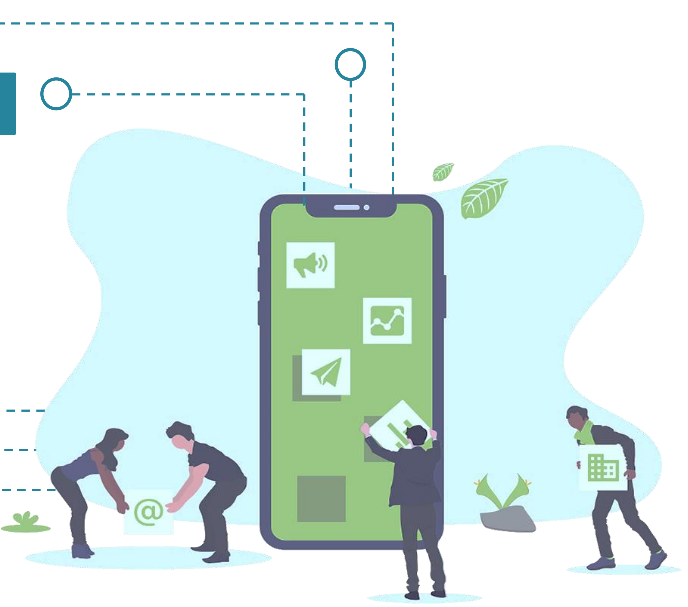
The Data Science Track



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12. Control Structures

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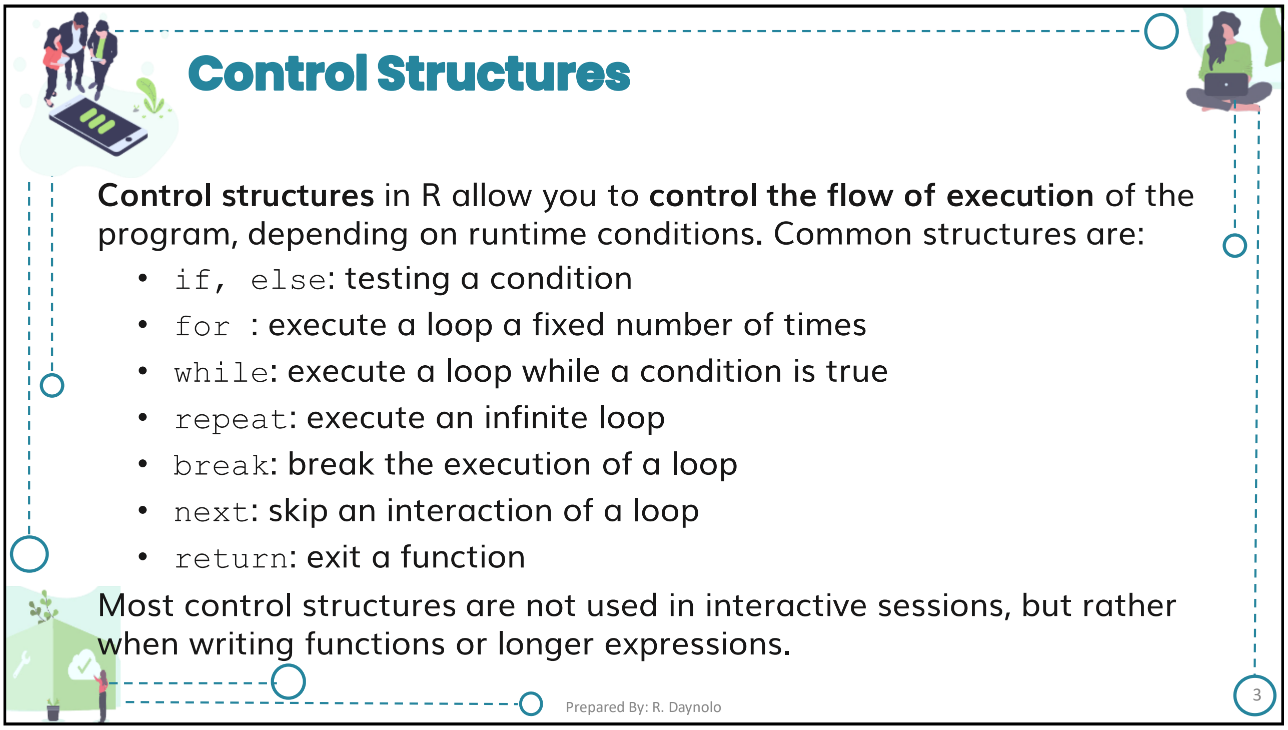

