Types, vectors, and functions in R

2024-07-18

Vectors and Types

Vectors

```
c(1, 3, 5)
c(TRUE, FALSE, TRUE, TRUE)
c("red", "blue")
```

Vectors

Vectors have 1 dimension

Vectors have a length

```
length(c("blue", "red"))
```

Some vectors have names.

```
names(c("x" = 1, "y" = 1))
```

Vectors have types

Types

Numeric/double (`c(1.0, 2.0, 3.0)`)

Integer (`c(1L, 2L, 3L)`)

Character (`c("a", "b", "c")`)

Factor (`factor(c("a", "b", "c"))`)

Logical (`TRUE`)

Dates and times

Packages to work with types

Strings/character: stringr

Factors: forcats

Dates: lubridate

Making vectors

```r
1:3
```

```
[1] 1 2 3
```

```r
c(1, 2, 3)
```

```
[1] 1 2 3
```

```r
rep(1, 3)
```

```
[1] 1 1 1
```

```r
seq(from = 1, to = 3, by = .5)
```

```
[1] 1.0 1.5 2.0 2.5 3.0
```

Your Turn 1

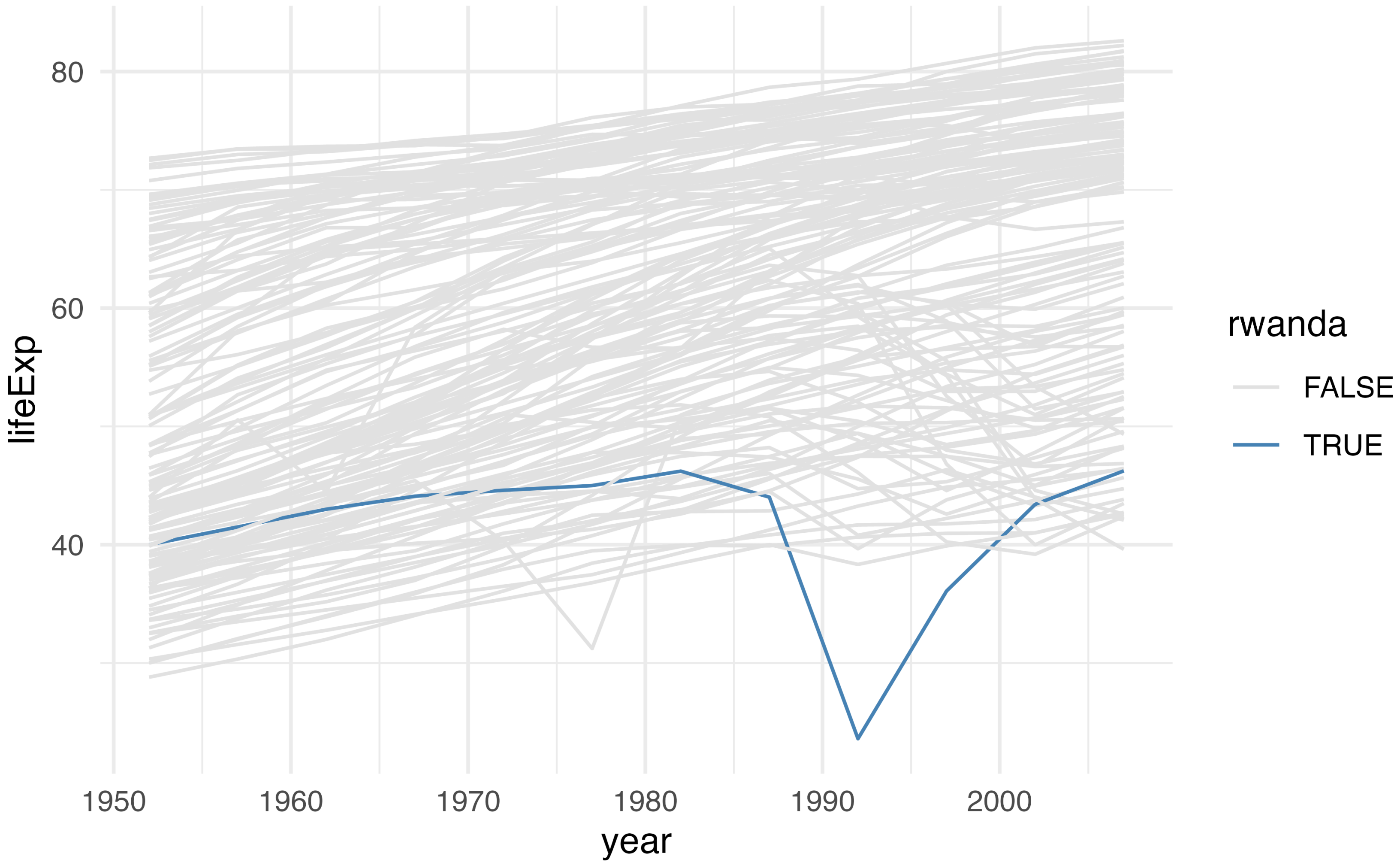
Create a character vector of colors using `c()`. Use the colors `"grey90"` and `"steelblue"`. Assign the vector to a name.

Use the vector you just created to change the colors in the plot below using `scale_color_manual()`. Pass it using the `values` argument.

Your Turn 1

```r
cols <- c("grey90", "steelblue")

gapminder |>
  mutate(rwanda = ifelse(country == "Rwanda", TRUE, FALS
  ggplot(aes(year, lifeExp, color = rwanda, group = cou
  geom_line() +
  scale_color_manual(values = cols) +
  theme_minimal()
```

Your Turn 1



80
60
40
lifeExp
1950
1960
1970
1980
1990
2000
year
rwanda
FALSE
TRUE

Working with vectors

Subset vectors with [] or [[]]

```r
x <- c(1, 5, 7)
x[2]
```

```
[1] 5
```

```r
x[[2]]
```

```
[1] 5
```

```r
x[c(FALSE, TRUE, FALSE)]
```

```
[1] 5
```

```r
x[[c(FALSE, TRUE, FALSE)]]
```

```
Error in x[[c(FALSE, TRUE, FALSE)]]: attempt to select more than
one element in vectorIndex
```

