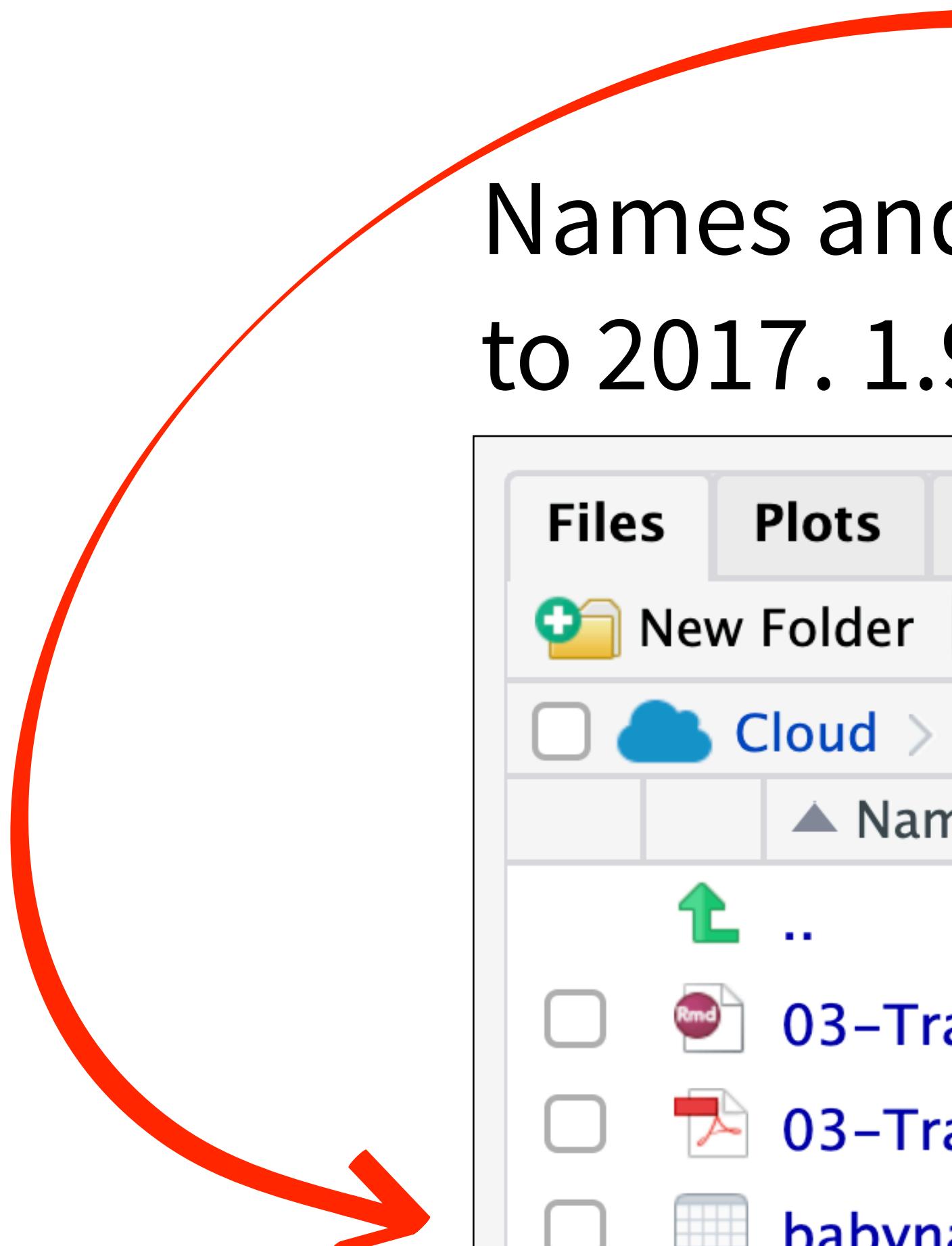


Transform Data with



babynames.csv

Names and sex of babies born in the US from 1880 to 2017. 1.9M rows.



	Name	Size	Modified
	..		
	03-Transform-Exercises.Rmd	4 KB	Jul 27, 2019, 1:49 PM
	03-Transform-Slides.pdf	9.2 MB	Jul 25, 2019, 11:17 PM
	babynames.csv	46.5 MB	Jul 25, 2019, 11:17 PM



