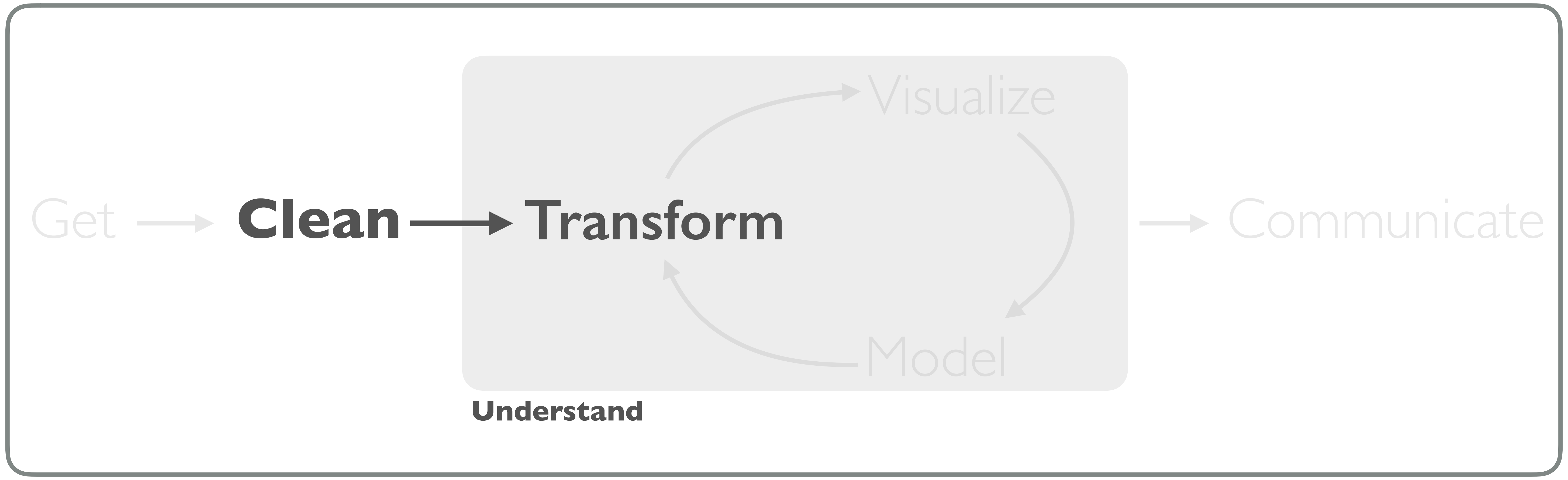
REGULAR EXPRESSIONS



Program

†A modified version of Hadley Wickham's analytic process

> “Analysts are often trained to handle tabular or rectangular data that are mostly numeric, but much of the data proliferating today are unstructured and text-heavy.”
>
> – Julia Silge and David Robinson

PREREQUISITES

PACKAGE PREREQUISITE

```
library(tidyverse)

if (packageVersion("devtools") < 1.6) {
  install.packages("devtools")
}

devtools::install_github("bradleyboehmke/harrypotter")
library(harrypotter)
```

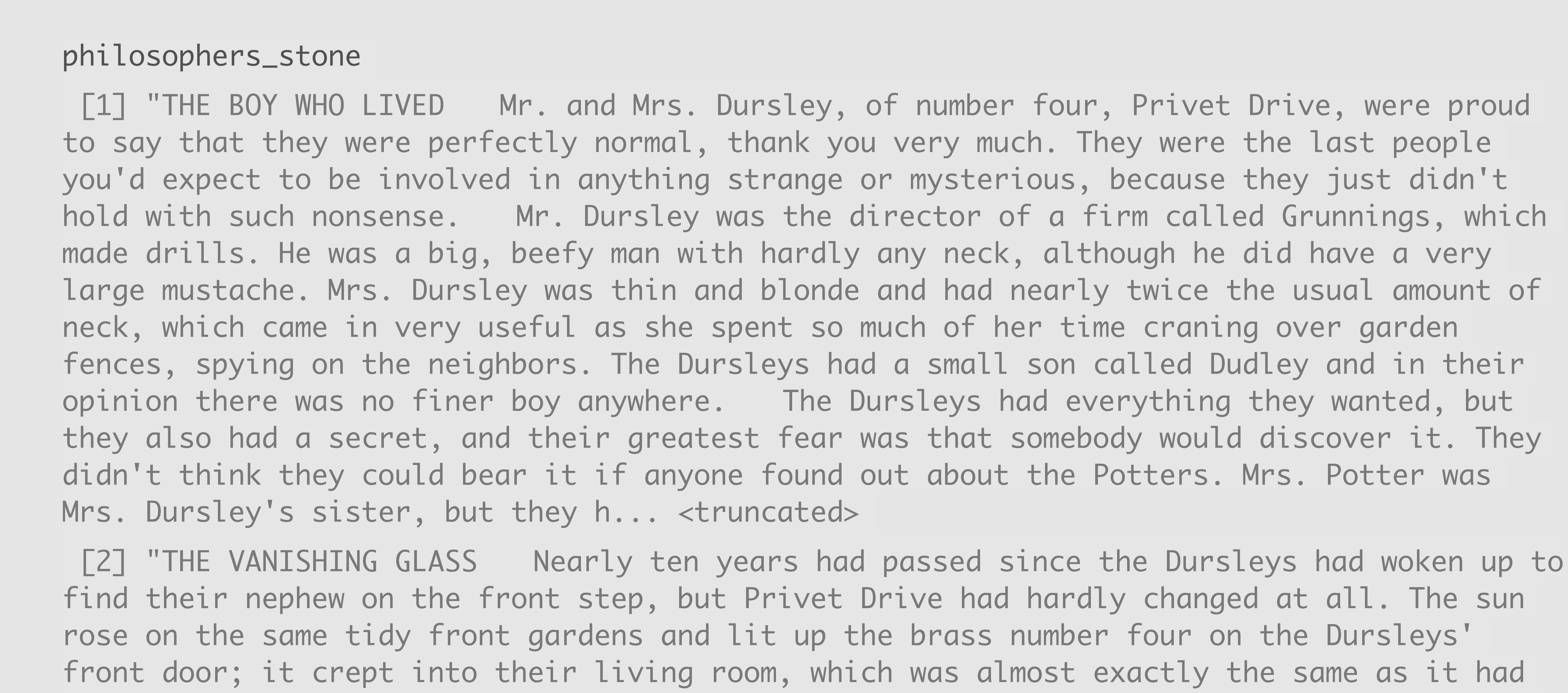
REGULAR EXPRESSIONS

- Regular expressions (regex) are strings to identify patterns in text
- Two areas of focus:
    i. regex functions
    ii. regex syntax
- The `stringr` package provides us a convenient approach to regex text mining
- We'll explore dealing with regex in both character strings and data frames