Working with vectors

Modify elements

```
x
```

```
[1] 1 5 7
```

Working with vectors

Modify elements

```r
x[[2]] <- 100
x
```

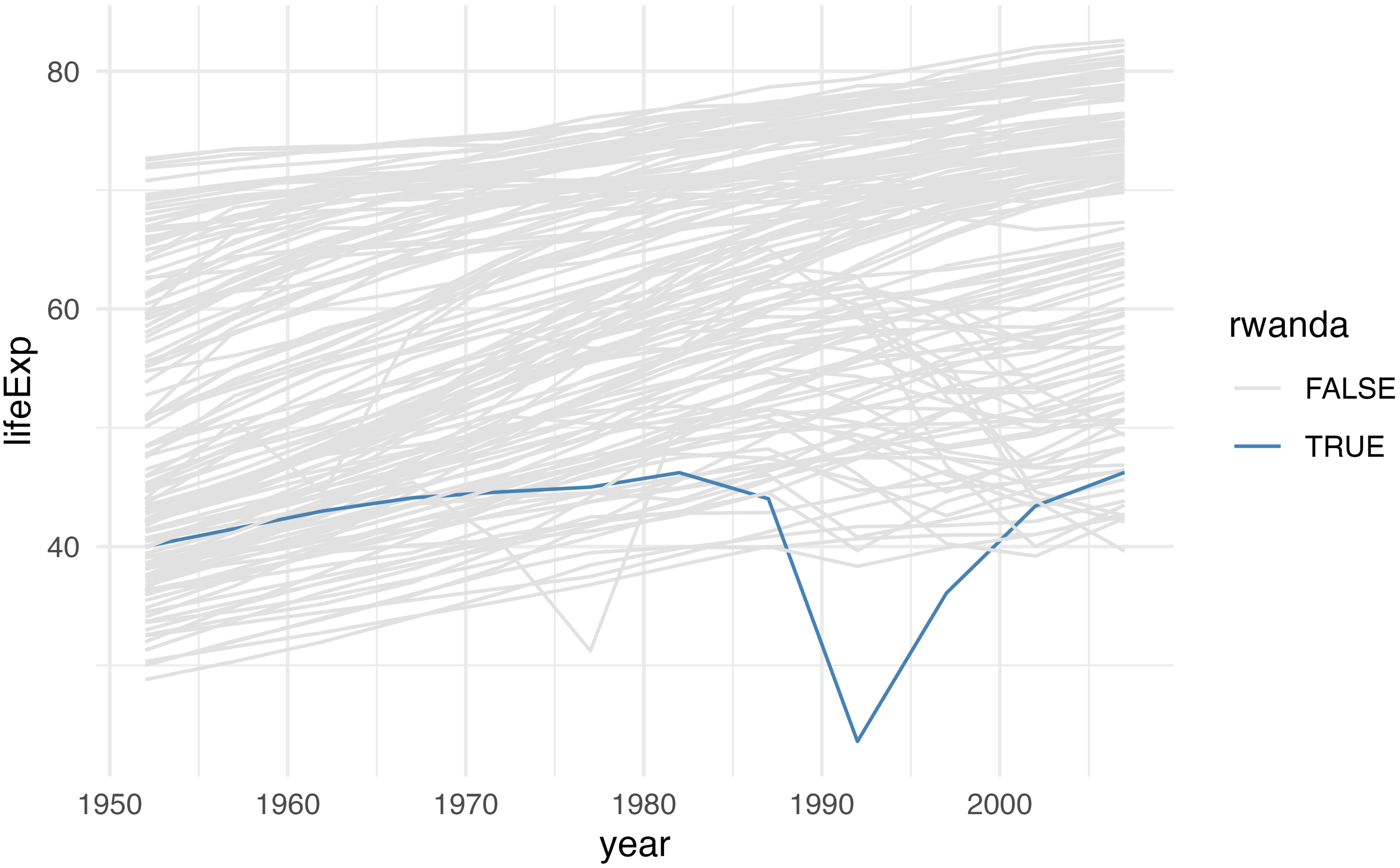
```
[1]   1 100   7
```

Working with vectors

Modify elements

```r
x[x > 10] <- NA
x
```

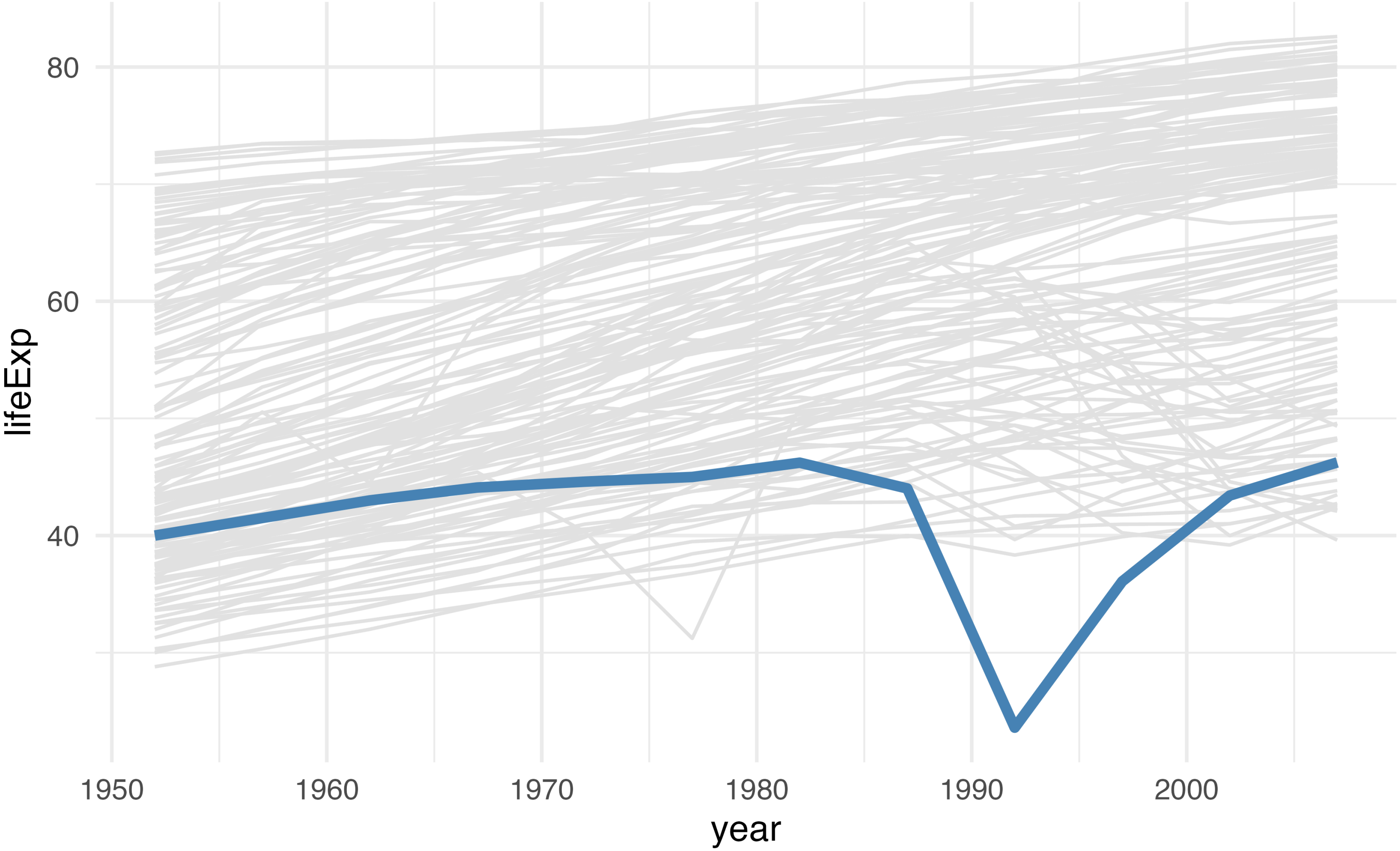
```
[1]  1 NA  7
```


80
60
40
lifeExp
1950
1960
1970
1980
1990
2000
year
rwanda
FALSE
TRUE

```r
cols <- c("grey90", "steelblue")

gapminder |>
  mutate(rwanda = ifelse(country == "Rwanda", TRUE, FALS
  ggplot(aes(year, lifeExp, color = rwanda, group = cou
  geom_line() +
  scale_color_manual(values = cols) +
  theme_minimal()
```

```r
cols <- c("grey90", "steelblue")

gapminder |>
  mutate(rwanda = ifelse(country == "Rwanda", TRUE, FALS
  ggplot(aes(year, lifeExp, group = country)) +
  geom_line(
    data = function(x) filter(x, !rwanda),
    color = cols[[1]]
  ) +
  theme_minimal()
```

```r
cols <- c("grey90", "steelblue")

gapminder |>
  mutate(rwanda = ifelse(country == "Rwanda", TRUE, FALS
  ggplot(aes(year, lifeExp, color = rwanda, group = cou
  geom_line(
    data = function(x) filter(x, !rwanda),
    color = cols[[1]]
  ) +
  geom_line(
    data = function(x) filter(x, rwanda),
    color = cols[[2]],
    linewidth = 1.5
  ) +
  theme_minimal()
```


80
60
40
lifeExp
1950
1960
1970