babynames

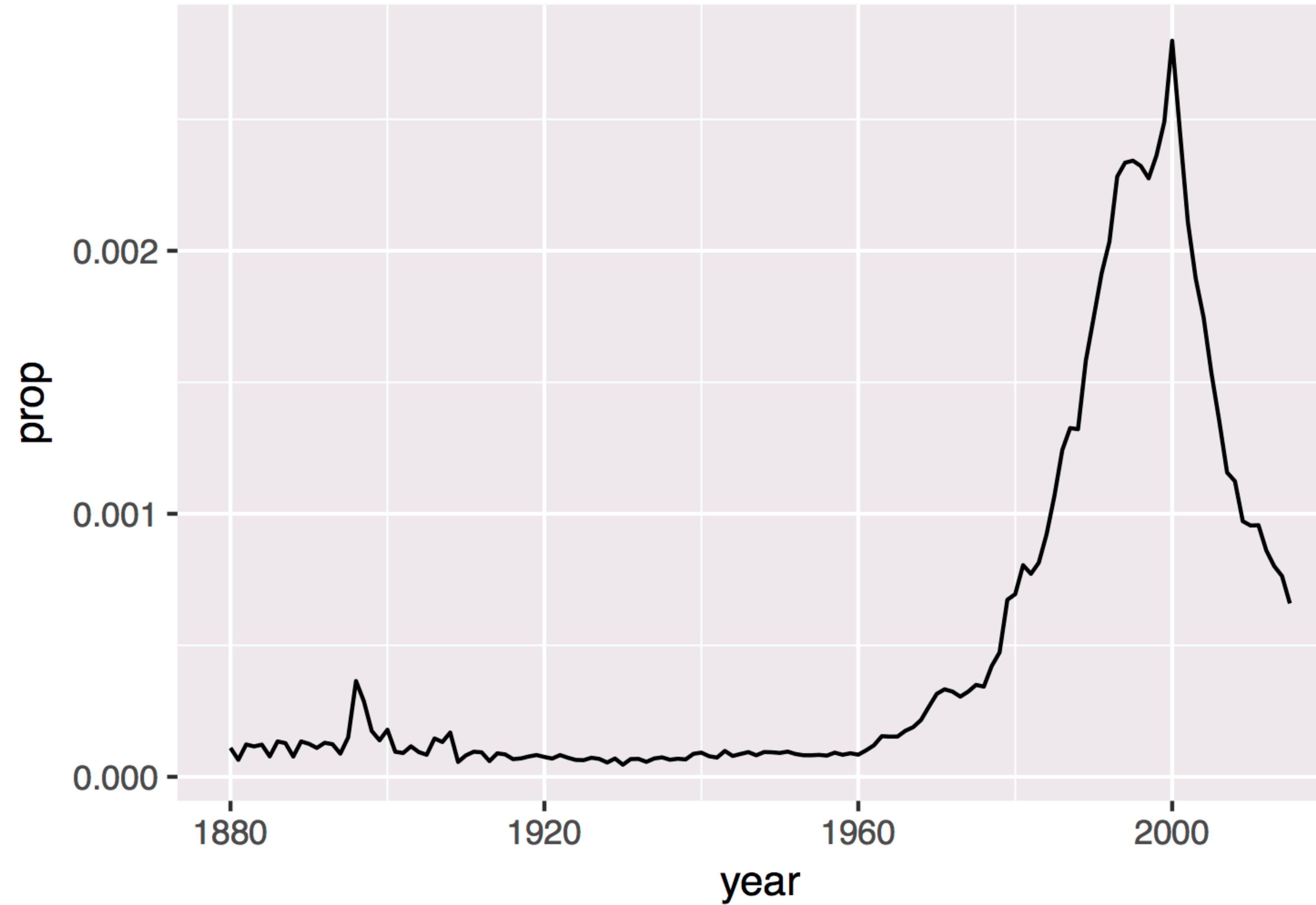
year	sex	name	n	prop
<dbl>	<chr>	<chr>	<dbl>	<dbl>
1880	F	Mary	7065	0.07238359
1880	F	Anna	2604	0.02667896
1880	F	Emma	2003	0.02052149
1880	F	Elizabeth	1939	0.01986579
1880	F	Minnie	1746	0.01788843
1880	F	Margaret	1578	0.01616720
1880	F	Ida	1472	0.01508119
1880	F	Alice	1414	0.01448696
1880	F	Bertha	1320	0.01352390
1880	F	Sarah	1288	0.01319605

1-10 of 1,924,665 rows

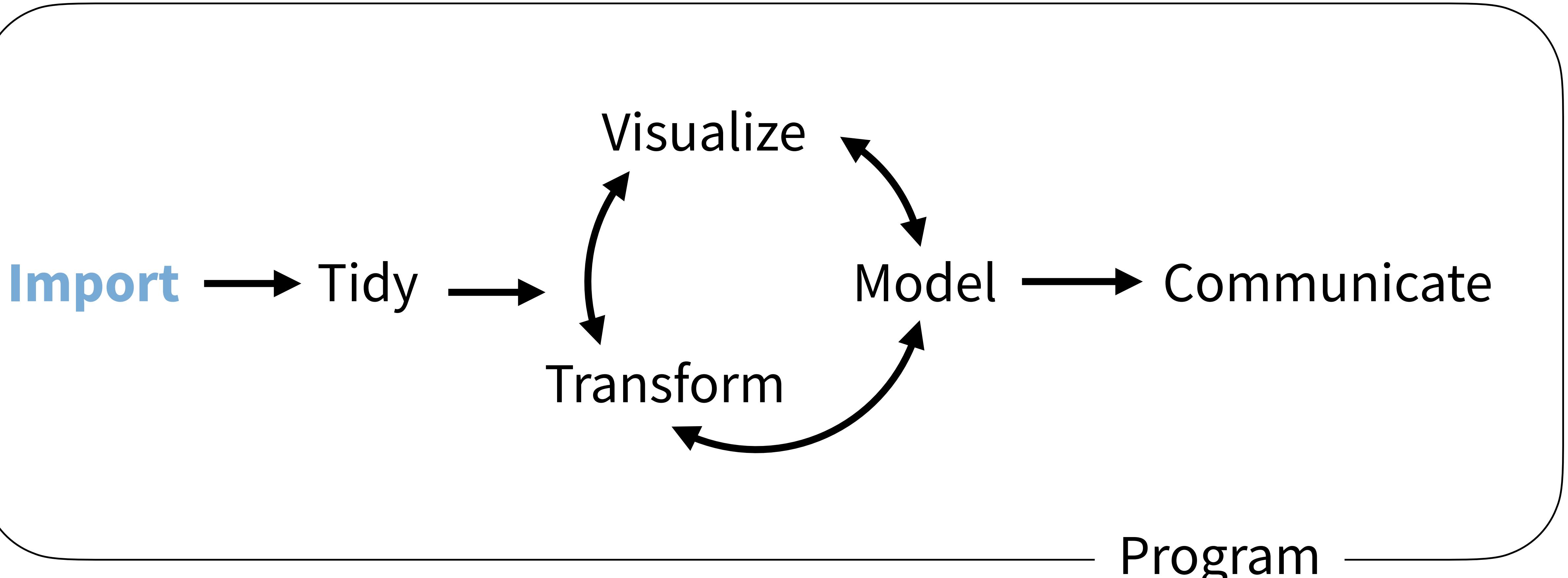
Previous 1 2 3 4 5 6 ... 100 Next



Proportion of boys with the name Garrett



(Applied) Data Science



Import data



babynames.csv

```
year,sex,name,n,prop
1880,F,Mary,7065,0.07238359
1880,F,Anna,2604,0.02667896
1880,F,Emma,2003,0.02052149
1880,F,Elizabeth,1939,0.01986579
1880,F,Minnie,1746,0.01788843
1880,F,Margaret,1578,0.0161672
1880,F,Ida,1472,0.01508119
1880,F,Alice,1414,0.01448696
```