REGEX FUNCTIONS

Dealing with character strings

DATA PREREQUISITE



```
philosophers_stone

 [1] "THE BOY WHO LIVED   Mr. and Mrs. Dursley, of number four, Privet Drive, were proud
to say that they were perfectly normal, thank you very much. They were the last people
you'd expect to be involved in anything strange or mysterious, because they just didn't
hold with such nonsense.   Mr. Dursley was the director of a firm called Grunnings, which
made drills. He was a big, beefy man with hardly any neck, although he did have a very
large mustache. Mrs. Dursley was thin and blonde and had nearly twice the usual amount of
neck, which came in very useful as she spent so much of her time craning over garden
fences, spying on the neighbors. The Dursleys had a small son called Dudley and in their
opinion there was no finer boy anywhere.   The Dursleys had everything they wanted, but
they also had a secret, and their greatest fear was that somebody would discover it. They
didn't think they could bear it if anyone found out about the Potters. Mrs. Potter was
Mrs. Dursley's sister, but they h... <truncated>

 [2] "THE VANISHING GLASS   Nearly ten years had passed since the Dursleys had woken up to
find their nephew on the front step, but Privet Drive had hardly changed at all. The sun
rose on the same tidy front gardens and lit up the brass number four on the Dursleys'
front door; it crept into their living room, which was almost exactly the same as it had
```

str_*

```
str_*(string, pattern)
```

`string`: character vector

`pattern`: regex pattern to look for

str_*

```
str_detect(philosophers_stone, "Harry")
 [1] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
[10] TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE
```

`str_detect:` does the expression exist?

str_*

```
str_detect(philosophers_stone, "Harry")

str_count(philosophers_stone, “Harry")
 [1]  20  79  68  48 147 117  63  49  70  82  68
[12]  99  62  45  93 116  99
```

str_count: how many instances are there?

str_*

```
str_detect(philosophers_stone, "Harry")

str_count(philosophers_stone, “Harry")

str_extract(philosophers_stone, “Harry")
 [1] "Harry" "Harry" "Harry" "Harry" "Harry"
 [6] "Harry" "Harry" "Harry" "Harry" "Harry"
[11] "Harry" "Harry" "Harry" "Harry" "Harry"
[16] "Harry" "Harry"
```

`str_extract:` extract the **first** instance

str_*

```
str_detect(philosophers_stone, "Harry")

str_count(philosophers_stone, “Harry")

str_extract(philosophers_stone, “Harry")

str_extract_all(philosophers_stone, “Harry")
[[1]]
 [1] "Harry" "Harry" "Harry" "Harry" "Harry"
 [6] "Harry" "Harry" "Harry" "Harry" "Harry"
[11] "Harry" "Harry" "Harry" "Harry" "Harry"
[16] "Harry" "Harry" "Harry" "Harry" "Harry"

[[2]]
 [1] "Harry" "Harry" "Harry" "Harry" "Harry"
 [6] "Harry" "Harry" "Harry" "Harry" "Harry"
[11] "Harry" "Harry" "Harry" "Harry" "Harry"
[16] "Harry" "Harry" "Harry" "Harry" "Harry"
```

`str_extract_all`: extract **all** instances

str_*

```
str_detect(philosophers_stone, "Harry")

str_count(philosophers_stone, “Harry")

str_extract(philosophers_stone, “Harry")

str_extract_all(philosophers_stone, “Harry")

str_locate_all(philosophers_stone, “Harry")
[[1]]
      start   end
 [1,]  5243  5247
 [2,]  5798  5802
 [3,]  5868  5872
 [4,] 10231 10235
 [5,] 18057 18061
 [6,] 18190 18194
 [7,] 18521 18525
```

`str_locate_all:` locate the position of **<u>all</u>** instances

YOUR TURN!

Take 5 minutes to explore the various **`str_*`** *functions*

REGEX SYNTAX

Dealing with character strings

`([a-z][^a-z0-9`

MULTIPLE WORDS / CASE SENSITIVE

```
str_count(philosophers_stone, "Harry  Potter”)

[1] 5 2 0 2 3 5 1 1 0 0 0 0 0 1 5 0 3
```

Phrases

MULTIPLE WORDS / CASE SENSITIVE

```
str_count(philosophers_stone, "Harry  Potter”)

str_count(philosophers_stone, "Harry|Potter”)

 [1]  28  57  56  30 109  76  50  44  55  67  52  73  52

[14]  31  70  80  61
```

“Harry” or “Potter”

MULTIPLE WORDS / CASE SENSITIVE

```
str_count(philosophers_stone, "Harry  Potter”)

str_count(philosophers_stone, "Harry | Potter”)

str_count(philosophers_stone, “ye(s|ah)”)

 [1] 17  5  3  7 25  9 13  5  8  4  5 10  1  4  8 12  8
```

“yes” or “yeah”

MULTIPLE WORDS / CASE SENSITIVE

```
str_count(philosophers_stone, "Harry  Potter”)

str_count(philosophers_stone, "Harry | Potter”)

str_count(philosophers_stone, “ye(s|ah)”)

str_count(philosophers_stone, “boy")                              ← default

 [1]  9  7  2  5 15 34  5  1  7  1  0  3  0  0  3  2  6


str_count(philosophers_stone, regex("boy", ignore_case = TRUE))   ← ignore case

 [1] 10  7  2  5 15 34  5  1  7  1  0  3  0  0  3  2  6
```

YOUR TURN!

How many times are “Mr” and “Mrs” used in `philosophers_stone`*?*

ANCHORS

```
str_count(deathly_hallows, "^Harry")
 [1] 0 1 0 1 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 1 1 1 1 0 0 0 0
[28] 1 0 0 0 0 1 0 0 0 0
```

^ :   Identify patterns at the **beginning** of an element

ANCHORS

```
str_count(deathly_hallows, "^Harry")
str_count(philosophers_stone,
          regex("end$", ignore_case = TRUE))
 [1] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
```

$: Identify patterns at the **end** of an element

YOUR TURN!

Extract all elements in **`deathly_hallows`** *that start with "Harry"*

SPECIAL PATTERNS

```
str_extract(philosophers_stone, “Harry.")
 [1] "Harry\"" "Harry "  "Harry "  "Harry!"
 [5] "Harry "  "Harry'"  "Harry'"  "Harry "
 [9] "Harry "  "Harry "  "Harry "  "Harry "
[13] "Harry "  "Harry,"  "Harry'"  "Harry "
[17] "Harry."
```

. : wild card - **any character**

SPECIAL PATTERNS

```
str_extract(philosophers_stone, “Harry.")

str_extract(philosophers_stone, "\\d")
 [1] NA   NA   "4" "1" "0" "1" NA   "3" "3" NA   "1" NA
[13] "1" "1" NA   "1" NA
```

`\\d:` digits

SPECIAL PATTERNS

```
str_detect(philosophers_stone, "Harry")

str_extract(philosophers_stone, "\\d")

str_extract(philosophers_stone, "[1|4]")
 [1] NA   NA   "4" "1" "1" "1" NA   "1" NA   NA   "1" NA  
[13] "1" "1" NA   "1" NA  
```

`[d|d]`: specified digits

SPECIAL PATTERNS

```
str_detect(philosophers_stone, "Harry")

str_count(philosophers_stone, “Harry")

str_extract(philosophers_stone, "[1|4]")

str_extract(philosophers_stone, ".[yz].")
 [1] "ey," "ly " "azi" "ey " "ry " "ry'" "ry " " yo"
 [9] "ry " "oy " "ey " "oze" "ry " "ey'" "dy " " ye"
[17] "ry."
```

`[a-zA-Z]`: specified letters

YOUR TURN!