1980
1990
2000
year

Your Turn 2

Create a numeric vector that has the following values: 3, 5, NA, 2, and NA.

Try using `sum()`. Then add `na.rm = TRUE`.

Check which values are missing with `is.na()`; save the results to a new object and take a look

Change all missing values of `x` to -9999.

Try `sum()` again without `na.rm = TRUE`.

Your Turn 2

```r
x <- c(3, 5, NA, 2, NA)
sum(x)
```

```
[1] NA
```

Your Turn 2

```r
sum(x, na.rm = TRUE)
```

```
[1] 10
```

Your Turn 2

```r
x_missing <- is.na(x)
x_missing
```

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

```r
x[x_missing] <- -9999
x
```

```
[1]     3     5 -9999     2 -9999
```

Writing Functions

Functions that return vectors

```r
gdpPercap <- gapminder |>
  filter(year == 1952, continent == "Americas") |>
  pull(gdpPercap)

sum(gdpPercap)
```

```
[1] 101976.6
```

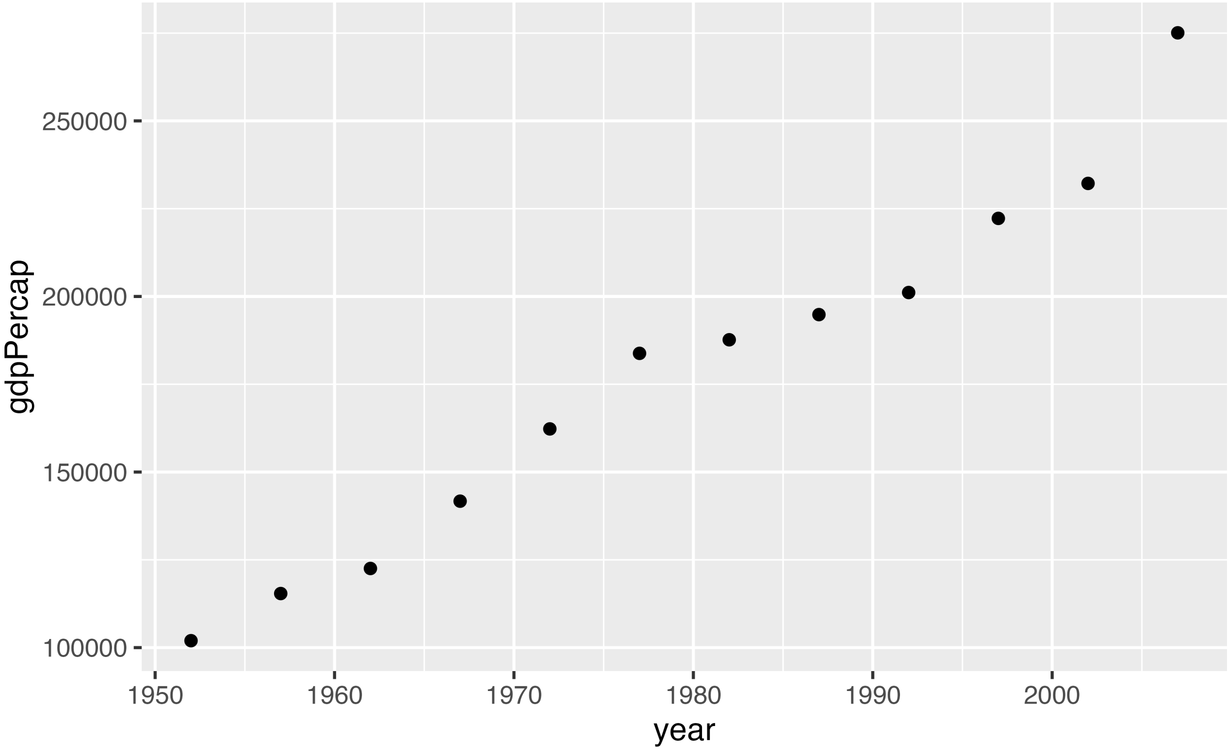
Functions that return data frames

```r
gapminder |>
  group_by(year) |>
  filter(continent == "Americas") |>
  summarize(gdpPercap = sum(gdpPercap))
```

```
# A tibble: 12 × 2
    year gdpPercap
   <int>     <dbl>
 1  1952   101977.
 2  1957   115401.
 3  1962   122539.
 4  1967   141706.
 5  1972   162283.
 6  1977   183800.
 7  1982   187668.
 8  1987   194835.
 9  1992   201123.
10  1997   222233.
11  2002   222102
```

