Vectors in R

CSC121

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Let's talk about...

```
> 2 + 5
[1] 7
```

Algorithm + Data + Structure = **Program**

- So far, we've seen a few examples these different parts of a program

Data Structures

Algorithm + Data + Structure = **Program**

- We know that all programming languages have to handle data
- Every programming language provides ways to organize and store data to make it easier and efficient to work with
- These are called **Data Structures**
- We're going to learn about one of R's fundamental data structures that helps us store and work with data more easily

Vectors

- All the numeric values we've seen so far are stored in an R data structure called a 'Vector'

- A **vector** in R is an ordered group of values
  - Every value in a vector is called an '**element**' of that vector

Vectors with one element

- All of the numbers we've been using are really one-element vectors!
  - For example, R automatically creates a vector every time we type a number into the Console and press Enter
  - For example...

Examples of Vectors

```
> 6
[1] 6
```

A one-element vector with the number ‘6’ in it

This ‘1’ means that the value directly beside it is the first element in the vector, in this case, 6

The ‘1’ does NOT mean there is only one element in the vector

Vectors with more than one element

- R's vector data structure allows us to group many elements together

- To quickly make a multi-element vector, R provides a function:

```
c(...)
```

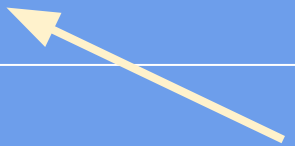
- 'c' stands for 'combine'.
- This function combines its arguments into a vector.
- The multiple dots '...' means multiple arguments with no specific limit

Creating a multi-element vector

A vector with two elements

```
> c(4, 7)
[1] 4 7
```

A two-element vector with the numbers 4 and 7.



- Notice how it still only says ‘1’. This is because the value directly beside it is the first element of the vector, 4. 7 is the second element of the vector.

- Let’s talk more about the order of these elements...

Elements have an ordering

- The elements in a vectors are ordered
- When creating a vector with the `c(...)` function, the elements take the order that the arguments to the function were in.

```
> c(23, 9, 534)
[1] 23 9 534
```

The order of the elements is:
First element: 23
Second element: 9
Third element: 534

Longer vectors

- Vectors can be quite long
  - Maximum size is about 2 billion elements
  - Don’t try this though...your computer will likely run out of memory and crash!

Longer Vectors

- Often, a large vector printed to the console is too long for one line
- This is where our [1] comes in

```
> c(4,7,534,938,6432,535)
[1] 4   7   534   938   6432
[6] 535
```

- The element to the right of the [1] is the first element of the vector
- The element to the right of the [6] is the sixth element of the vector

Working with Vectors

- Just like any other data in R, vectors can be stored in a variable

```
> v <- c(24, 5, 347)
> v
[1] 24 5 347
```

- Vectors can be passed as arguments to functions: `FunctionWithVectorArgument(v)`

Indexing

- Often you'll be working with a vector, and you'll want to isolate one of its elements

- **Indexing**
  - The *position* of each element in a vector is called its index
    - First element: index **1**
    - Second element: index **2**
    - Third element: index **3**
    - etc..

Indexing

```
> c(24, 5, 347)
[1] 24 5 347
```

- If we have the vector above, we say:
  - The element at index 1 is 24
  - The element at index 2 is 5
  - The element at index 3 is 347

- Order matters! `c(5, 7)` is not the same as `c(7, 5)`

Indexing

```
> v <- c(24, 5, 347)
```

- We can access the element at each index using **vector indexing**:

```
> v[1]
> [1] 24
```

```
> v[2]
> [1] 5
```

```
> v[3]
> [1] 347
```

- Notice how we get a new value in its own one-element vector, which is what we're used to seeing

Indexing multiple elements

- We can access multiple values to create new vectors from the original vector
- We can use the colon ‘:’ to get a range of elements from the vector
- In general, given a vector v, and two positive integers x and y,

`v[x:y]` gives a vector with the elements of v from index x to index y (inclusive)

Indexing multiple elements

```
> v <- c(24, 5, 347, 97, 43)
```

- Given the vector above
  - We can use the colon ':' to get a range of elements from the vector. Think of it as getting a 'slice' of the vector.

```
> v[1:3]
[1] 24 5 347
```

```
> v[4:5]
[1] 97 43
```

Can find length of vectors

```
> v <- c(24, 5, 347, 97, 43)
> length(v)
[1] 5
```

```
> v[length(v)]
[1] 43
```

Type of a Vector

- The type of the vector is defined by the type of its elements
- All elements in a vector must be of the same type
- If you put different types in, R will find a way to convert them to force them to be the same type

```
> v <- c(24, 5, 347)
> typeof(v)
[1] “double”
```

Type of a Vector

- The type of the vector is defined by the type of its elements
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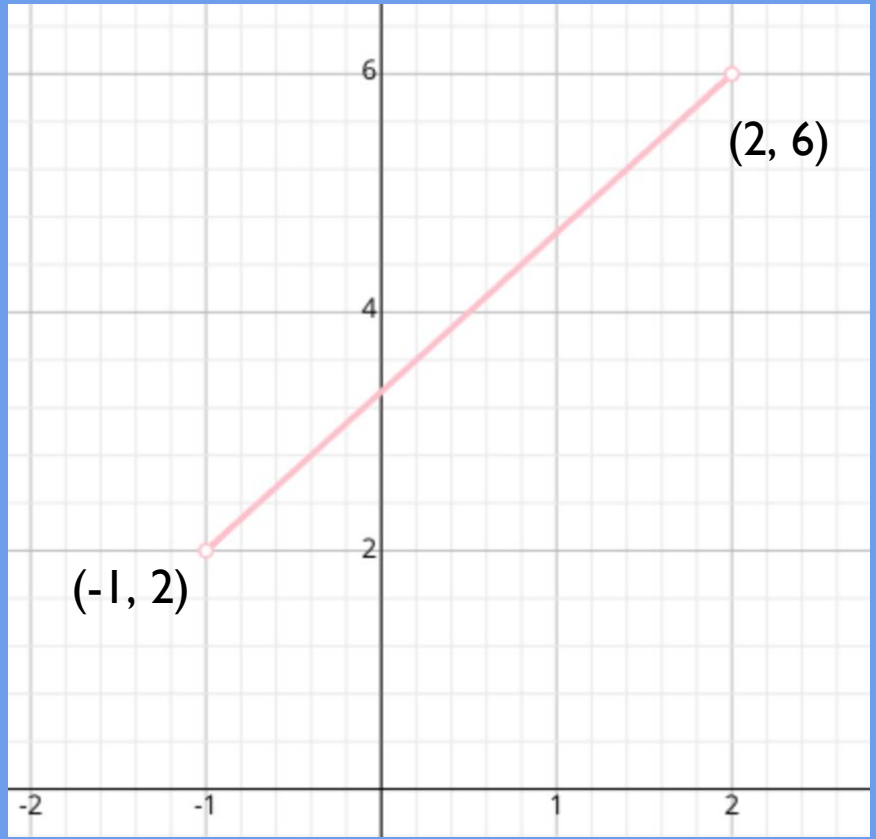
```
> v <- c(24, as.integer(5), 347)
> typeof(v)
[1] “double”
```

R converts the integer value to a double to ensure all values have the same type

Let’s look at vectors in RStudio

Let's write a function for finding the distance between two points on a graph

You are given the two points **(–1, 2)** and **(2, 6)**, and you want to find the distance between them
The points look like this:



Distance formula

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$