
```

```
a b c
1 2 3
```

```
        u["a"]
```

```
a
1
```

```
        t <- c("a", "c")
        u[t]
```

```
a c
1 3
```

Quick R Video

Let's look at a quick example of creating and modifying R vectors.

Please pop this video out and watch it in the full panopto player!

07 - Vectors

[Auto-generated transcript. Edits may have been applied for clarity.]

Recap!

(Atomic) Vector (1D group of elements with an ordering)

- Vectors useful to know about as they are the most basic data object we'll use
- `seq()` and `:`
- Subset vectors using `vec[index]`