Functions that make plots

```r
gapminder |>
  group_by(year) |>
  filter(continent == "Americas") |>
  summarize(gdpPercap = sum(gdpPercap)) |>
  ggplot(aes(year, gdpPercap)) +
  geom_point()
```



Why write functions?

To make repetitive code reusable

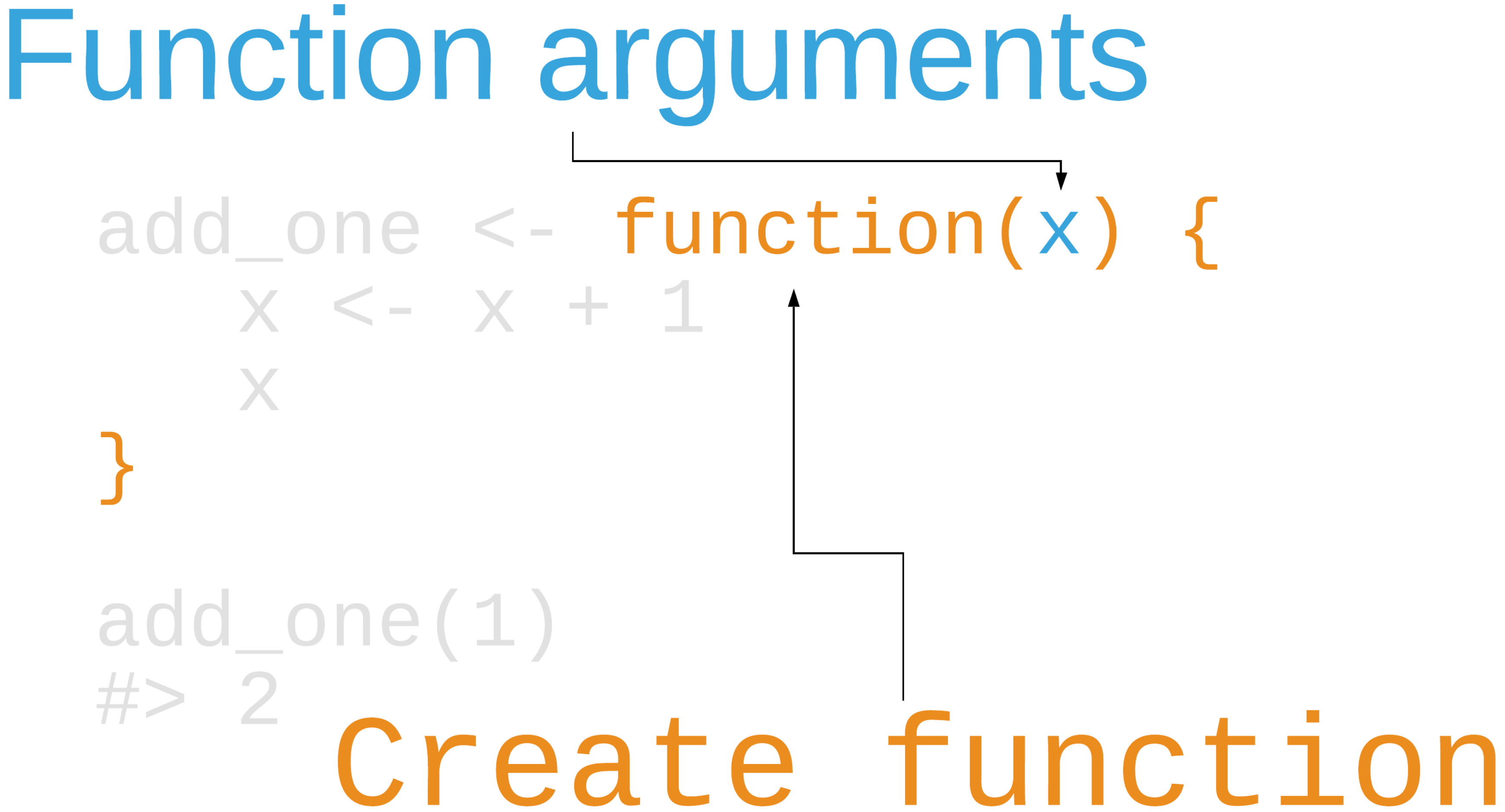
To make complex code understandable

To make useful code shareable

Writing functions

```
add_one <- function(x) {
   x <- x + 1
   x
}

add_one(1)
#> 2
```