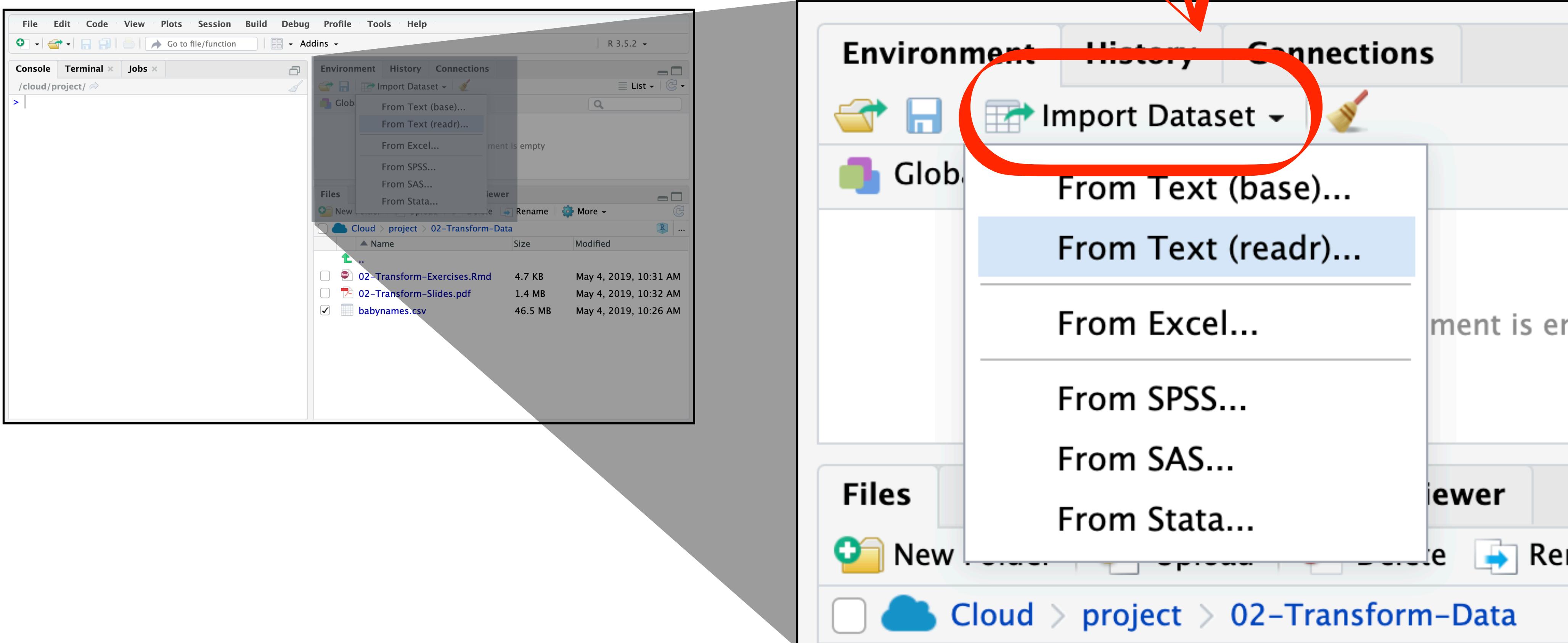
babynames.csv

```
year,sex,name,n,prop
1880,F,Mary,7065,0.07238359
1880,F,Anna,2604,0.02667896
1880,F,Emma,2003,0.02052149
1880,F,Elizabeth,1939,0.01986579
1880,F,Minnie,1746,0.01788843
1880,F,Margaret,1578,0.0161672
1880,F,Ida,1472,0.01508119
1880,F,Alice,1414,0.01448696
```



Import

Click Import Dataset From Text (readr)...



Pop Quiz

But is this reproducible?

**THE CODE
EQUIVALENT**



Import Text Data

File/URL:

/cloud/project/02-Transform-Data/babynames.csv Browse...

Data Preview:

year (double) ▾	sex (logical) ▾	name (character) ▾	n (double) ▾	prop (double) ▾
1880	FALSE	Mary	7065	0.07238359
1880	FALSE	Anna	2604	0.02667896
1880	FALSE	Emma	2003	0.02052149
1880	FALSE	Elizabeth	1939	0.01986579

Previewing first 50 entries.

Import Options:

Name: babynames First Row as Names
Skip: 0 Trim Spaces Open Data Viewer Delimiter: Comma ▾ Escape: None ▾
Quotes: Default ▾ Comment: Default ▾ Locale: Configure... NA: Default ▾

Code Preview:

library(readr)
babynames <- read_csv("02-Transform-Data/babynames.csv")
View(babynames)

? Reading rectangular data using readr Import Cancel

**ONE
COMPLICATION!**

Import Text Data

File/URL:

/cloud/project/02-Transform-Data/babynames.csv [Browse...](#)

Data Preview:

year (double) ▾	sex (logical) ▾	name (character) ▾	n (double) ▾	prop (double) ▾
1880	FALSE	Mary	7065	0.07238359
1880	FALSE	Anna	2604	0.02667896
1880	FALSE	Emma	2003	0.02052149
1880	FALSE	Elizabeth	1939	0.01986579

Previewing first 50 entries.

Import Options:

Name: <input type="text" value="babynames"/>	<input checked="" type="checkbox"/> First Row as Names	Delimiter: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="Comma"/>	Escape: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="None"/>
Skip: <input type="text" value="0"/>	<input checked="" type="checkbox"/> Trim Spaces	Quotes: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="Default"/>	Comment: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="Default"/>
	<input checked="" type="checkbox"/> Open Data Viewer	Locale: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="Configure..."/>	NA: <input style="width: 100px; height: 25px; border: none; padding: 0 5px; border-bottom: 1px solid #ccc;" type="button" value="Default"/>

Code Preview:

`library(readr)
babynames <- read_csv("02-Transform-Data/babynames.csv")
View(babynames)`

[?](#) Reading rectangular data using `readr` [Import](#) [Cancel](#)

Working directory

R associates itself with a folder (i.e. directory) on your computer. To see which one, run **getwd()** at the console.

