Logicals

David Gerard

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Learning Objectives

- Boolean logic and R.
- Subsetting using logicals.

Logicals

- A logical is a variable that can take on either `TRUE` or `FALSE`.
- Since 13 is greater than 4, the following is returned `TRUE`

```
13 > 4
```

```
## [1] TRUE
```

and the following is returned `FALSE`

```
13 < 4
```

```
## [1] FALSE
```

- Use `>=` and `<=` to test for "greater than or equal" and "less than or equal", respectively

```
4 > 4
```

```
## [1] FALSE
```

```
4 >= 4
```

```
## [1] TRUE
```

```
4 < 4
```

```
## [1] FALSE
```

```
4 <= 4
```

```
## [1] TRUE
```

- Use `==` comparisons to test if two quantities are equal:

```
13 == 4
```

```
## [1] FALSE
```

- Use `!=` to test if two quantities are *not* equal:

```
13 != 4
```

```
## [1] TRUE
```

- These operations can be vectorized:

```
x <- c(1, 2, 3, 4)
y <- c(1, 4, 4, 4)
x == y
```

```
## [1]  TRUE FALSE FALSE  TRUE
```

```
x != y
```

```
## [1] FALSE  TRUE  TRUE FALSE
```

```
x > y
```

```
## [1] FALSE FALSE FALSE FALSE
```

```
x < y
```

```
## [1] FALSE  TRUE  TRUE FALSE
```

- Use "and" `&` to test if both of two conditions are `TRUE`

```
TRUE & TRUE
```

```
## [1] TRUE
```

```
TRUE & FALSE
```

```
## [1] FALSE
```

```
FALSE & TRUE
```

```
## [1] FALSE
```

```
FALSE & FALSE
```

```
## [1] FALSE
```

- Use "or" `|` to test if either (or both) of two conditions are `TRUE`

```
TRUE | TRUE
```

```
## [1] TRUE
```

```
TRUE | FALSE
```

```
## [1] TRUE
```

```
FALSE | TRUE
```

```
## [1] TRUE
```

```
FALSE | FALSE
```

```
## [1] FALSE
```

- `&` and `|` can also be vectorized:

```
x <- c(1, 2, 3, 4)
y <- c(1, 4, 4, 4)
(x < 3) & (y >= 4)
```

```
## [1] FALSE  TRUE FALSE FALSE
```

```
(x < 3) | (y >= 4)
```

```
## [1] TRUE TRUE TRUE TRUE
```

- Use logicals to extract elements of vectors

```
x <- 1:5
x[c(TRUE, FALSE, TRUE, TRUE, FALSE)]
```

```
## [1] 1 3 4
```

```
logvec <- c(TRUE, FALSE, TRUE, TRUE, FALSE)
x[logvec]
```

```
## [1] 1 3 4
```

```
logvec <- c(TRUE, FALSE, TRUE, TRUE, TRUE)
x[logvec]
```

```
## [1] 1 3 4 5
```

- Use logicals to extract elements of a vector that satisfy some condition

```
x <- 1:5
logvec <- x < 3
logvec
```

```
## [1]  TRUE  TRUE FALSE FALSE FALSE
```

```
x[logvec]
```

```
## [1] 1 2
```

1. **Exercise**: If we list all the natural numbers below 10 that are multiples of 3 or 5, we get 3, 5, 6 and 9. The sum of these multiples is 23. Find the sum of all the multiples of 3 or 5 below 1000.
2. **Exercise**: What the sum of all integers that are either (divisible by 4 and less than 700) or (divisible by 3 and between 500 and 1000)?