How many times is the word "Harry" get followed by a word that starts with a vowel in `philosophers_stone`*?*

REPETITION

```
str_extract(philosophers_stone, "[aeiou]{4}")

str_extract(philosophers_stone, "[aeiou]{3,}")

str_extract(philosophers_stone, “[aeiou]{3,4}")
 [1] "iou" "uie" "iou" "uee" "iou" "iou" "uie" "uea"
 [9] "uie" "iou" "iou" "iou" "eei" "iou" "iou" "iou"
[17] "uie"
```

`{n}`: find n repetitions

`{n,}`: find n or more repetitions

`{n,m}`: find n to m repetitions

YOUR TURN!

1. *Without computer support, what is this finding:*

```
str_count(philosophers_stone, regex("((no[[:punct:]])[ ]){3}", ignore_case = TRUE))
```

2. *Extract the 25 characters that precede and follow the use of “Harry" in* `philosophers_stone`

REGEX

Doing similar stuff with a data frame

DATA PREREQUISITE

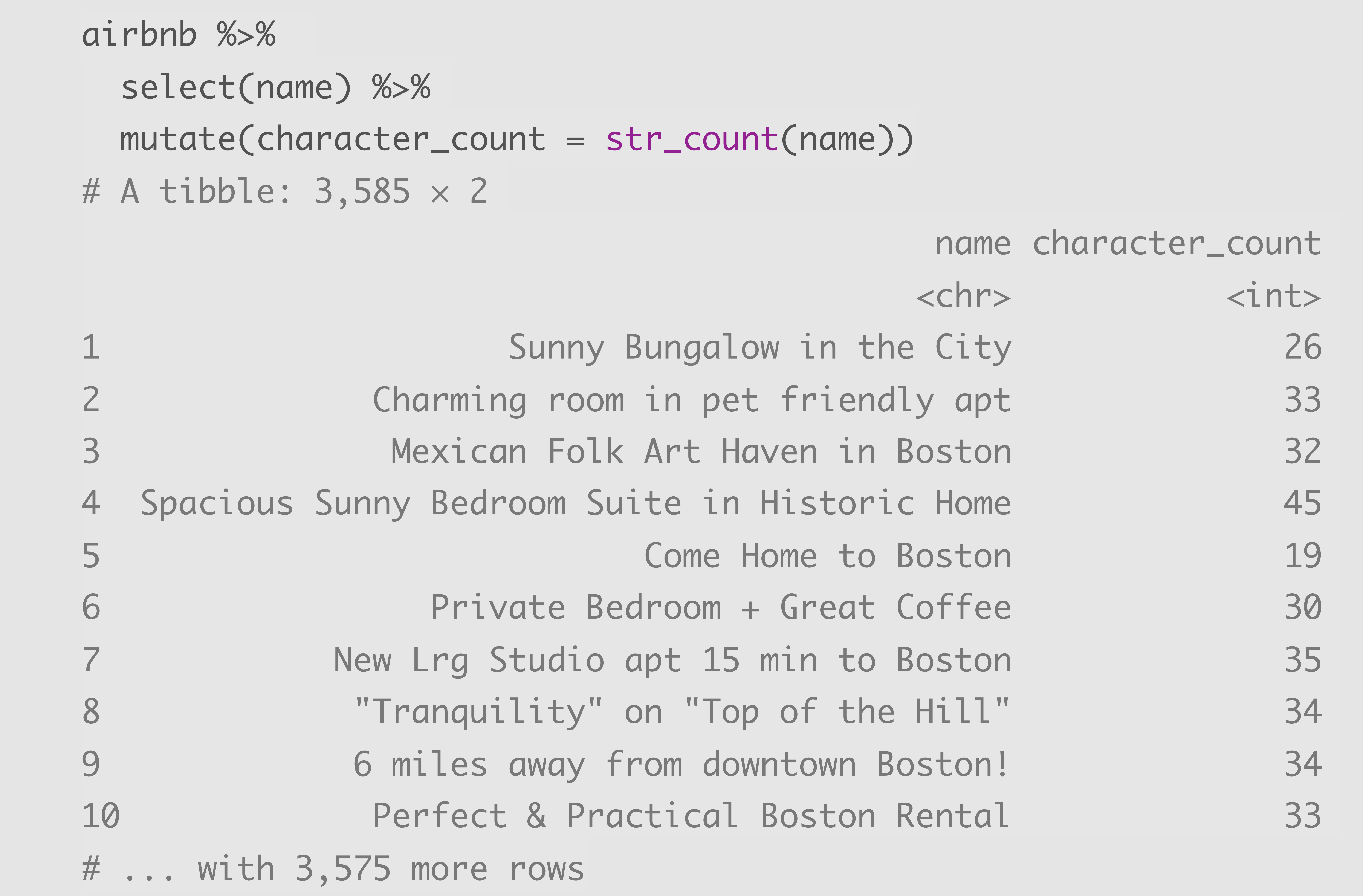
```
airbnb <- read_rds(“data/airbnb.rds”)

airbnb
# A tibble: 3,585 × 95
         id                              listing_url    scrape_id last_scraped
      <int>                                    <chr>        <dbl>       <date>
1  12147973 https://www.airbnb.com/rooms/12147973 2.016091e+13   2016-09-07
2   3075044  https://www.airbnb.com/rooms/3075044 2.016091e+13   2016-09-07
3      6976     https://www.airbnb.com/rooms/6976 2.016091e+13   2016-09-07
4   1436513  https://www.airbnb.com/rooms/1436513 2.016091e+13   2016-09-07
5   7651065  https://www.airbnb.com/rooms/7651065 2.016091e+13   2016-09-07
6  12386020 https://www.airbnb.com/rooms/12386020 2.016091e+13   2016-09-07
7   5706985  https://www.airbnb.com/rooms/5706985 2.016091e+13   2016-09-07
8   2843445  https://www.airbnb.com/rooms/2843445 2.016091e+13   2016-09-07
9    753446   https://www.airbnb.com/rooms/753446 2.016091e+13   2016-09-07
10   849408   https://www.airbnb.com/rooms/849408 2.016091e+13   2016-09-07
```