- This folder is known as your "working directory"
- When you save files, R will save them here
- When you load files, R will look for them here

Quiz

Where R look for files when you call
them from an R Markdown document?

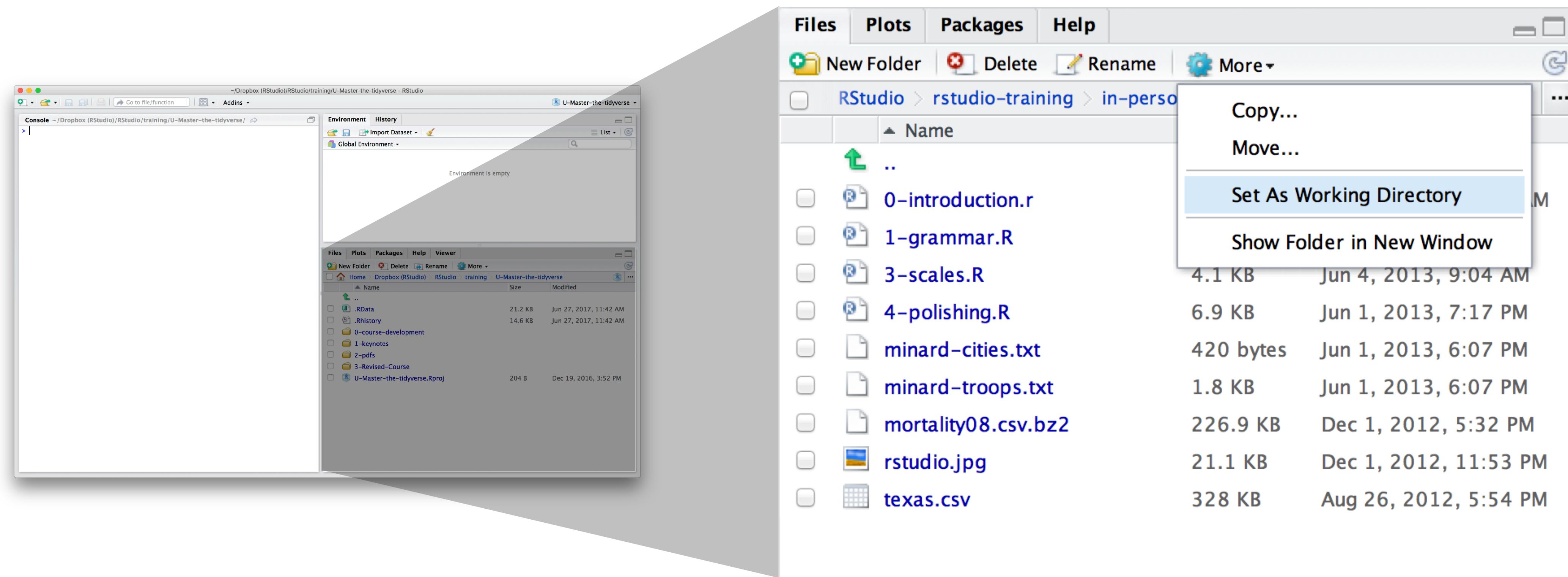
**WORKING
DIRECTORY**

\neq

**.RMD
DIRECTORY**

Changing the Working directory

Navigate in the files pane to a new directory. Click
More > Set As Working Directory



Your Turn 1

Move your working directory to the folder where you saved the slides, the Quarto lab and the **babynames.csv** file to work on data transformation (presumably 03_Transform_Data).

Import the **babynames.csv** dataset. Give it the name **babynames**.

Copy the import code into the code chunk in **03-Transform-Exercises.qmd** (so the document can reload it later).



babynames



Names of male and female babies born
in the US from 1880 to 2015. 1.8M rows.

```
# install.packages("babynames")
library(babynames)
```

write_csv()

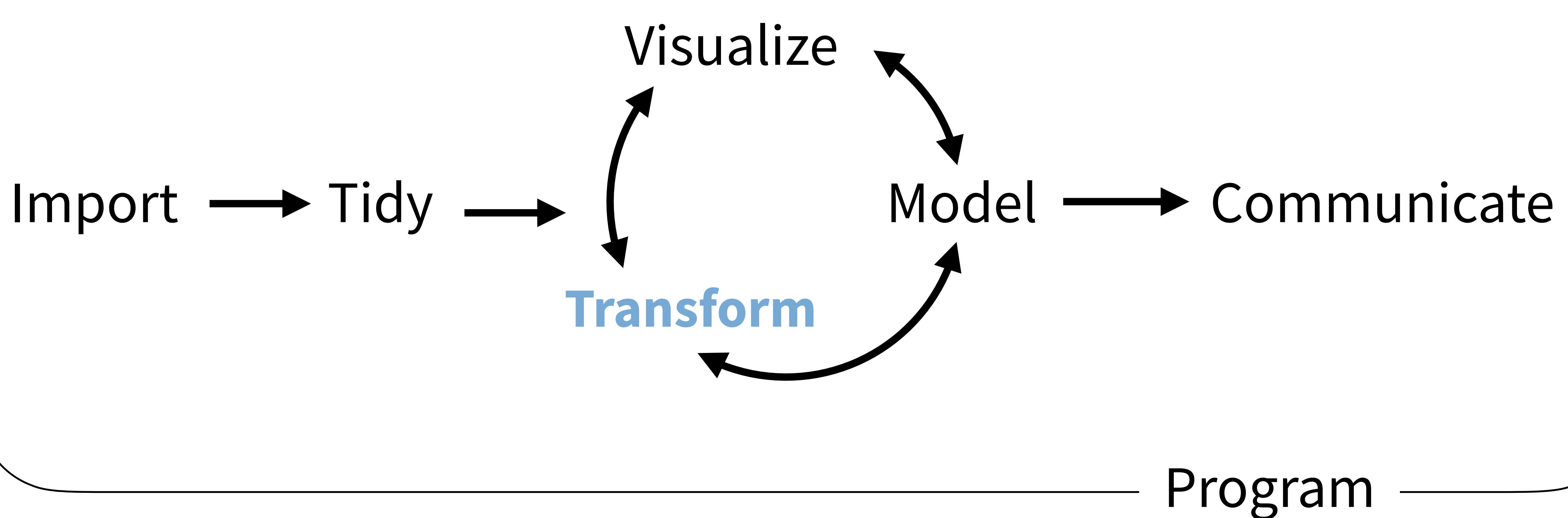
Saves data set as a csv on your computer.

```
write_csv(babynames, path = "babynames.csv")
```

