Week 5: *Iteration*

EMSE 4571 / 6571: Intro to Programming for Analytics

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Common problems in homeworks

Use `almostEqual()` in test cases with numbers

```
almostEqual <- function(n1, n2, threshold = 0.00001) {
    return(abs(n1 - n2) <= threshold)
}
```

This could fail:

```
stopifnot(getTheCents(2.45) == 45)
```

Instead, use:

```
stopifnot(almostEqual(getTheCents(2.45), 45))
```

Common problems in homeworks

Check your full script for errors

- Restart R and run your whole code from the top
- **Sequence matters**: Have you called a function before defining it?

Please don't copy-paste from ChatGPT

(It's soooo obvious)

```r
kthDigit <- function(x, k) {
  x_str <- as.character(x)
  if (k <= nchar(x_str)) {
    return(as.numeric(substr(x_str, nchar(x_str) - k + 1, nchar(x_str) - k + 1)))
  } else {
    return(0)
  }
}
```

And you lose the chance to think 😞

Read homework feedback on Box

Go to box.com

Search for folder named `netID-p4a` (e.g., `jph-p4a`)

Week 5: *Iteration*

1. for loops

2. breaking and skipping

BREAK

3. while loops

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"Flow Control"

Code that alters the otherwise linear flow of operations in a program.

Last week:

- `if` statements
- `else` statements

This week:

- `for` loops
- `while` loops
- `break` statements
- `next` statements

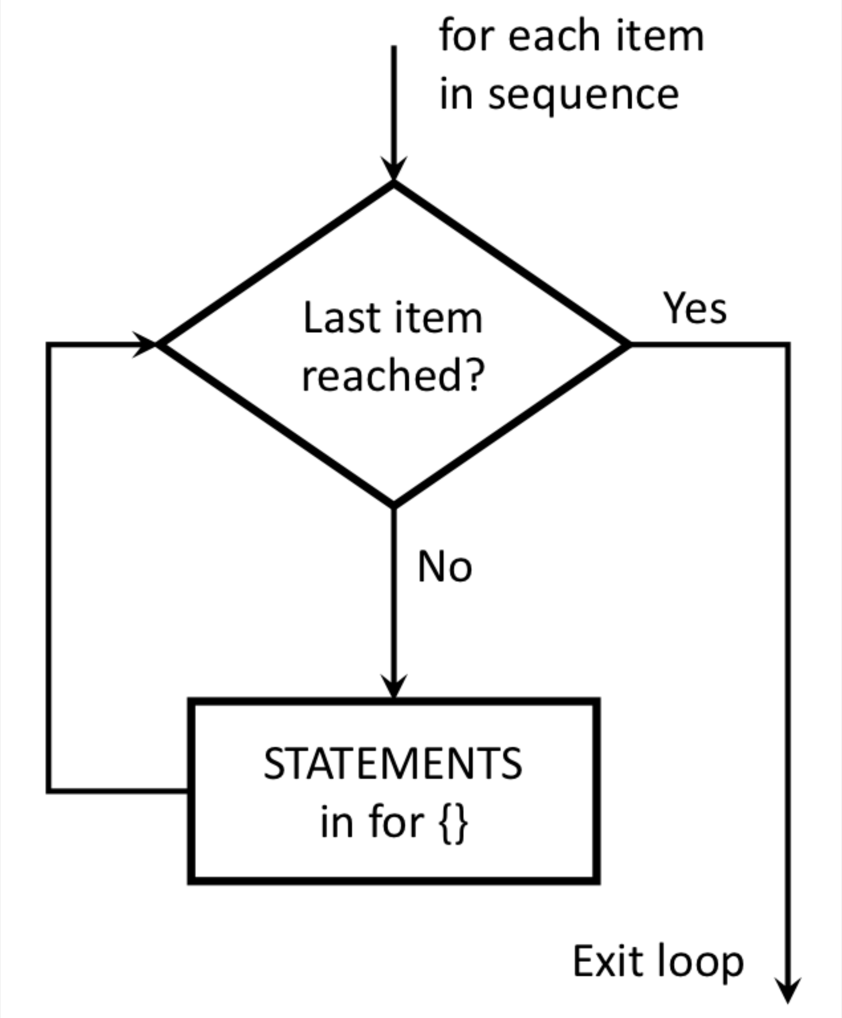
The `for` loop

Basic format:

```
for (item in sequence) {
    # Do stuff with item

    # Loop stops after last item
}
```

Flow chart:



Making a sequence

(Side note: these are vectors...that's next week - read ahead!)