DATA FRAME REGEX MADE EASY

stringr + dplyr =

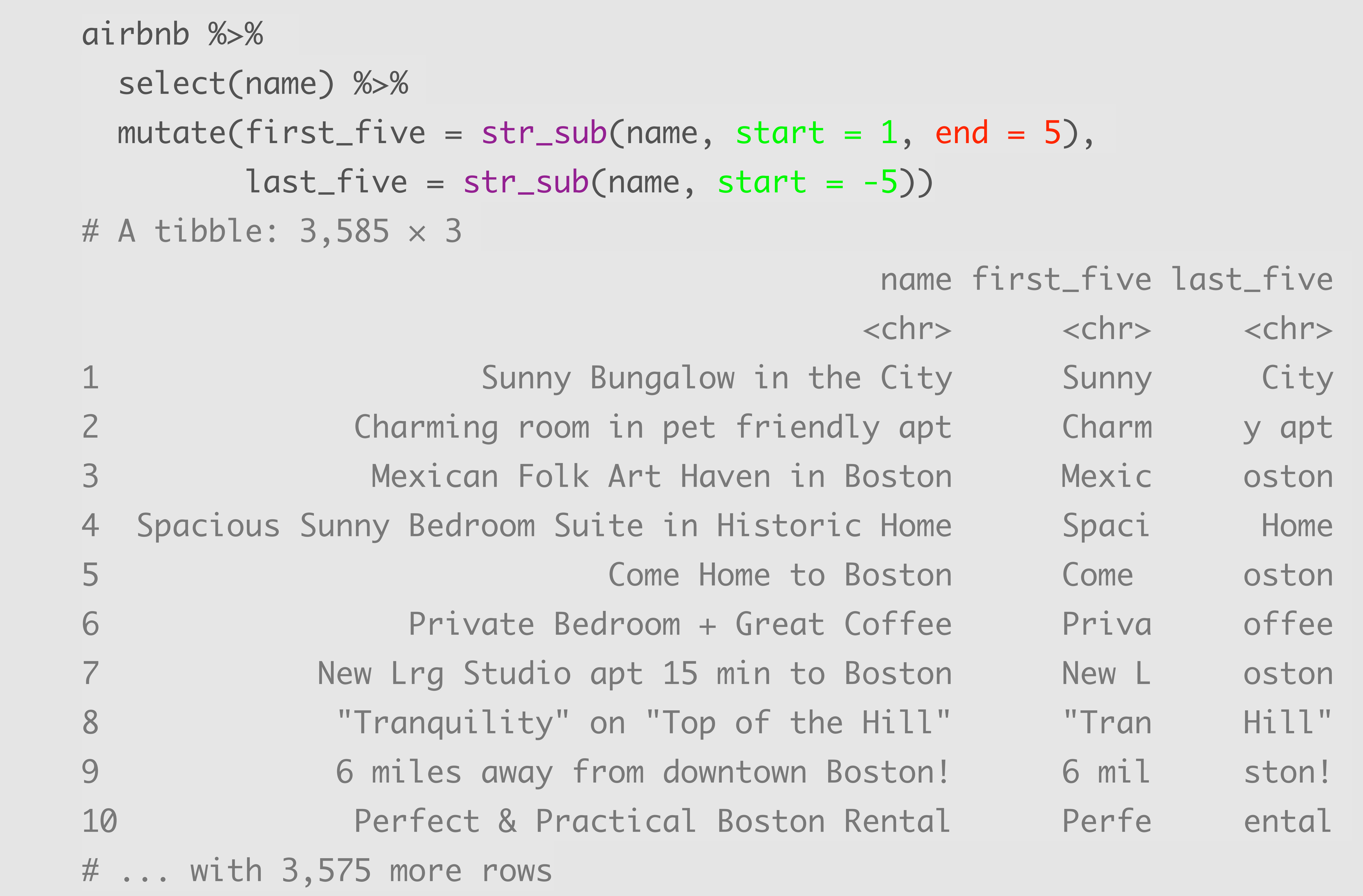
BASICS



```
airbnb %>%
  select(name) %>%
  mutate(character_count = str_count(name))
# A tibble: 3,585 × 2
                                               name character_count
                                              <chr>           <int>
1                        Sunny Bungalow in the City              26
2                 Charming room in pet friendly apt              33
3                  Mexican Folk Art Haven in Boston              32
4  Spacious Sunny Bedroom Suite in Historic Home              45
5                             Come Home to Boston              19
6                      Private Bedroom + Great Coffee              30
7                New Lrg Studio apt 15 min to Boston              35
8                  "Tranquility" on "Top of the Hill"              34
9                  6 miles away from downtown Boston!              34
10                  Perfect & Practical Boston Rental              33
# ... with 3,575 more rows
```

- We can use **str_count** to count the number of characters in a character field

BASICS



```
airbnb %>%
  select(name) %>%
  mutate(first_five = str_sub(name, start = 1, end = 5),
         last_five = str_sub(name, start = -5))
# A tibble: 3,585 × 3
                                            name first_five last_five
                                           <chr>      <chr>     <chr>
1                    Sunny Bungalow in the City      Sunny      City
2              Charming room in pet friendly apt      Charm     y apt
3              Mexican Folk Art Haven in Boston      Mexic     oston
4  Spacious Sunny Bedroom Suite in Historic Home      Spaci      Home
5                          Come Home to Boston      Come      oston
6                 Private Bedroom + Great Coffee      Priva     offee
7             New Lrg Studio apt 15 min to Boston      New L     oston
8              "Tranquility" on "Top of the Hill"      "Tran     Hill"
9              6 miles away from downtown Boston!      6 mil     ston!
10               Perfect & Practical Boston Rental      Perfe     ental
# ... with 3,575 more rows
```

- We can use **str_sub** with start and end arguments to take out a substring

BASICS

```
airbnb %>%
  select(host_name) %>%
  mutate(lower_case = str_to_lower(host_name),
         upper_case = str_to_upper(host_name))
# A tibble: 3,585 x 3
   host_name lower_case upper_case
       <chr>      <chr>      <chr>
1   Virginia   virginia   VIRGINIA
2     Andrea     andrea     ANDREA
3       Phil       phil       PHIL
4     Meghna     meghna     MEGHNA
5      Linda      linda      LINDA
6    Deborah    deborah    DEBORAH
7     Juliet     juliet     JULIET
8    Marilyn    marilyn    MARILYN
9       Sami       sami       SAMI
10     Damon      damon      DAMON
# ... with 3,575 more rows
```