Writing functions

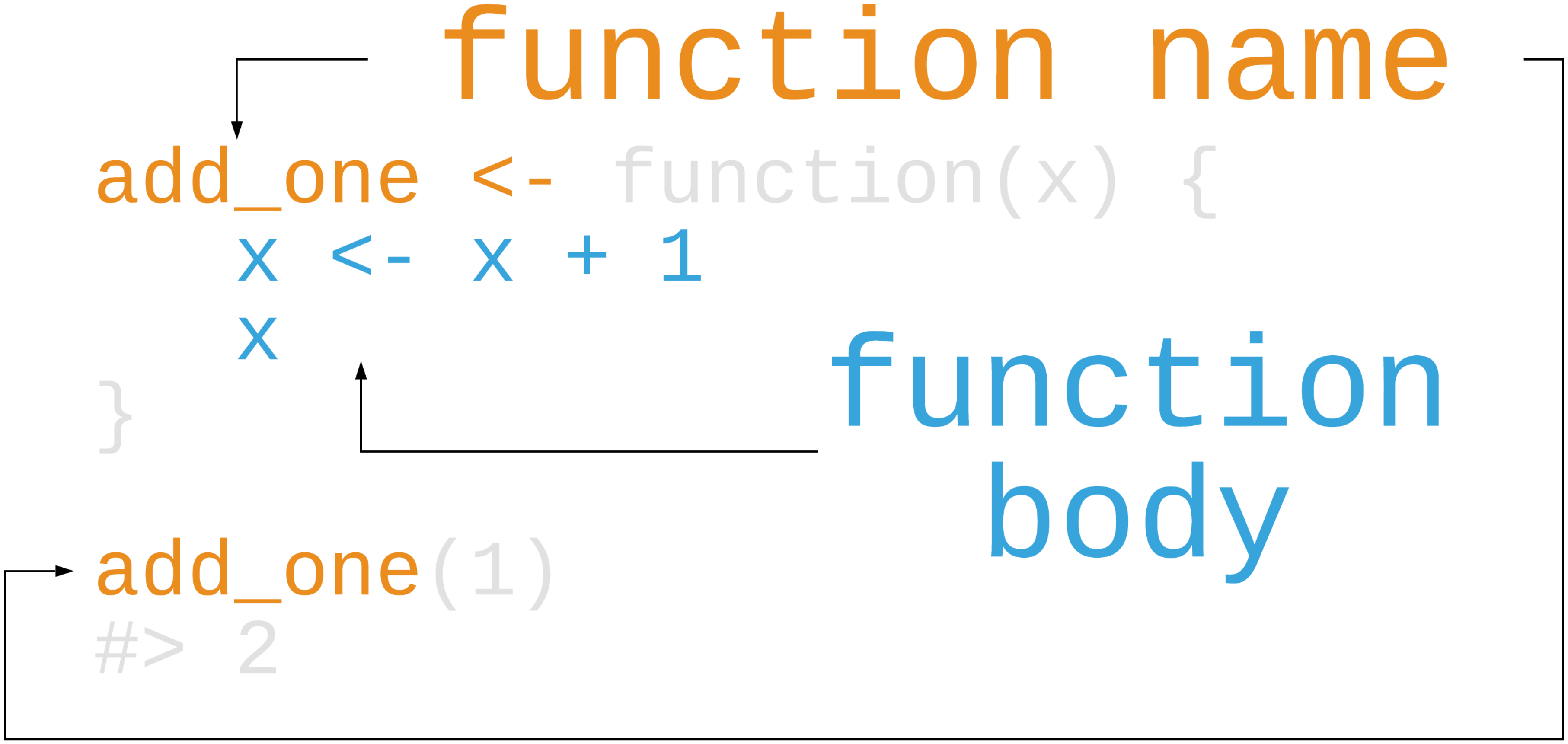


Function arguments

```
add_one <- function(x) {
    x <- x + 1
    x
}

add_one(1)
#> 2
```

Create function

Writing functions

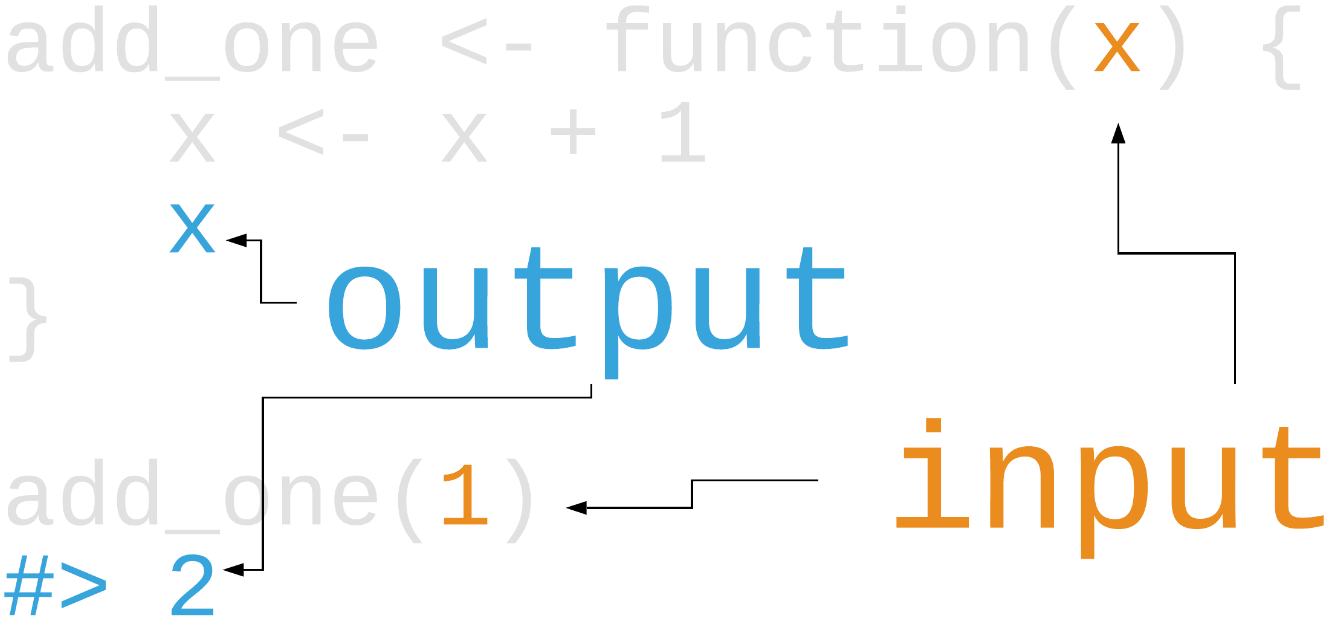


function name

```
add_one <- function(x) {
    x <- x + 1
    x
}

add_one(1)
#> 2
```

function body

Writing functions



```
add_one <- function(x) {
    x <- x + 1
    x
}

add_one(1)
#> 2
```

output

input

Your Turn 3

Create a function called `sim_data` that doesn't take any arguments.

In the function body, we'll return a `tibble`.

For `x`, have `rnorm()` return 50 random numbers.

For `sex`, use `rep()` to create 50 values of "male" and "female". Hint: You'll have to give `rep()` a character vector. for the first argument. The `times` argument is how many times `rep()` should repeat the first argument, so make sure you account for that.

For `age()` use the `sample()` function to sample 50 numbers from 25 to 50 with replacement.