Control Structures

Control structures in R allow you to **control the flow of execution** of the program, depending on runtime conditions. Common structures are:

- `if, else`: testing a condition
- `for` : execute a loop a fixed number of times
- `while`: execute a loop while a condition is true
- `repeat`: execute an infinite loop
- `break`: break the execution of a loop
- `next`: skip an interaction of a loop
- `return`: exit a function

Most control structures are not used in interactive sessions, but rather when writing functions or longer expressions.

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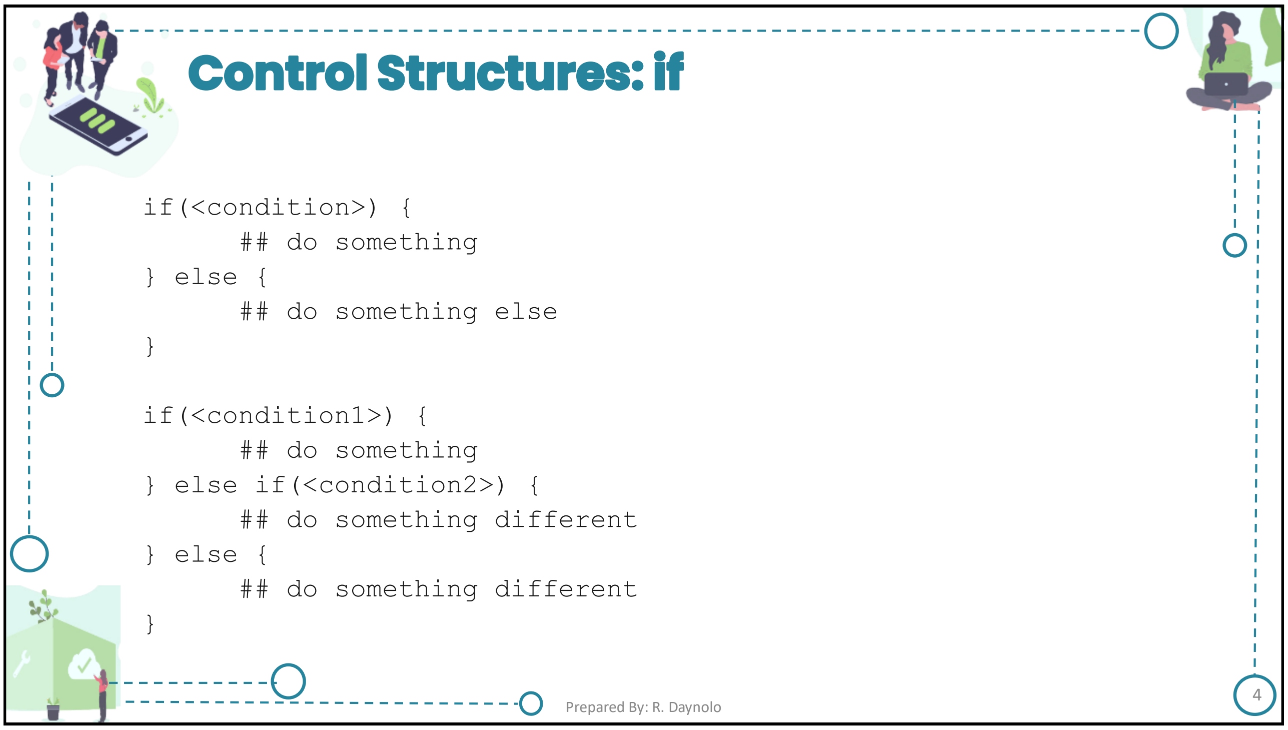

Control Structures: if

```
if(<condition>) {
      ## do something
} else {
      ## do something else
}

if(<condition1>) {
      ## do something
} else if(<condition2>) {
      ## do something different
} else {
      ## do something different
}
```