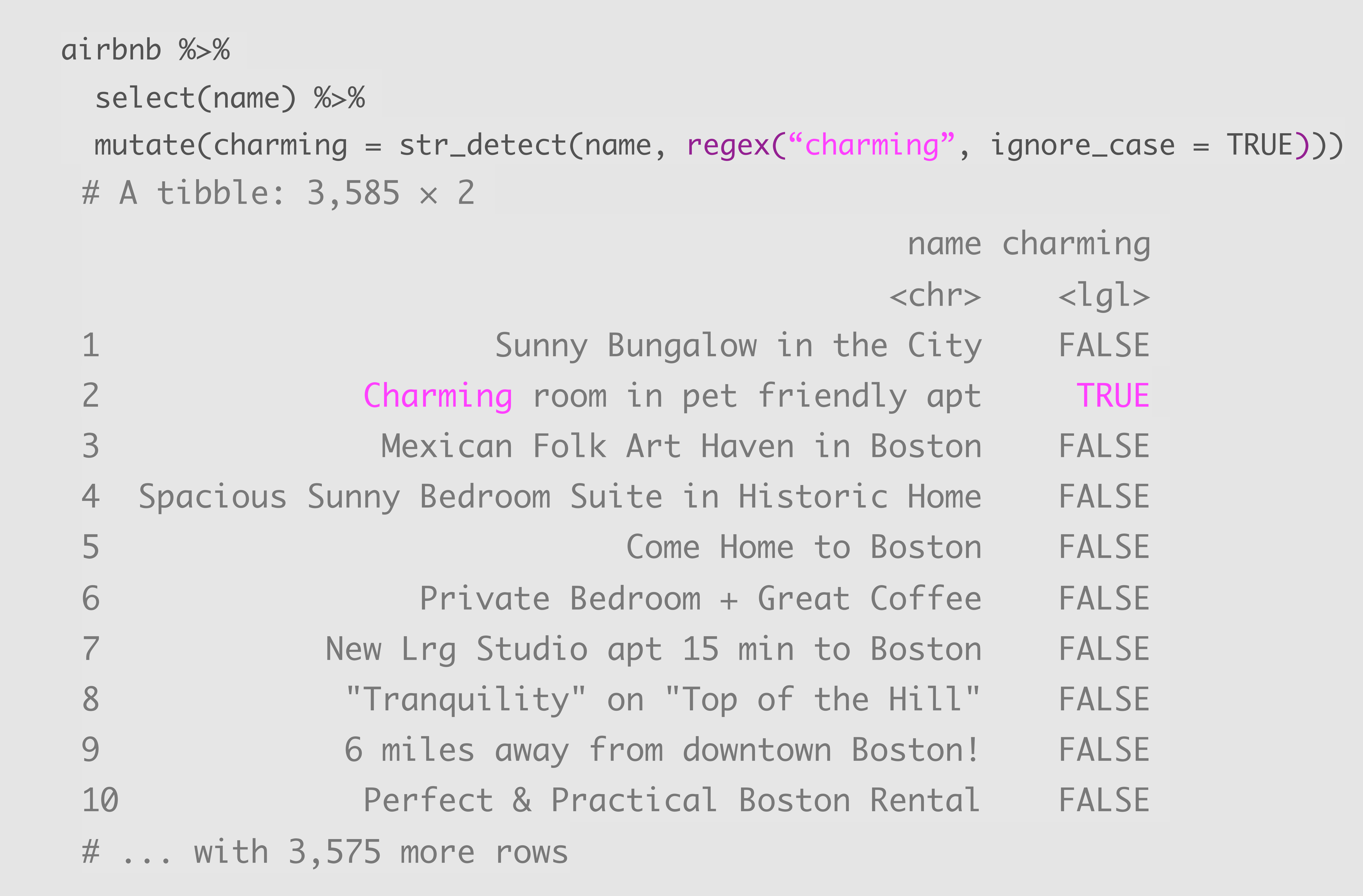
- We can use `str_to_lower` and `str_to_upper` to normalize text case

YOUR TURN!

1. *What is the average number of characters used in the* **`name`** *column? What about the* **`description`** *column?*

2. *What is the most common name in the* **`host_name`** *column?*

FILTERING



```
airbnb %>%
  select(name) %>%
  mutate(charming = str_detect(name, regex(“charming”, ignore_case = TRUE)))
 # A tibble: 3,585 × 2
                                             name charming
                                            <chr>    <lgl>
 1                      Sunny Bungalow in the City    FALSE
 2                 Charming room in pet friendly apt     TRUE
 3                   Mexican Folk Art Haven in Boston    FALSE
 4   Spacious Sunny Bedroom Suite in Historic Home    FALSE
 5                             Come Home to Boston    FALSE
 6                  Private Bedroom + Great Coffee    FALSE
 7              New Lrg Studio apt 15 min to Boston    FALSE
 8               "Tranquility" on "Top of the Hill"    FALSE
 9               6 miles away from downtown Boston!    FALSE
 10                 Perfect & Practical Boston Rental    FALSE
 # ... with 3,575 more rows
```

- We can use str_detect to see if the word “charming” exists in the name
- Since str_detect supplies a logical response we can use this for filtering…

FILTERING

```
airbnb %>%
  select(name) %>%
  filter(str_detect(name, regex("charming", ignore_case = TRUE)))
# A tibble: 92 x 1
   name
   <chr>
 1 Charming room in pet friendly apt
 2 Cozy room in a charming villa.
 3 Charming Gambrel on a sweet street
 4 Charming 3 bedroom-15 min to Boston
 5 Charming new house-15 min to Boston
 6 Queen room in a charming villa
 7 Charming sunlit house in Boston
 8 Charming Victorian near T
 9 Charming 2BD Across from Arboretum
10 Charming Boston Apartment
# ... with 82 more rows
```

- We can use str_detect to see if the word "charming" exists in the name
- Since str_detect supplies a logical response we can use this for filtering…

FILTERING

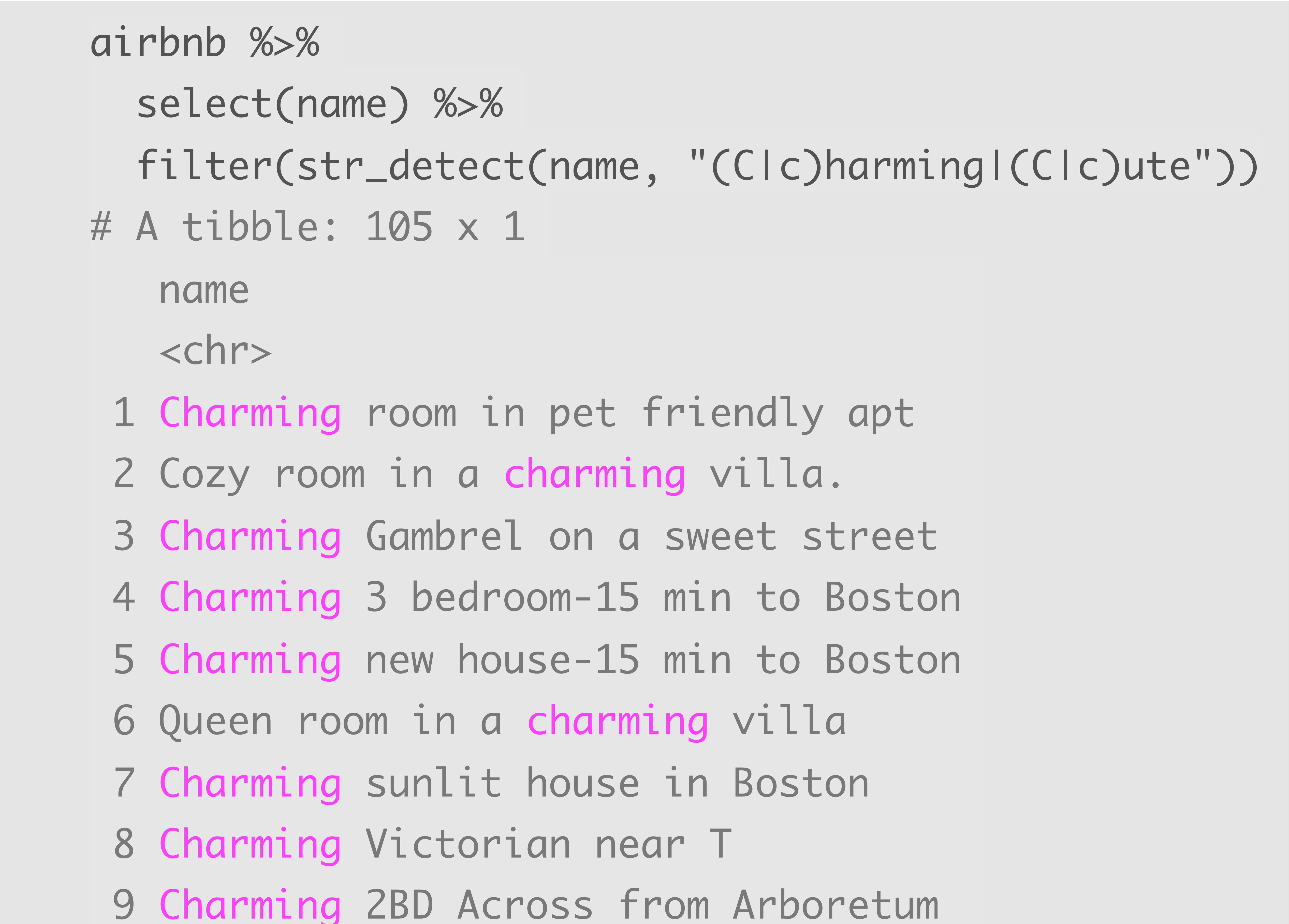
- We can use different approaches to get to the same results
- What do you expect these to return????

```
airbnb %>%
  select(name) %>%
  filter(str_detect(name, "(C|c)harming|(C|c)ute"))
# A tibble: 105 x 1
   name
   <chr>
 1 Charming room in pet friendly apt
 2 Cozy room in a charming villa.
 3 Charming Gambrel on a sweet street
 4 Charming 3 bedroom-15 min to Boston
 5 Charming new house-15 min to Boston
 6 Queen room in a charming villa
 7 Charming sunlit house in Boston
 8 Charming Victorian near T
 9 Charming 2BD Across from Arbore
```