Call `sim_data()`

Your Turn 3

```r
sim_data <- function() {
  tibble(
    x = rnorm(50),
    sex = rep(c("male", "female"), times = 25),
    age = sample(25:50, size = 50, replace = TRUE)
  )
}

sim_data()
```

Your Turn 3

```
# A tibble: 50 × 3
           x sex      age
       <dbl> <chr>  <int>
 1 -1.08     male      41
 2 -0.599    female    29
 3  0.00901  male      41
 4  1.77     female    37
 5 -0.279    male      49
 6 -0.350    female    25
 7 -0.357    male      32
 8  2.35     female    36
 9 -1.29     male      37
10 -1.55     female    41
# ℹ 40 more rows
```

E-Values

The strength of unmeasured confounding required to explain away a value

Rate ratio: 3.9 = **E-value: 7.3**

Your Turn 4

Write a function to calculate an E-Value given an RR.

Call the function `evalue` and give it an argument called `estimate`. In the body of the function, calculate the E-Value using `estimate + sqrt(estimate * (estimate - 1))`

Call `evalue()` for a risk ratio of 3.9

Your Turn 4

```r
evalue <- function(estimate) {
  estimate + sqrt(estimate * (estimate - 1))
}
```

Invoking the function with `()`

```r
evalue(3.9)
```

```
[1] 7.263034
```

Control Flow

```
if (PREDICATE) {
  true_result
}
```

Control Flow

```
if (PREDICATE) {
  true_result
} else {
  default_result
}
```

Control Flow

```
if (PREDICATE) {
  true_result
} else if (ANOTHER_PREDICATE) {
  true_result
} else  {
  default_result
}
```

If-else with vectors

```r
ifelse(PREDICATE_VECTOR, true_result, false_result)
dplyr::case_when(
  PREDICATE_VECTOR ~ true_result,
  PREDICATE_VECTOR ~ next_true_result,
  .default = default_result
)
switch(
  x,
  value1 = result1,
  value2 = result2
)
```

Validation and stopping

if (is.numeric(x)) stop(), warn()

```r
function(x) {
  if (is.numeric(x)) stop("x must be a character")
  # do something with a character
}
```

Your Turn 5

Use `if ()` together with `is.numeric()` to make sure `estimate` is a number. Remember to use `!` for not.

If the estimate is less than 1, set `estimate` to be equal to `1 / estimate`.

Call `evalue()` for a risk ratio of 3.9. Then try 0.80. Then try a character value.

Your Turn 5

```r
evalue <- function(estimate) {
  if (!is.numeric(estimate)) stop("`estimate` must be nu
  if (estimate < 1) estimate <- 1 / estimate
  estimate + sqrt(estimate * (estimate - 1))
}
```

Your Turn 5

```r
evalue(3.9)
```

```
[1] 7.263034
```

```r
evalue(.80)
```

```
[1] 1.809017
```

```r
evalue("3.9")
```

```
Error in evalue("3.9"): `estimate` must be numeric
```

Your Turn 6

Add a new argument called `type`. Set the default value to `"rr"`

Check if `type` is equal to `"or"`. If it is, set the value of `estimate` to be `sqrt(estimate)`

Call `evalue()` for a risk ratio of 3.9. Then try it again with `type = "or"`.

Your Turn 6

```r
evalue <- function(estimate, type = "rr") {
  if (!is.numeric(estimate)) stop("`estimate` must be nu
  if (type == "or") estimate <- sqrt(estimate)
  if (estimate < 1) estimate <- 1 / estimate
  estimate + sqrt(estimate * (estimate - 1))
}
```

Your Turn 6

```r
evalue(3.9)
```

```
[1] 7.263034
```

```r
evalue(3.9, type = "or")
```

```
[1] 3.362342
```

Your Turn 7: Challenge!

Create a new function called `transform_to_rr` with arguments `estimate` and `type`.

Use the same code above to check if `type == "or"` and transform if so. Add another line that checks if `type == "hr"`. If it does, transform the estimate using this formula: `(1 - 0.5^sqrt(estimate)) / (1 - 0.5^sqrt(1 / estimate))`.

Move the code that checks if `estimate < 1` to `transform_to_rr` (below the OR and HR transformations)

Return `estimate`

In `evalue()`, change the default argument of `type` to be a character vector containing "rr", "or", and "hr".

Get and validate the value of `type` using `match.arg()`. Follow the pattern `argument_name <- match.arg(argument_name)`

Transform `estimate` using `transform_to_rr()`. Don't forget to pass it both `estimate` and `type`!

Your Turn 7: Challenge!

```r
transform_to_rr <- function(estimate, type) {
  if (type == "or") estimate <- sqrt(estimate)
  if (type == "hr") {
    estimate <-
      (1 - 0.5^sqrt(estimate)) / (1 - 0.5^sqrt(1 / estimate))
  }
  if (estimate < 1) estimate <- 1 / estimate

  estimate
}

evalue <- function(estimate, type = c("rr", "or", "hr")) {
  # validate arguments
  if (!is.numeric(estimate)) stop("`estimate` must be numeric")
  type <- match.arg(type)

  # calculate evalue
  estimate <- transform_to_rr(estimate, type)
  estimate + sqrt(estimate * (estimate - 1))
}
```

Your Turn 7: Challenge!

```r
evalue(3.9)
```

```
[1] 7.263034
```

```r
evalue(3.9, type = "or")
```

```
[1] 3.362342
```

```r
evalue(3.9, type = "hr")
```

```
[1] 4.474815
```

```r
evalue(3.9, type = "rd")
```

```
Error in match.arg(type): 'arg' should be one of "rr", "or", "hr"
```

Programming with the tidyverse

Pass the dots: `...`

```r
select_gapminder <- function(...) {
  gapminder |>
    select(...)
}

select_gapminder(pop, year)
```

Pass the dots: `...`

```
# A tibble: 1,704 × 2
         pop  year
       <int> <int>
 1   8425333  1952
 2   9240934  1957
 3  10267083  1962
 4  11537966  1967
 5  13079460  1972
 6  14880372  1977
 7  12881816  1982
 8  13867957  1987
 9  16317921  1992
10  22227415  1997
# ℹ 1,694 more rows
```

Your Turn 8

Use `...` to pass the arguments of your function, `filter_summarize()`, to `filter()`.

In summarize, get the n and mean life expectancy for the data set

Check `filter_summarize()` with `year == 1952`.

Try `filter_summarize()` again for 2002, but also filter countries that have "and" in the country name. Use `str_detect()` from the stringr package.