Table to save

file
path to save at

(Applied) Data Science



babynames

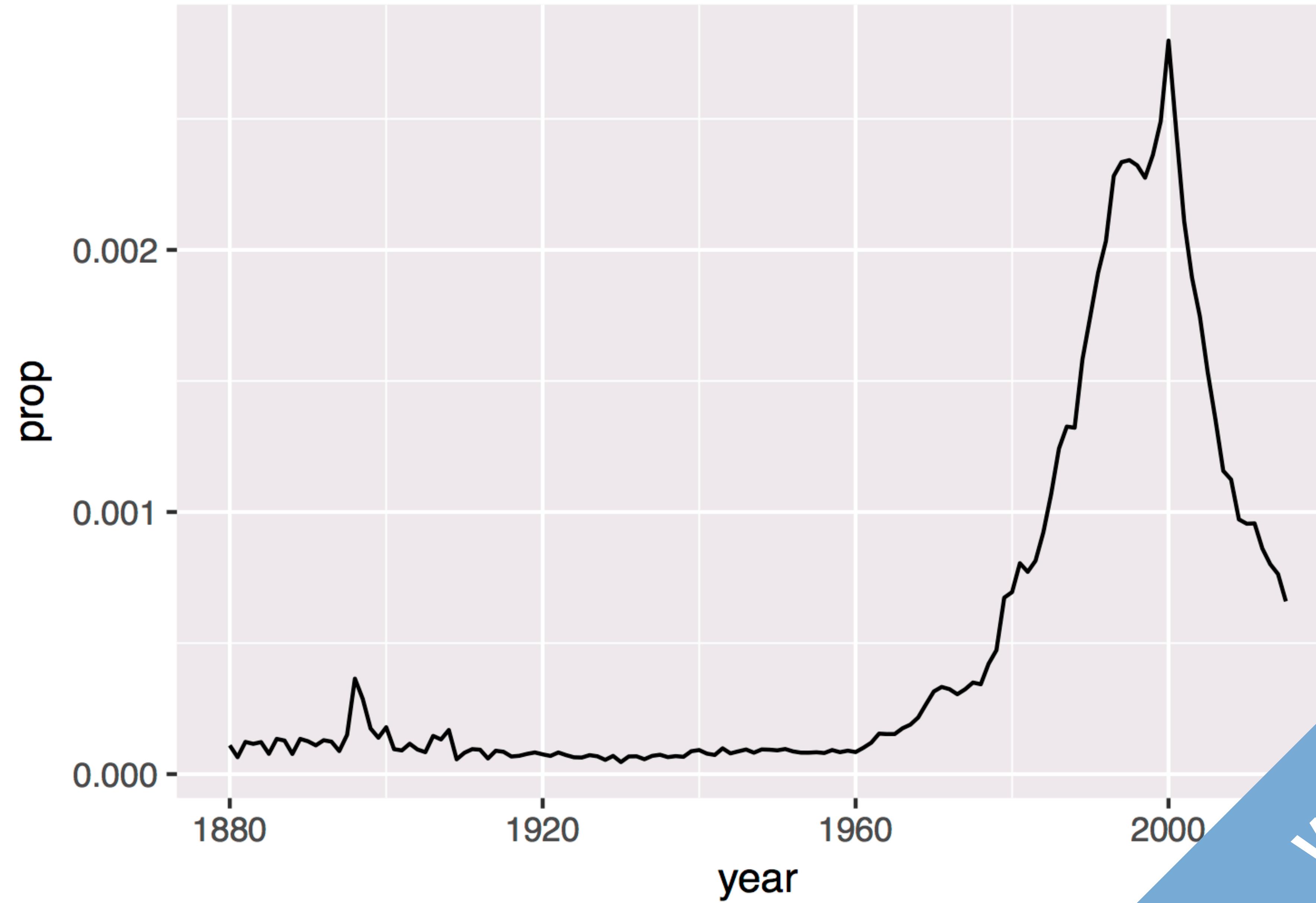
year	sex	name	n	prop
<dbl>	<chr>	<chr>	<dbl>	<dbl>
1880	F	Mary	7065	0.07238359
1880	F	Anna	2604	0.02667896
1880	F	Emma	2003	0.02052149
1880	F	Elizabeth	1939	0.01986579
1880	F	Minnie	1746	0.01788843
1880	F	Margaret	1578	0.01616720
1880	F	Ida	1472	0.01508119
1880	F	Alice	1414	0.01448696
1880	F	Bertha	1320	0.01352390
1880	F	Sarah	1288	0.01319605