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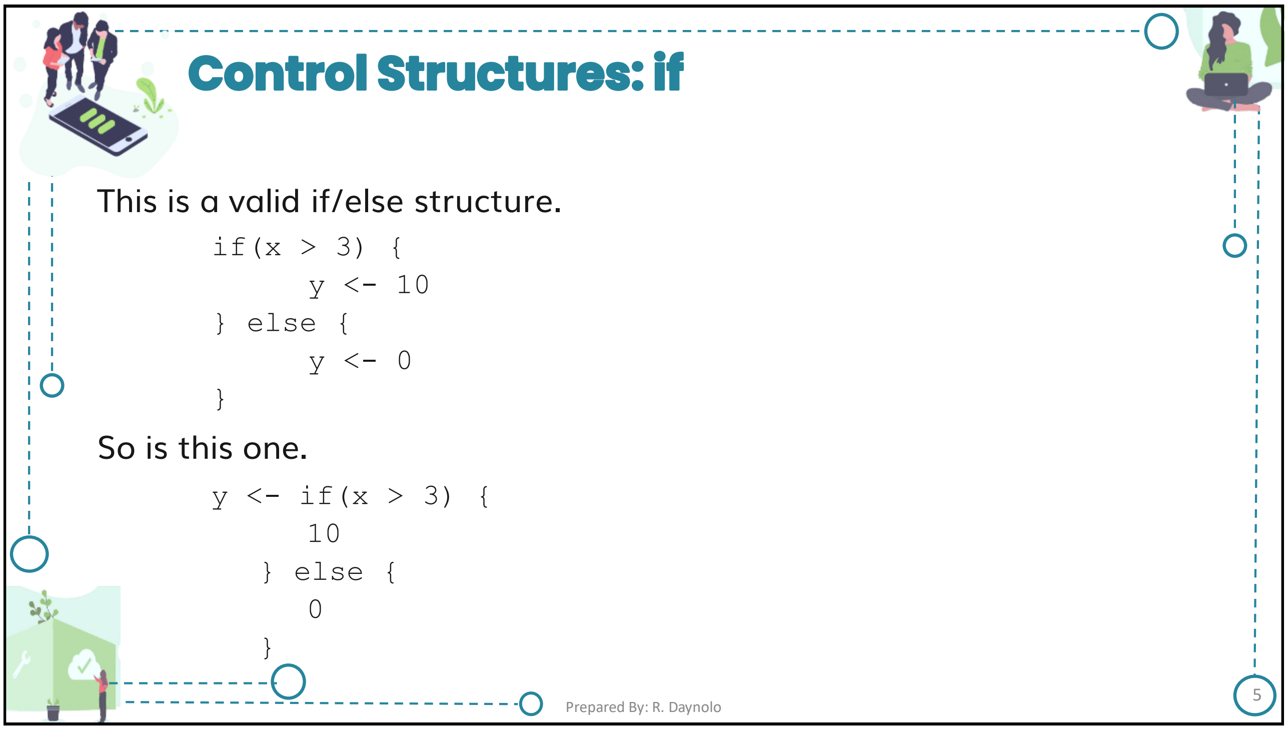

Control Structures: if

This is a valid if/else structure.

```
if(x > 3) {
        y <- 10
} else {
        y <- 0
}
```

So is this one.

```
y <- if(x > 3) {
        10
    } else {
        0
    }
```