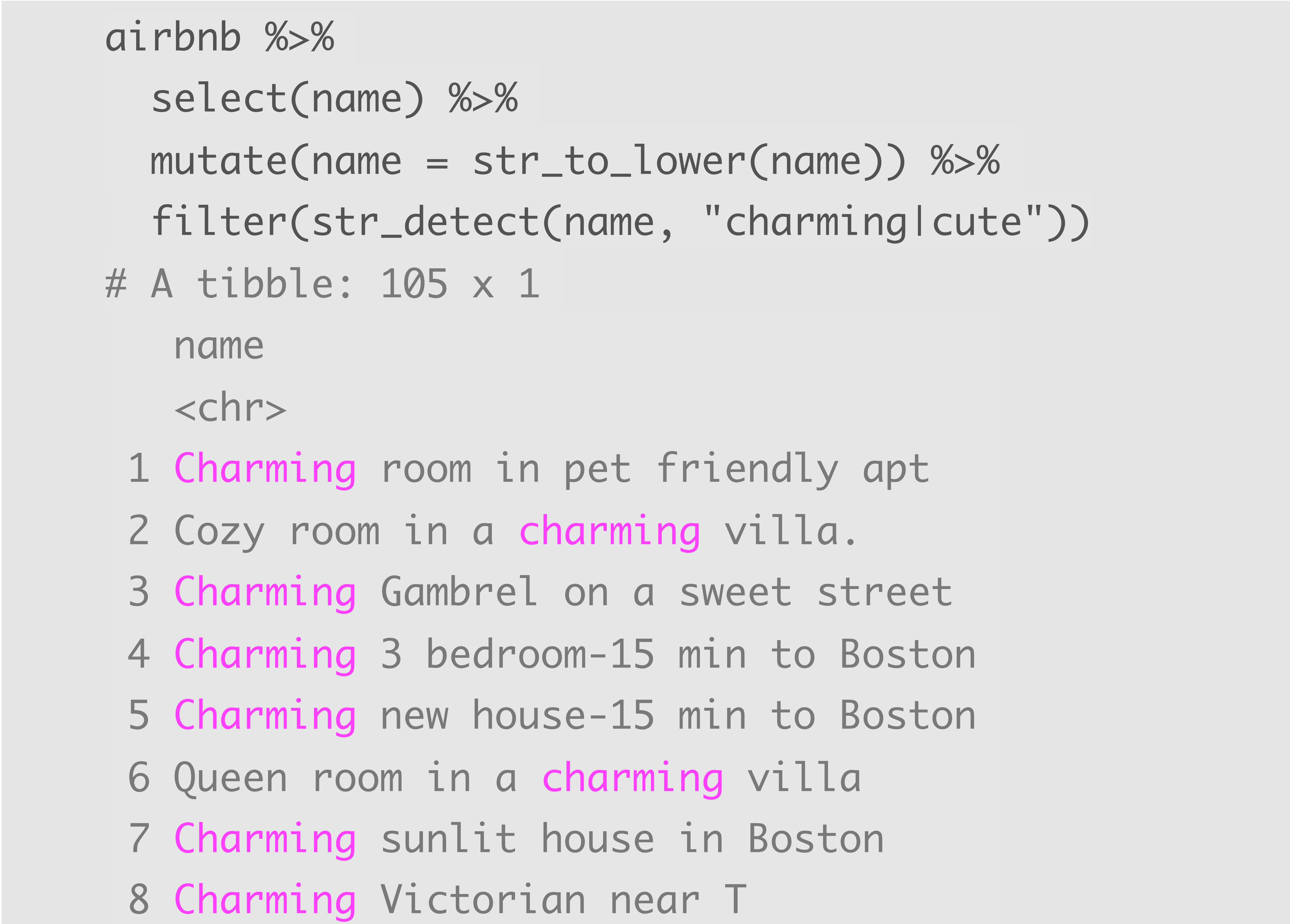
```
airbnb %>%
  select(name) %>%
  mutate(name = str_to_lower(name)) %>%
  filter(str_detect(name, "charming|cute"))
# A tibble: 105 x 1
   name
   <chr>
 1 Charming room in pet friendly apt
 2 Cozy room in a charming villa.
 3 Charming Gambrel on a sweet street
 4 Charming 3 bedroom-15 min to Boston
 5 Charming new house-15 min to Boston
 6 Queen room in a charming villa
 7 Charming sunlit house in Boston
 8 Charming Victorian near T
```

FILTERING

- We can use different approaches to get to the same results



```
airbnb %>%
  select(name) %>%
  filter(str_detect(name, "(C|c)harming|(C|c)ute"))
# A tibble: 105 x 1
   name
   <chr>
 1 Charming room in pet friendly apt
 2 Cozy room in a charming villa.
 3 Charming Gambrel on a sweet street
 4 Charming 3 bedroom-15 min to Boston
 5 Charming new house-15 min to Boston
 6 Queen room in a charming villa
 7 Charming sunlit house in Boston
 8 Charming Victorian near T
 9 Charming 2BD Across from Arboretum
```