1-10 of 1,924,665 rows

Previous 1 2 3 4 5 6 ... 100 Next

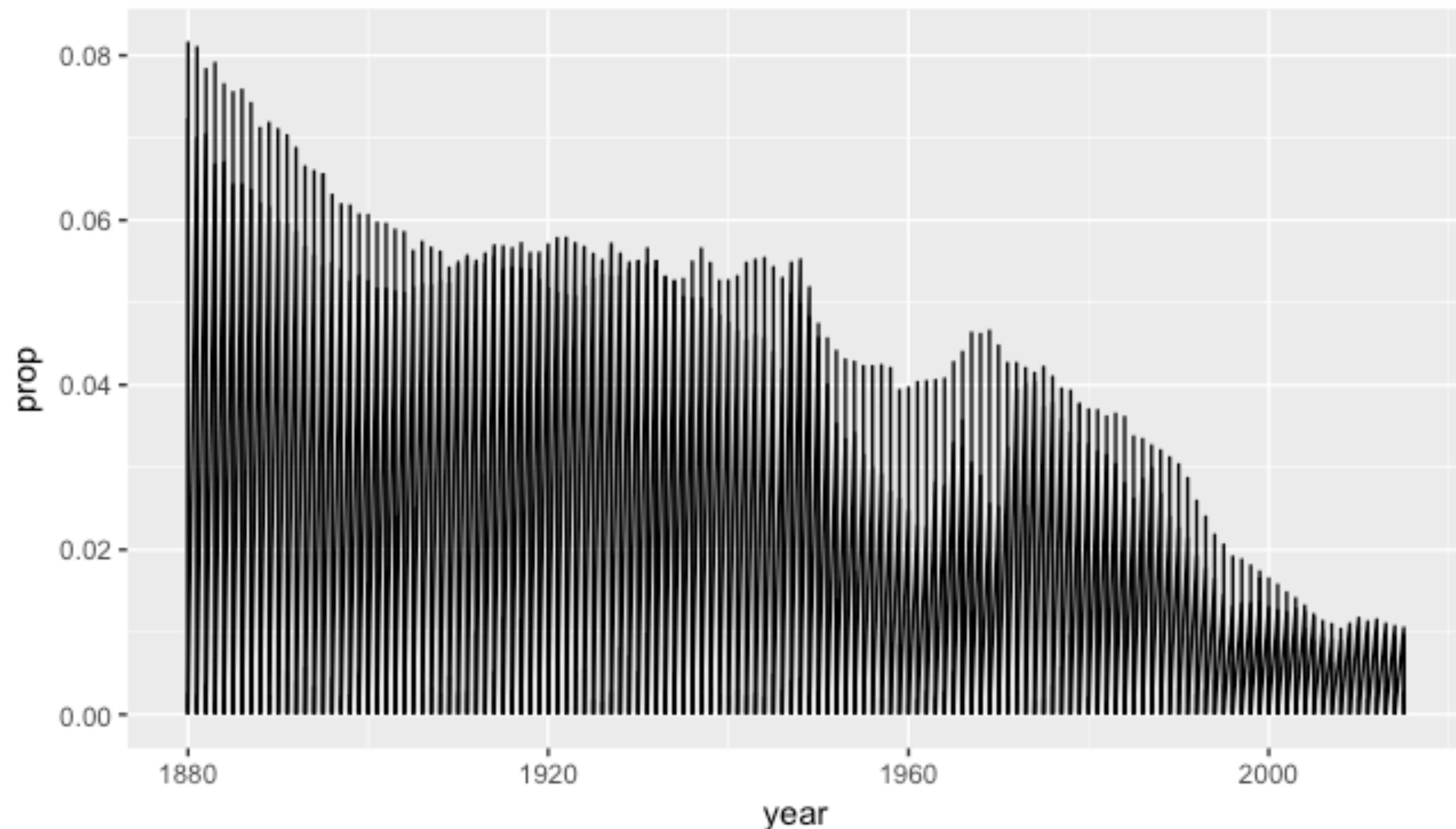


Proportion of boys with the name Garrett



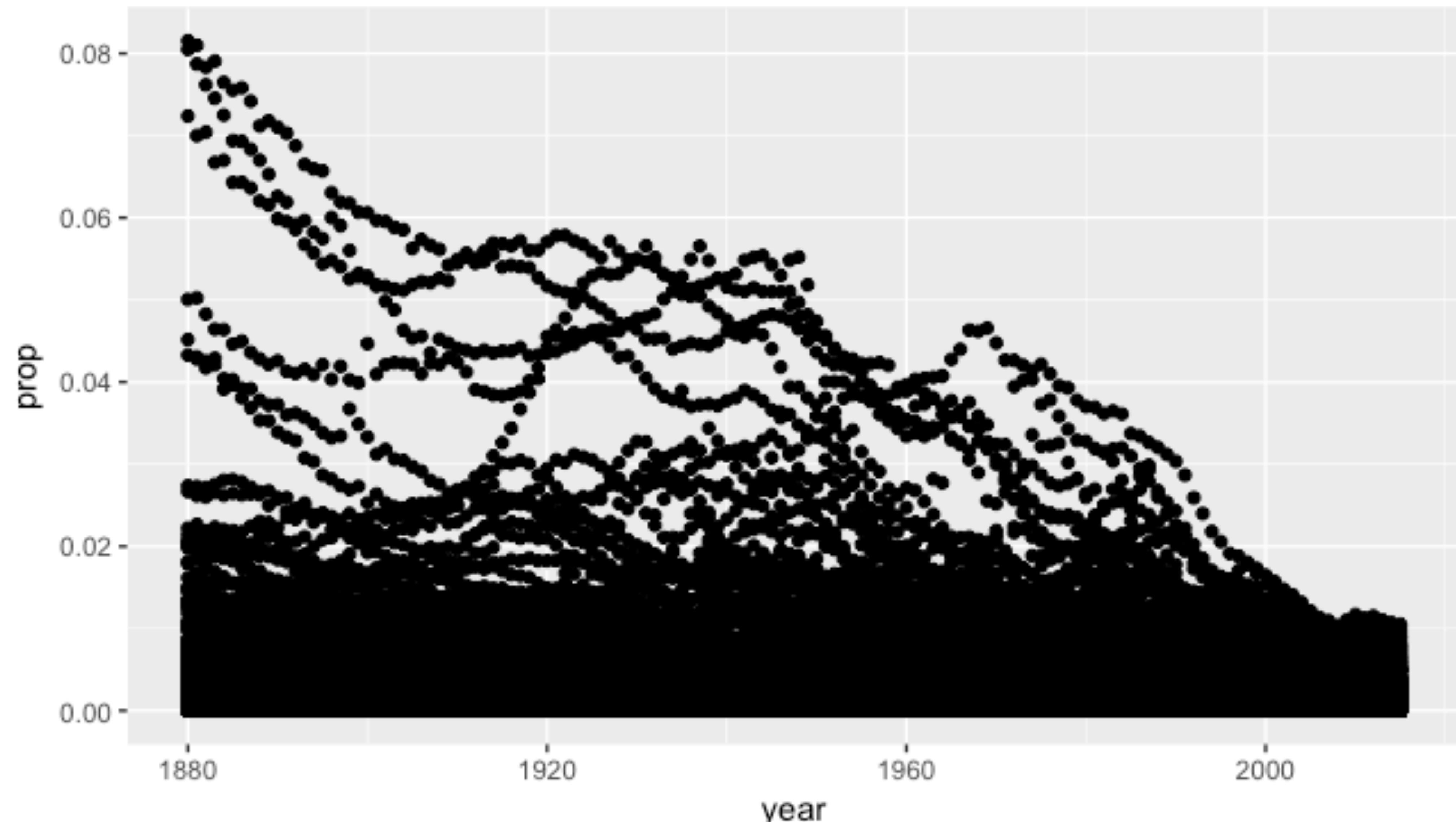
Which geom?