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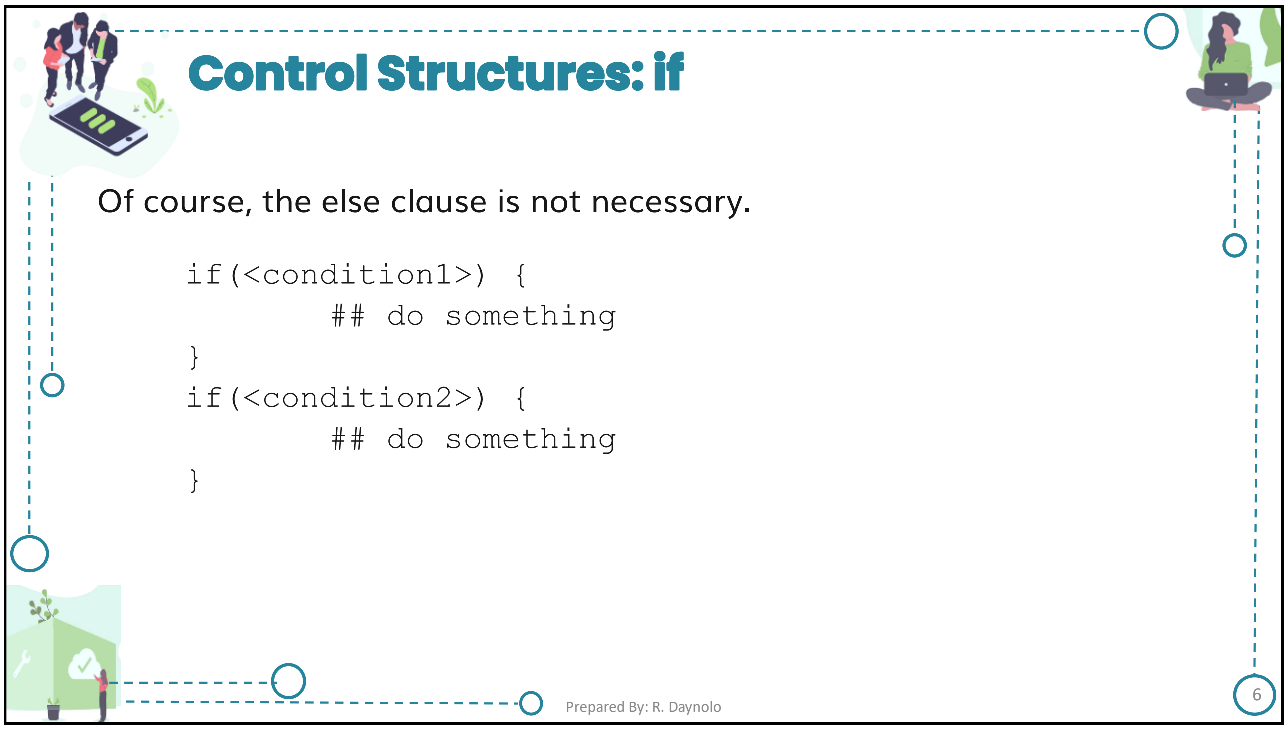

Control Structures: if

Of course, the else clause is not necessary.

```
if(<condition1>) {
        ## do something
}
if(<condition2>) {
        ## do something
}
```

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Control Structures: for

for loops take an interactor variable and assign it successive values from a sequence or vector. for loops are most commonly used for iterating over the elements of an object (list, vector, etc.)

```
for(i in 1:10) {
      print(i)
}
```

This loop takes the i variable and in each iteration of the loop gives it values 1, 2, 3, …, 10, and then exits.

Control Structures: for

These loops have the same behavior.

```
x <- c("a", "b", "c", "d")
for(i in 1:4) {
      print(x[i])
}
```

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

Control Structures: for

These loops have the same behavior.

```
for(i in seq_along(x)) {
      print(x[i])
}
```

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

Control Structures: for

These loops have the same behavior.

```
for(letter in x) {
      print(letter)
}
```

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

Control Structures: for

These loops have the same behavior.

```
for(i in 1:4) print(x[i])
```

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

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Control Structures: Nested for loops

`for` loops can be nested

```
x <- matrix(1:6, 2, 3)

for(i in seq_len(nrow(x))) {
        for(j in seq_len(ncol(x))) {
                print(x[i, j])
        }
}
```

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Control Structures: Nested for loops

for loops can be nested

```
[1] 1
[1] 3
[1] 5
[1] 2
[1] 4
[1] 6
```

Note: Be careful with nesting. Nesting beyond 2 – 3 levels is often very difficult to read/understand.

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Control Structures: while

while loops begin by testing a condition. If it is true, then they execute the loop body. Once the loop body is executed, the condition is tested again, and so forth.

```
count <- 0

while(count < 10) {
      print(count)
      count <- count + 1
}
```

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Control Structures: while

```
[1] 0
[1] 1
[1] 2
[1] 3
[1] 4
[1] 5
[1] 6
[1] 7
[1] 8
[1] 9
```

Note: While loops can potentially result in infinite loops if not written properly. Use with care!