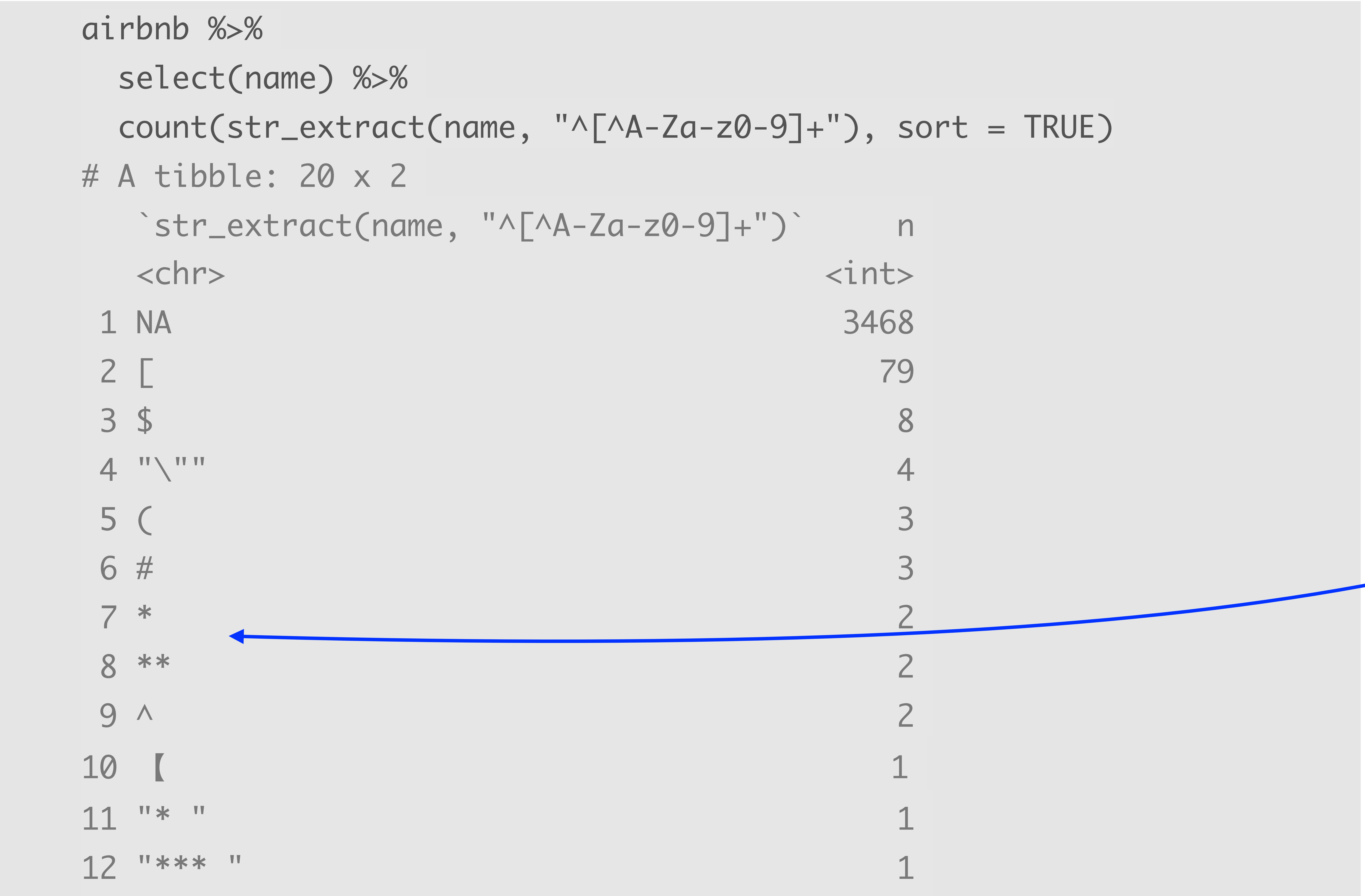
```
airbnb %>%
  select(name) %>%
  mutate(name = str_to_lower(name)) %>%
  filter(str_detect(name, "charming|cute"))
# A tibble: 105 x 1
   name
   <chr>
 1 Charming room in pet friendly apt
 2 Cozy room in a charming villa.
 3 Charming Gambrel on a sweet street
 4 Charming 3 bedroom-15 min to Boston
 5 Charming new house-15 min to Boston
 6 Queen room in a charming villa
 7 Charming sunlit house in Boston
 8 Charming Victorian near T
```

YOUR TURN!

1. *Using the* **`house_rules`** *column, how many observations (aka hosts) advocate for "no shoes"?*

2. *How would you filter out these observations?*

CLEANING



```
airbnb %>%
  select(name) %>%
  count(str_extract(name, "^[^A-Za-z0-9]+"), sort = TRUE)
# A tibble: 20 x 2
   `str_extract(name, "^[^A-Za-z0-9]+")`     n
   <chr>                                 <int>
 1 NA                                     3468
 2 [                                        79
 3 $                                         8
 4 "\""                                      4
 5 (                                         3
 6 #                                         3
 7 *                                         2
 8 **                                        2
 9 ^                                         2
10 【                                        1
11 "*  "                                     1
12 "***  "                                   1
```

- Sometimes we need to do some cleaning. For example, if we wanted to look for the most common first words used in names, we may want to clean up non-alphanumeric characters.

CLEANING

```
airbnb %>%
  select(name) %>%
  mutate(
    name = str_replace_all(name, "[^A-Za-z0-9]+", " "),
    name = str_replace_all(name, "[[:punct:]]+", " "),
    name = str_trim(name),
    name = str_to_lower(name)
    ) %>%
  count(str_extract(name, "^[A-Za-z0-9]+"), sort = TRUE)
# A tibble: 626 x 2
   `str_extract(name, "^[A-Za-z0-9]+")`     n
   <chr>                                <int>
 1 cozy                                   183
 2 private                                169
 3 beautiful                              120
 4 spacious                               114
 5 lux                                    104
```

- Remove all non-alphanumerics
- Remove punctuations
- Remove extra white spaces
- Standardize to lowercase
- Extract and count first alphanumeric words