Two ways to make a sequence:

1. Use the `seq()` function

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

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

```r
seq(1, 10, by = 2)
```

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

2. Use the `:` operator (step size = 1)

```r
1:10
```

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

```r
10:1
```

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

Quick code tracing

02:00

What will this function print?

```
for (i in 1:5) {
    if ((i %% 2) == 0) {
        cat('--')
    } else if ((i %% 3) == 0) {
        cat('----')
    }
    cat(i, '\n')
}
```

Quick code tracing

02:00

What will this function print?

```
n <- 6
for (i in seq(n)) {
    cat('|')
    for (j in seq(1, n, 2)) {
        cat('*')
    }
    cat('|', '\n')
}
```

Your turn

15:00

1) `sumFromMToN(m, n)`: Write a function that sums the total of the integers between `m` and `n`.
Challenge: Try solving this without a loop!

- `sumFromMToN(5, 10) == (5 + 6 + 7 + 8 + 9 + 10)`
- `sumFromMToN(1, 1) == 1`

2) `sumEveryKthFromMToN(m, n, k)`: Write a function to sum every kth integer from `m` to `n`.

- `sumEveryKthFromMToN(1, 10, 2) == (1 + 3 + 5 + 7 + 9)`
- `sumEveryKthFromMToN(5, 20, 7) == (5 + 12 + 19)`
- `sumEveryKthFromMToN(0, 0, 1) == 0`

3) `sumOfOddsFromMToN(m, n)`: Write a function that sums every *odd* integer between `m` and `n`.
Challenge: Try solving this without a loop!

- `sumOfOddsFromMToN(4, 10) == (5 + 7 + 9)`
- `sumOfOddsFromMToN(5, 9) == (5 + 7 + 9)`

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Breaking out of a loop

Force a loop to stop with `break`

Note: `break` doesn't require `()`

```
for (val in 1:5) {
    if (val == 3) {
        break
    }
    cat(val, '\n')
}
```

```
1
2
```

Quick code tracing

02:00

What will this code print?

```r
for (i in 1:3) {
    cat('|')
    for (j in 1:5) {
        if (j == 3) {
            break
        }
        cat('*')
    }
    cat('|', '\n')
}
```

Skipping iterations

Skip to the next iteration in a loop with `next`

Note: `next` doesn't require `()`

```
for (val in 1:5) {
    if (val == 3) {
        next
    }
    cat(val, '\n')
}
```

```
1
2
4
5
```

Quick code tracing

02:00

What will this code print?

```
for (i in 1:3) {
    cat('|')
    for (j in 1:5) {
        if (j == 3) {
            next
        }
        cat('*')
    }
    cat('|', '\n')
}
```

Your turn

15:00

`sumOfOddsFromMToNMax(m, n, max)`: Write a function that sums every *odd* integer from `m` to `n` up until the sum is less than or equal to the value `max`.

Your solution **must** use both `break` and `next` statements.

- `sumOfOddsFromMToNMax(1, 5, 4) == (1 + 3)`
- `sumOfOddsFromMToNMax(1, 5, 3) == (1)`
- `sumOfOddsFromMToNMax(1, 5, 10) == (1 + 3 + 5)`

Intermission

05:00

Week 5: *Iteration*

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BREAK

3. while loops

Lame joke time:

A friend calls her programmer roommate and said, "*while* you're out, buy some milk"...

...she never returned home.