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Control Structures: while

Sometimes there will be more than one condition in the test.

```
z <- 5
while(z >= 3 && z <= 10) {
      print(z)
      coin <- rbinom(1, 1, 0.5)
      if(coin == 1) { ## random walk
            z <- z + 1
      } else {
            z <- z - 1
      }
}
```

Note: Conditions are always evaluated from left to right.

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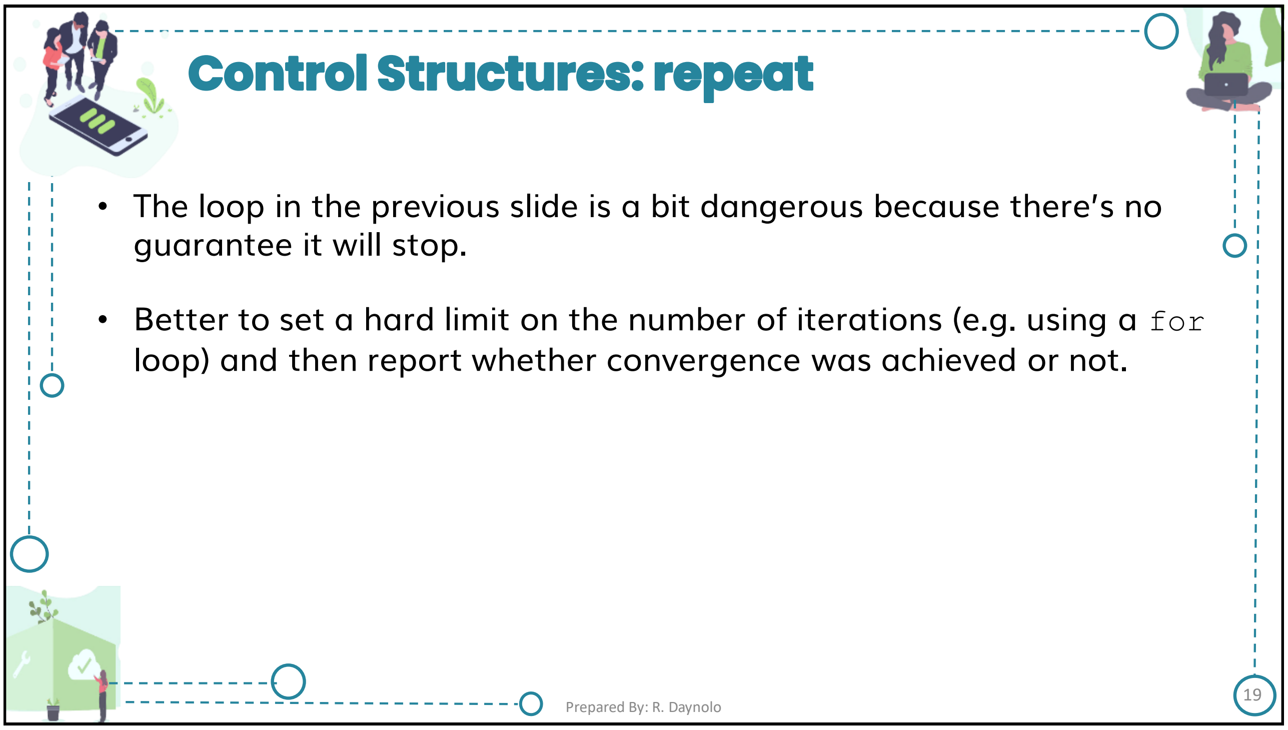
Control Structures: repeat

- Repeat initiates an infinite loop; these are not commonly used in statistical applications but they do have their uses. The only way to exit a `repeat` loop is to call `break`.
- One possible paradigm might be in an iterative algorithm where you may be searching for a solution and you don't want to stop until you're close enough to the solution. In this kind of situation, you often don't know in advance how many iterations it's going to take to get "close enough" to the solution.

Control Structures: repeat

```
x0 <- 1
tol <- 1e-8
repeat {
        x1 <- computeEstimate()
        if(abs(x1 - x0) < tol) {
                break
        } else {
                x0 <- x1
        }
}
```

Note: The above code will not run if the `computeEstimate()` function is not defined (this function is made it up for the purpose of this demonstration).