Your Turn 8

```r
filter_summarize <- function(...) {
  gapminder |>
    filter(...) |>
    summarize(n = n(), mean_lifeExp = mean(lifeExp))
}
```

```r
filter_summarize(year == 1952)
```

```
# A tibble: 1 × 2
      n mean_lifeExp
  <int>        <dbl>
1   142         49.1
```

```r
filter_summarize(year == 2002, str_detect(country, " an
```

```
# A tibble: 1 × 2
      n mean_lifeExp
  <int>        <dbl>
1     4         69.9
```

Writing functions with dplyr, ggplot2, and friends

```r
plot_hist <- function(x) {
  ggplot(gapminder, aes(x = x)) + geom_histogram()
}

plot_hist(lifeExp)
```

```
Error in `geom_histogram()`:
! Problem while computing aesthetics.
ℹ Error occurred in the 1st layer.
Caused by error:
! object 'lifeExp' not found
```

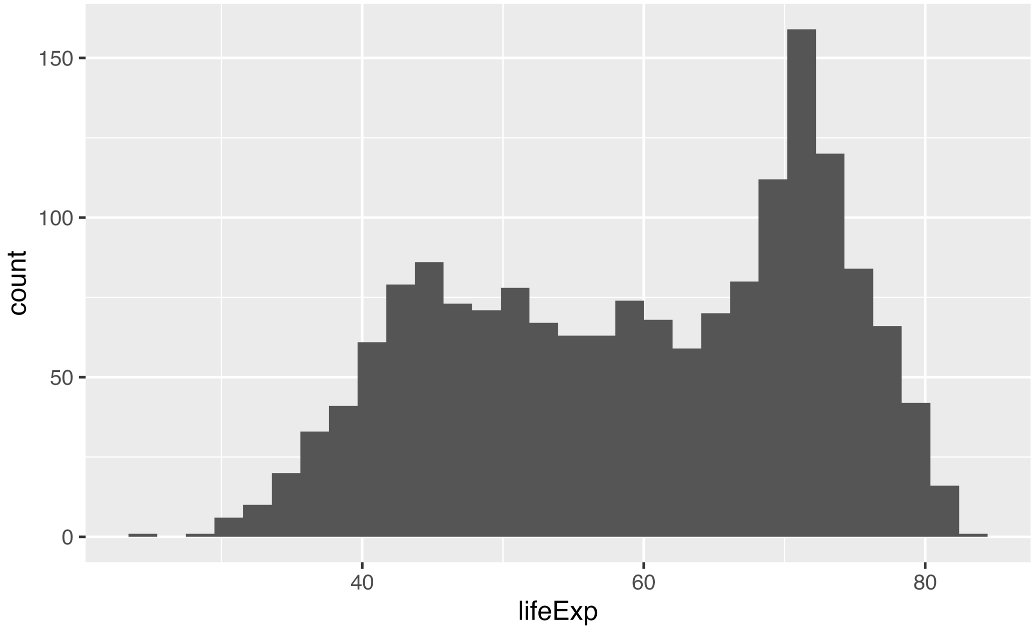
Programming with dplyr, ggplot2, and friends

```r
plot_hist <- function(x) {
  ggplot(gapminder, aes(x = x)) + geom_histogram()
}

plot_hist("lifeExp")
```

```
Error in `geom_histogram()`:
! Problem while computing stat.
ℹ Error occurred in the 1st layer.
Caused by error in `setup_params()`:
! `stat_bin()` requires a continuous x aesthetic.
✖ the x aesthetic is discrete.
ℹ Perhaps you want `stat="count"`?
```

Curly-curly: { variable }

```r
plot_hist <- function(x) {
  ggplot(gapminder, aes(x = {{ x }})) + geom_histogram(
}

plot_hist(lifeExp)
```



Your turn 9

Filter gapminder by `year` using the value of `.year` (notice the period before hand!). You do NOT need curly-curly for this. (Why is that?)

Arrange it by the variable. This time, do wrap it in curly-curly!

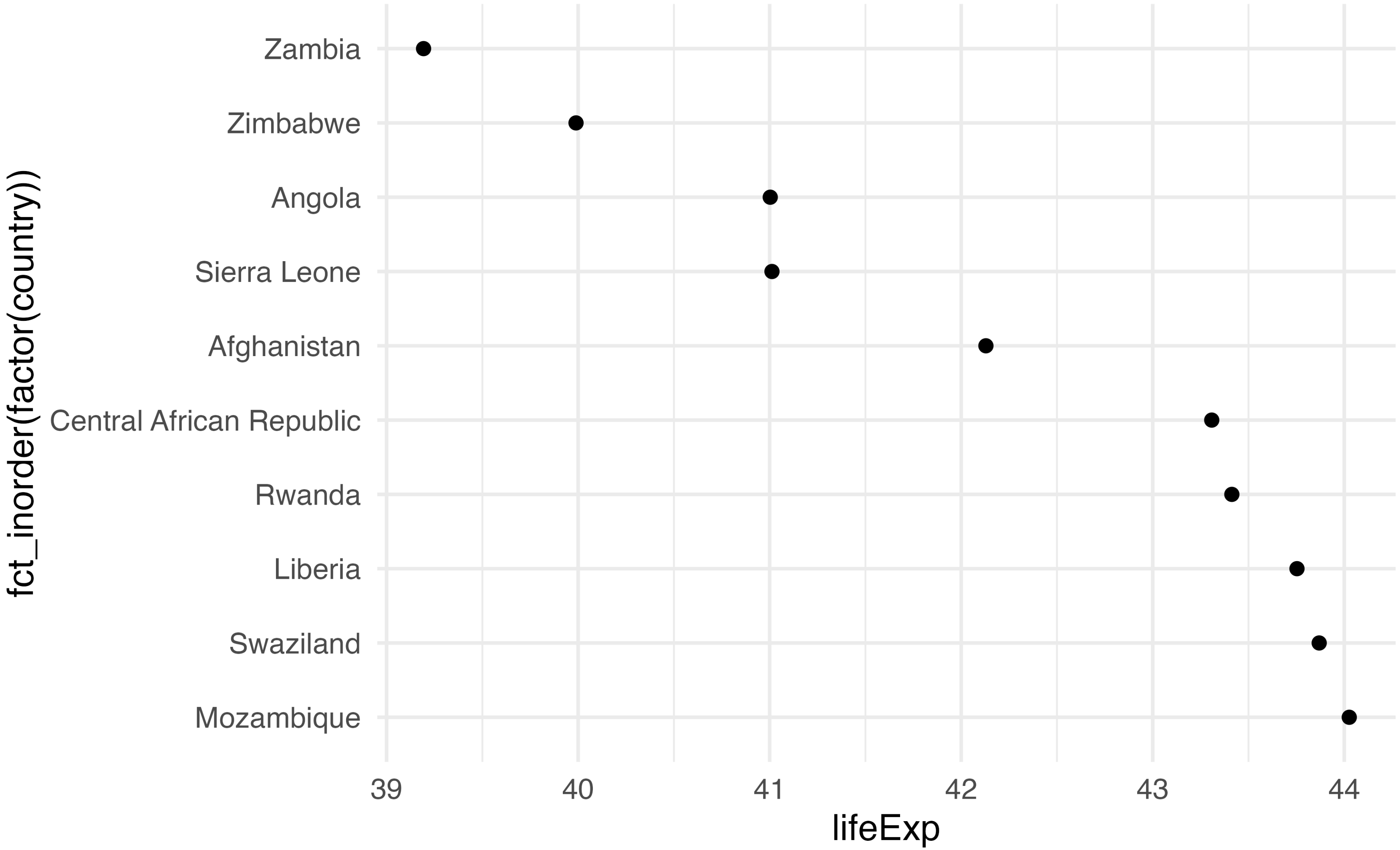
Make a scatter plot. Use `variable` for x. For y, we'll use `country`, but to keep it in the order we arranged it by, we'll turn it into a factor. Wrap the the `factor()` call with `fct_inorder()`. Check the help page if you want to know more about what this is doing.