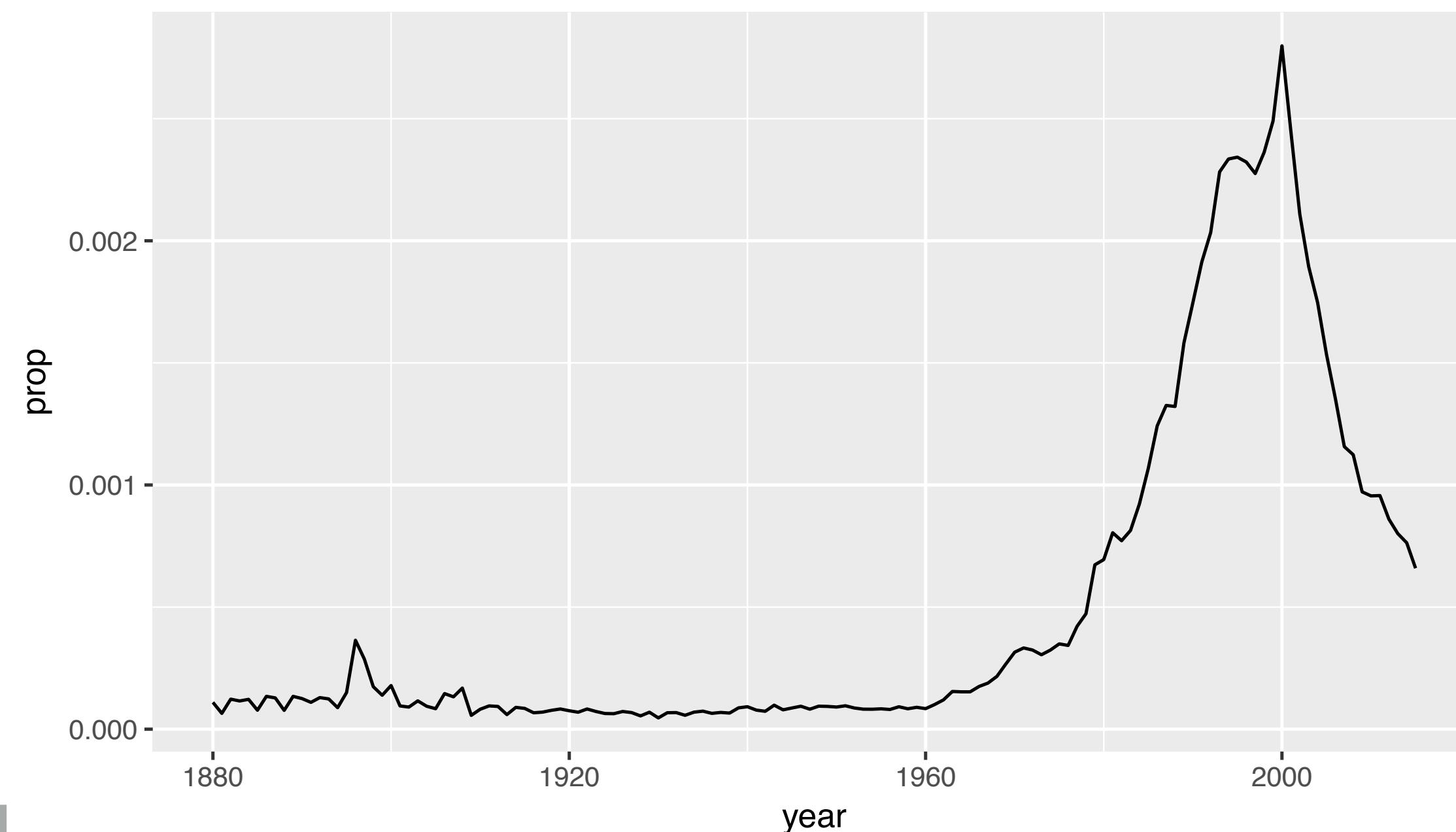
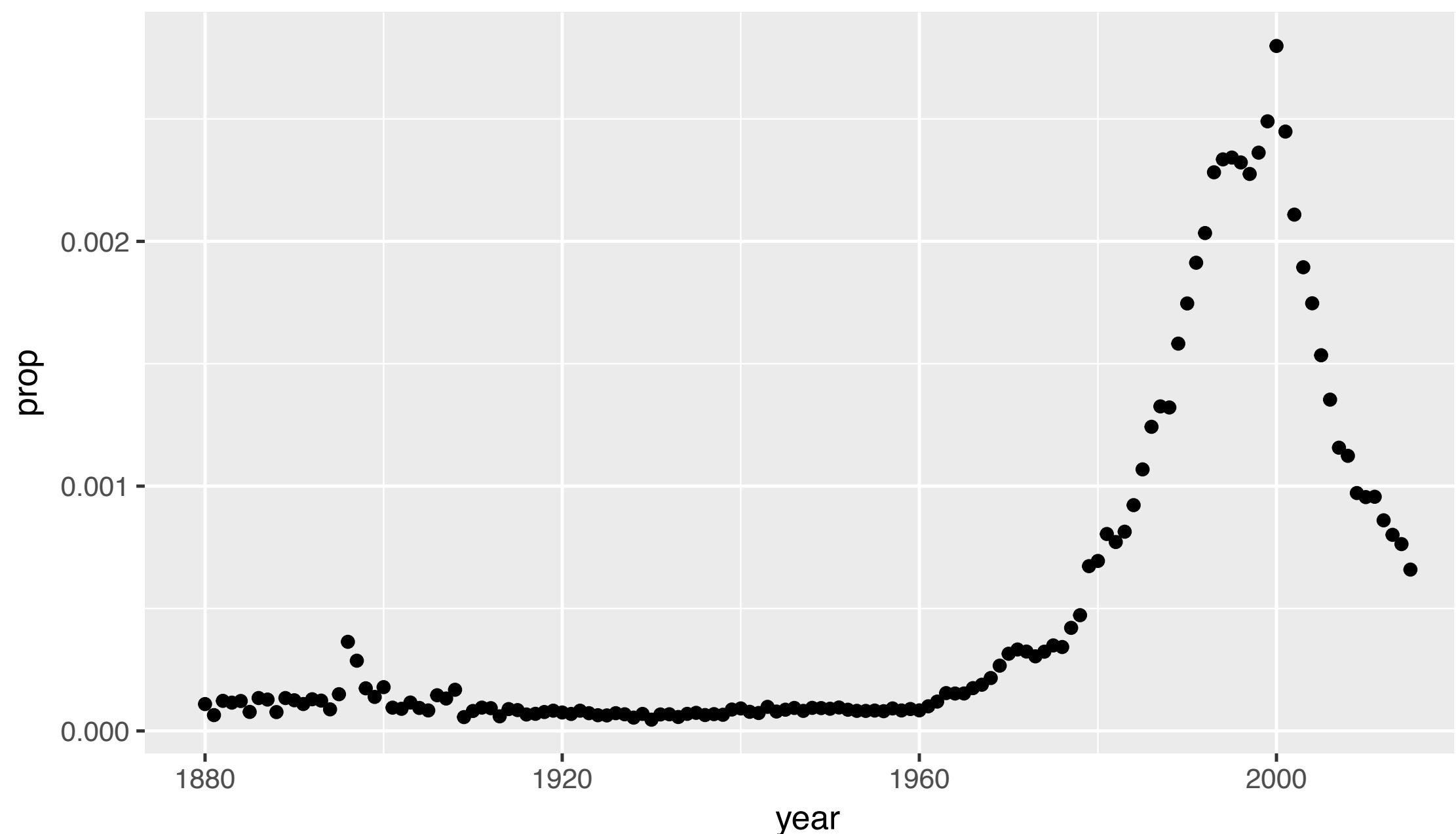