Control Structures: repeat

- The loop in the previous slide is a bit dangerous because there's no guarantee it will stop.
- Better to set a hard limit on the number of iterations (e.g. using a `for` loop) and then report whether convergence was achieved or not.

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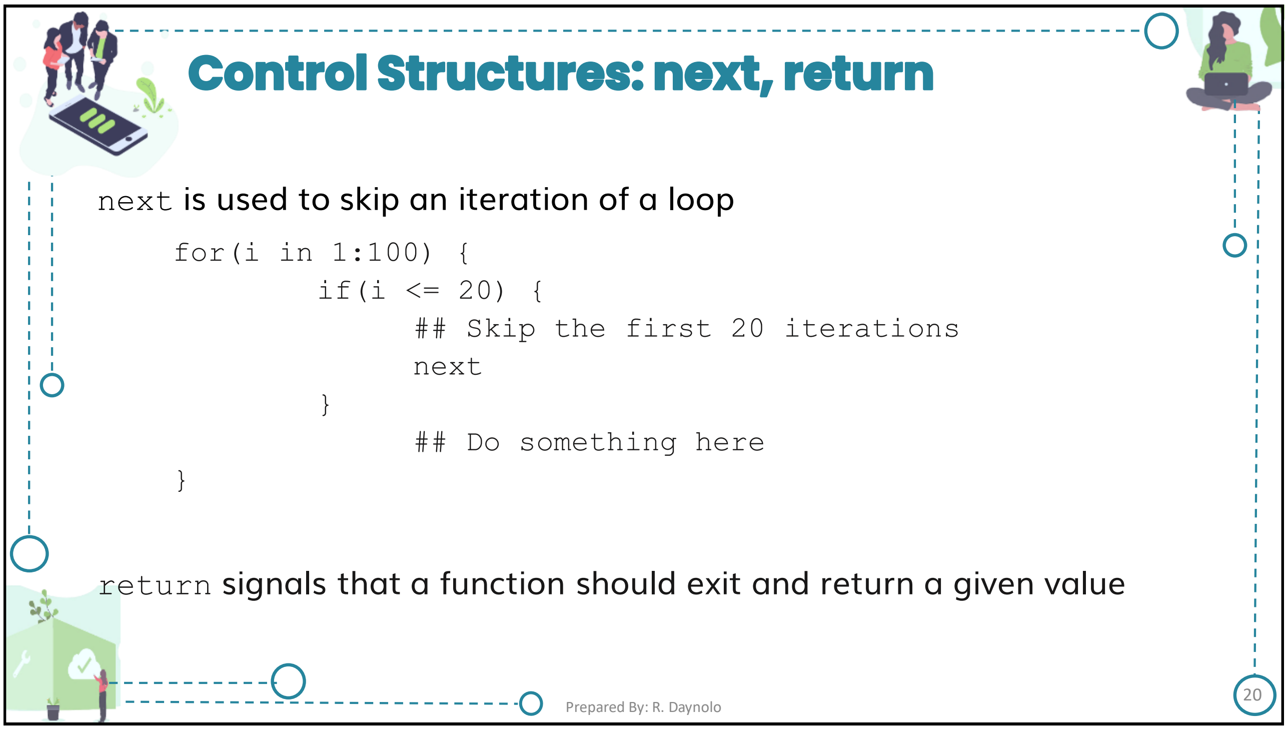

Control Structures: next, return

`next` is used to skip an iteration of a loop

```
for(i in 1:100) {
        if(i <= 20) {
              ## Skip the first 20 iterations
              next
        }
              ## Do something here
}
```

`return` signals that a function should exit and return a given value

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Control Structures: break

`break` is used to exit a loop immediately, regardless of what iteration the loop may be on

```
for(i in 1:100) {
        print(i)
        if(i > 20) {
                ## Stop loop after 20 iterations
                break
        }
}
```

Control Structures

Summary

- Control structures like if, while, and for allow you to control the flow of an R program
- Infinite loops should generally be avoided, even if they are theoretically correct.
- Control structures mentioned here are primarily useful for writing programs; for command-line interactive work, the *apply functions are more useful.