Your turn 9

```r
top_scatter_plot <- function(variable, .year) {
  gapminder |>
    filter(year == .year) |>
    arrange(desc({{ variable }})) |>
    #  take the 10 lowest values
    tail(10) |>
    ggplot(aes(x = {{ variable }}, y = fct_inorder(fact
    geom_point() +
    theme_minimal()
}
```

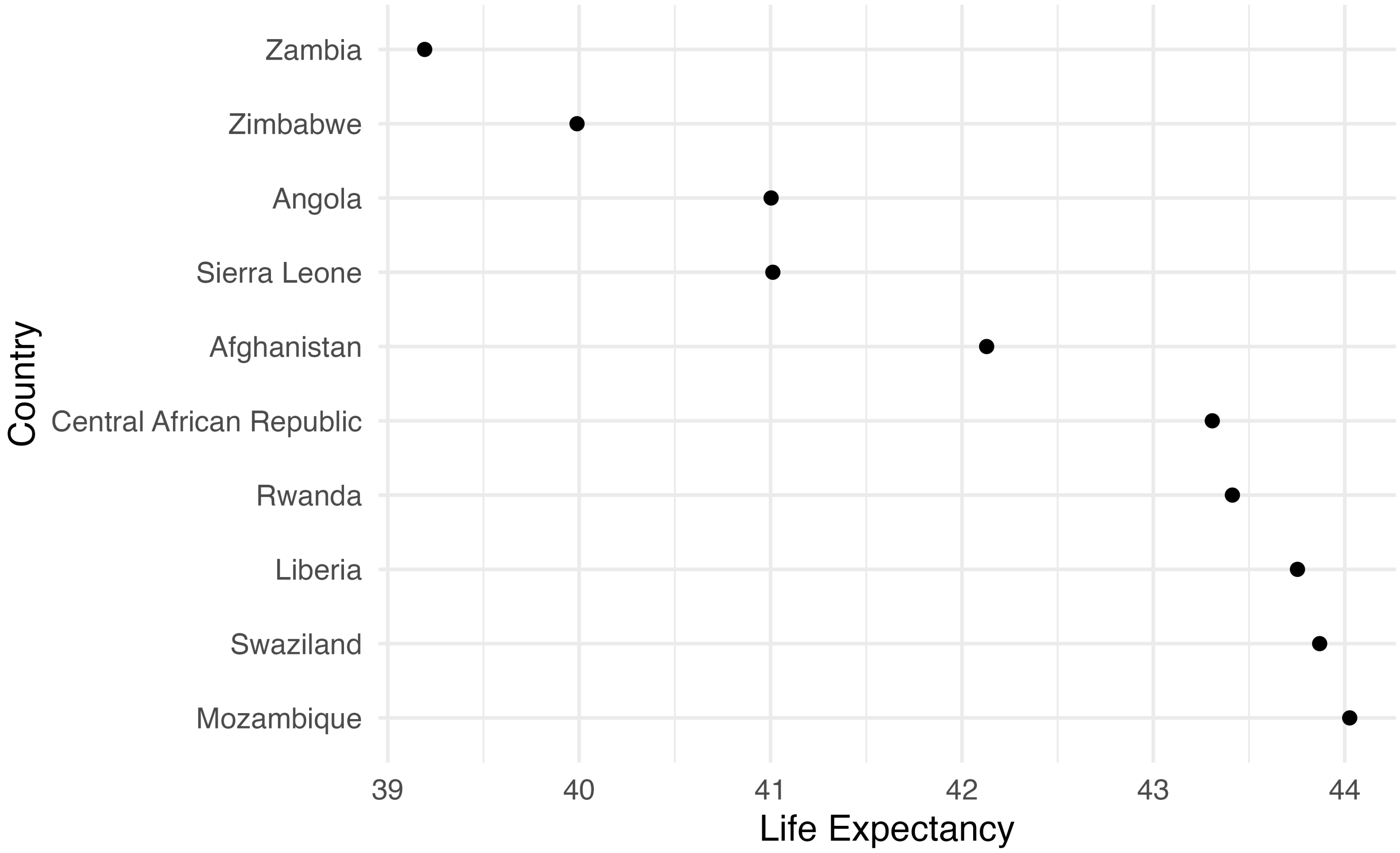
Your turn 9

```r
top_scatter_plot(lifeExp, 2002)
```



Your turn 9

```r
top_scatter_plot(lifeExp, 2002) +
  labs(x = "Life Expectancy", y = "Country")
```



Resources

R for Data Science, 2nd ed.: A comprehensive but friendly introduction to the Tidyverse. Free online.

Advanced R, 2nd ed.: Detailed guide to how R works and how to make your code better. Free online.