CHALLENGE

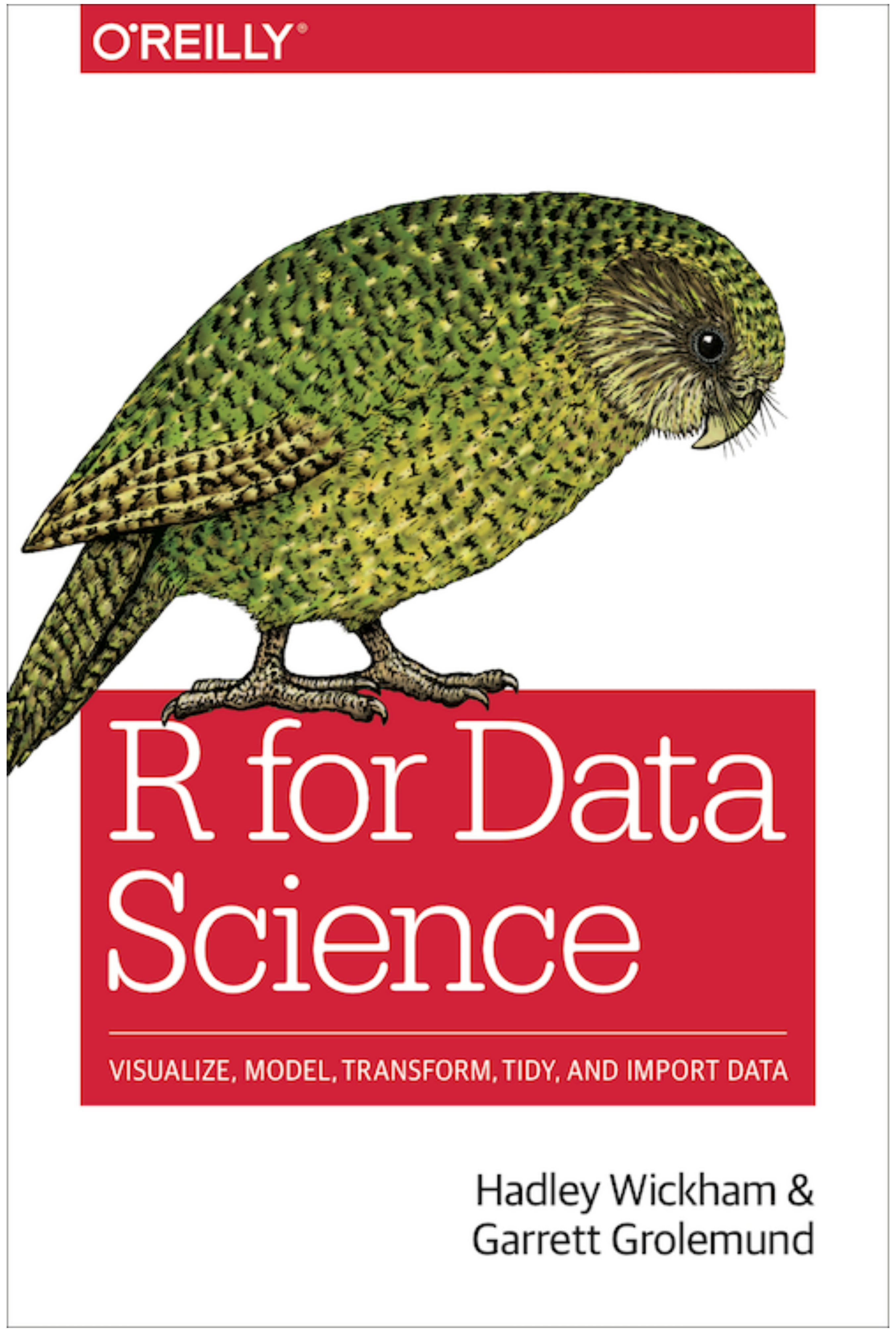
CHALLENGE

In the Kaggle competition for predicting Titanic survivors, the most important predictor variable ended up being the passenger's title (i.e. Mr., Mrs., Miss., Master).

Using the **`titanic::titanic_train`** *data, extract the passengers title and create a new feature named "Title".*

SO LITTLE TIME!

LEARN MORE

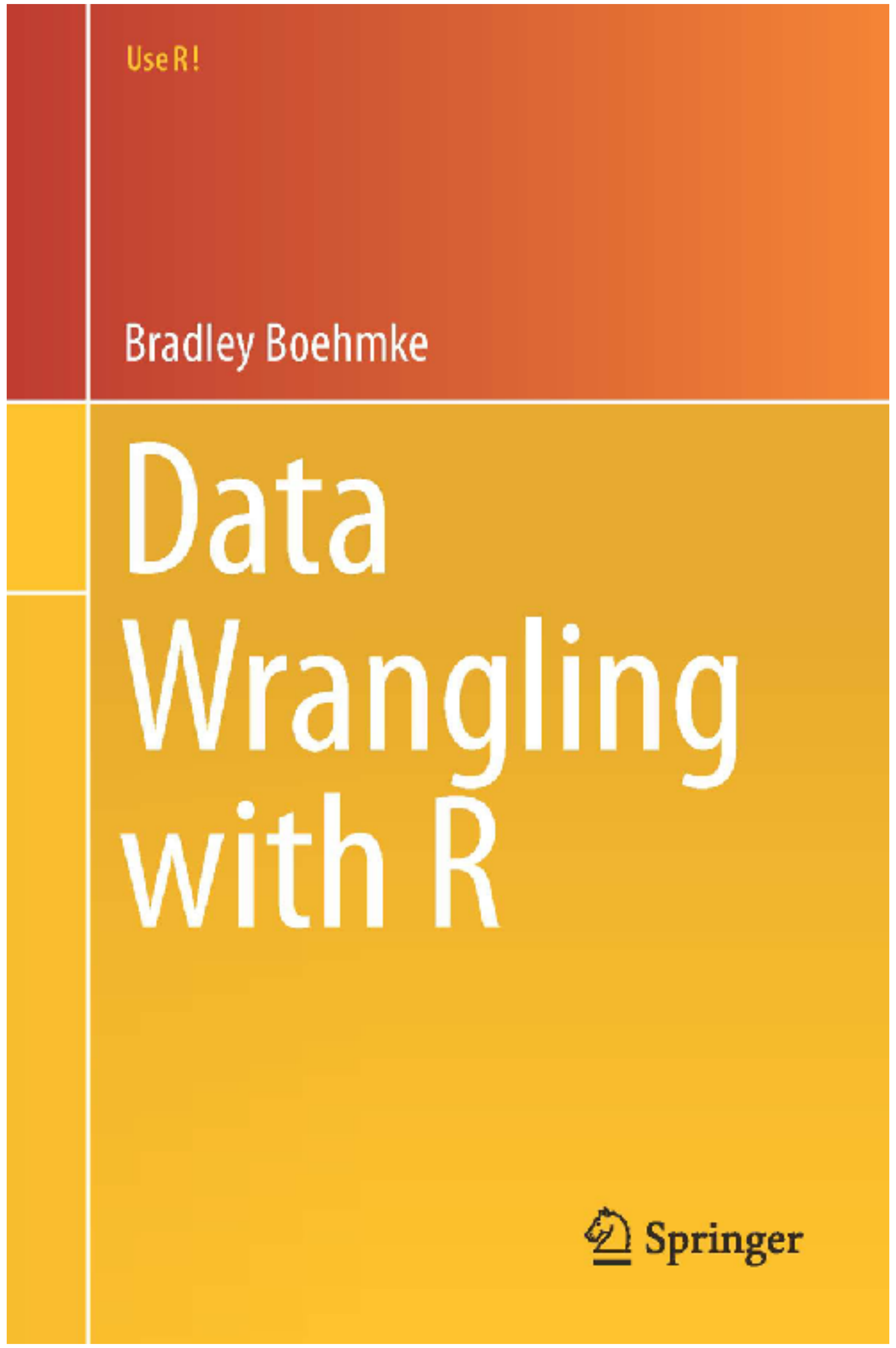


O'REILLY®

R for Data Science

VISUALIZE, MODEL, TRANSFORM, TIDY, AND IMPORT DATA

Hadley Wickham &
Garrett Grolemund



Use R!

Bradley Boehmke

Data Wrangling with R

Springer

WHAT TO REMEMBER

FUNCTIONS TO REMEMBER

Operator/Function	Description
`str_*`	stringr functions for regular expressions
`regex(pattern, ignore_case = TRUE)`	ignore case
`“x | y” “(x|y)”`	using or for finding multiple forms of regular expressions
`^ $`	anchors - finding regex at beginning or end of element
`., \\d, \\s, [0-9], [a-zA-Z]`	finding regex patterns
`+, {n}, {n,}, {n,m}`	finding repetitions of regex patterns