🤣

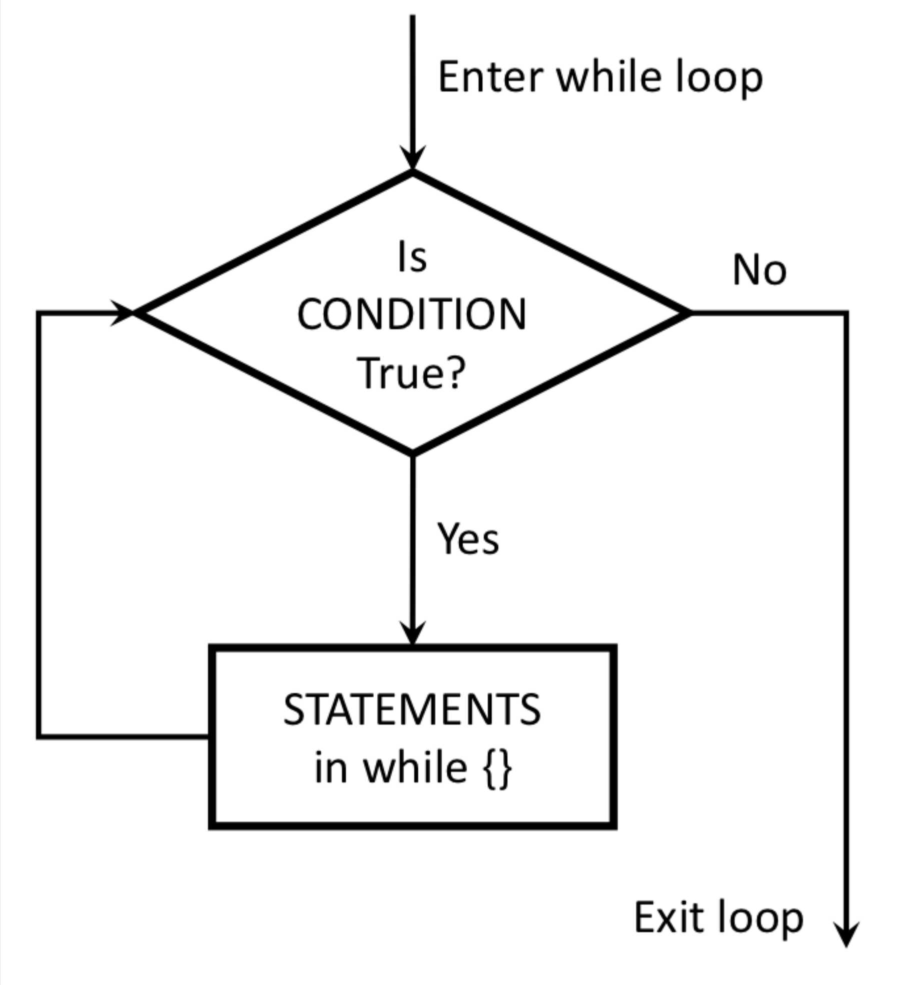
The `while` loop

Basic format:

```
while (CONDITION) {
    # Do stuff here

    # Update condition
}
```

Here's the general idea:



Quick code tracing

02:00

Consider this function:

```r
f <- function(x) {
    n <- 1
    while (n < x) {
        cat(n, '\n')
        n <- 2*n
    }
}
```

What will this code print?

```r
f(5)
f(10)
f(50)
f(60)
f(64)
```

`for` vs. `while`

Use `for` loops when the number of iterations is ***known***.

1. Build the sequence
2. Iterate over it

```r
for (i in 1:5) { # Define the sequence
    cat(i, '\n')
}
```

```
#> 1
#> 2
#> 3
#> 4
#> 5
```

Use `while` loops when the number of iterations is ***unknown***.

1. Define stopping condition
2. Iterate until condition is met

```r
i <- 1
while (i <= 5) { # Set stopping condition
    cat(i, '\n')
    i <- i + 1 # Update condition
}
```

```
#> 1
#> 2
#> 3
#> 4
#> 5
```

Mystery Function

02:00

What does this function do?

(You can assume that n is a number)

```r
mystery_function <- function(n) {
    if (n == 0) {
      cat(0)
    }
    n <- abs(n)
    while (n > 0) {
        cat(n %% 10, '\n')
        n <- n %/% 10
    }
}
```

Your turn: Write functions

15:00

In your practice file, you have the solution for the function `isMultipleOf4Or7(n)`, which returns `TRUE` if `n` is a multiple of 4 or 7 and `FALSE` otherwise.

- `isMultipleOf4Or7(0) == FALSE`
- `isMultipleOf4Or7(1) == FALSE`
- `isMultipleOf4Or7(4) == TRUE`
- `isMultipleOf4Or7(7) == TRUE`
- `isMultipleOf4Or7(28) == TRUE`

Your job is to write `nthMultipleOf4Or7(n)`:

A function that returns the nth positive integer that is a multiple of either 4 or 7.

- `nthMultipleOf4Or7(1) == 4`
- `nthMultipleOf4Or7(2) == 7`
- `nthMultipleOf4Or7(3) == 8`
- `nthMultipleOf4Or7(4) == 12`
- `nthMultipleOf4Or7(5) == 14`
- `nthMultipleOf4Or7(6) == 16`

Your turn

20:00

`isPrime(n)`: Write a function that takes a non-negative integer, `n`, and returns `TRUE` if it is a prime number and `FALSE` otherwise. Here's some test cases:

- `isPrime(1) == FALSE`
- `isPrime(2) == TRUE`
- `isPrime(7) == TRUE`
- `isPrime(13) == TRUE`
- `isPrime(14) == FALSE`

`nthPrime(n)`: Write a function that takes a non-negative integer, `n`, and returns the nth prime number, where `nthPrime(1)` returns the first prime number (2). Hint: use the function `isPrime(n)` as a helper function!

- `nthPrime(1) == 2`
- `nthPrime(2) == 3`
- `nthPrime(3) == 5`
- `nthPrime(4) == 7`
- `nthPrime(7) == 17`

HW 5

- Trickier turtles
- Read about Happy Numbers