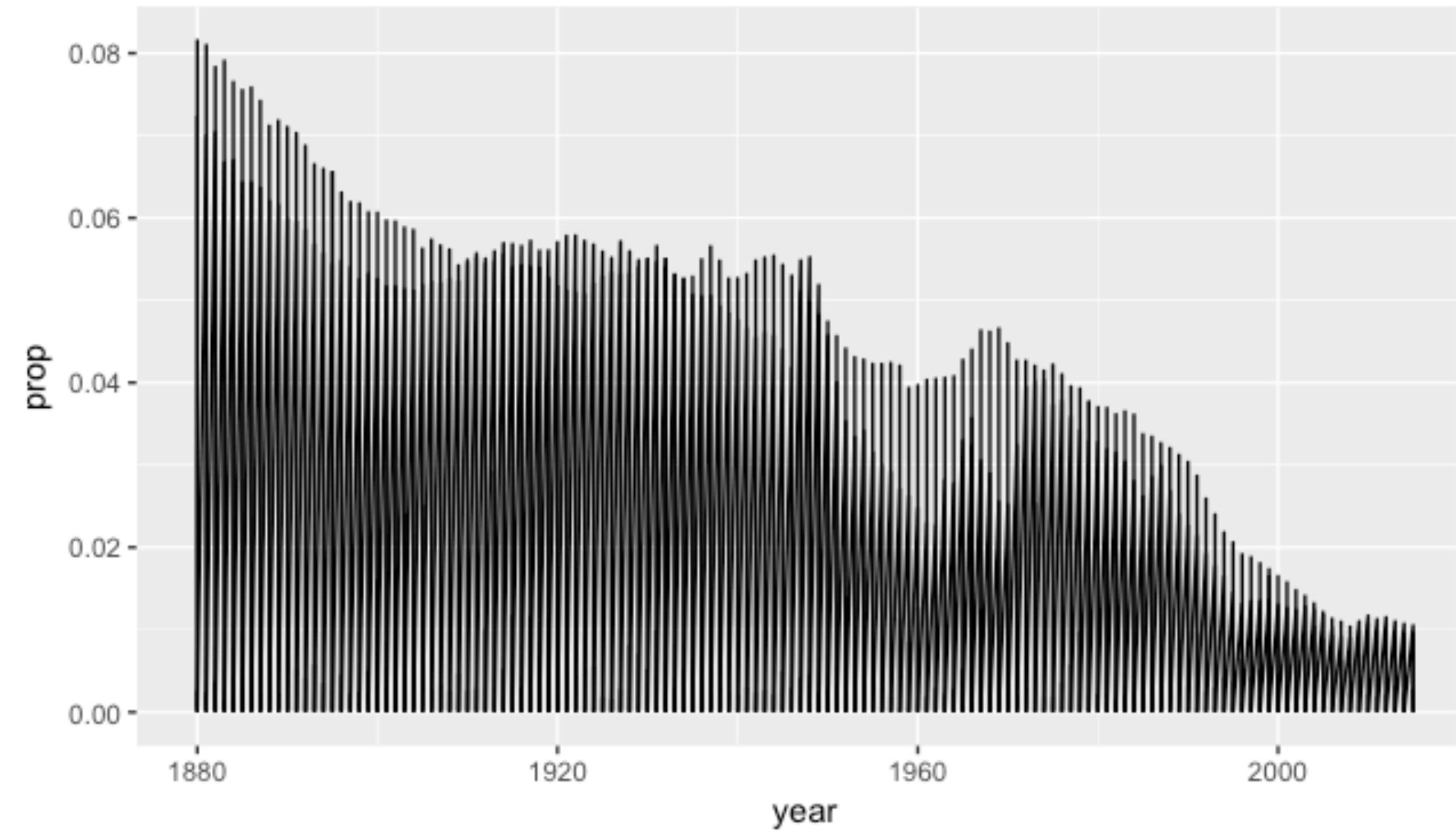
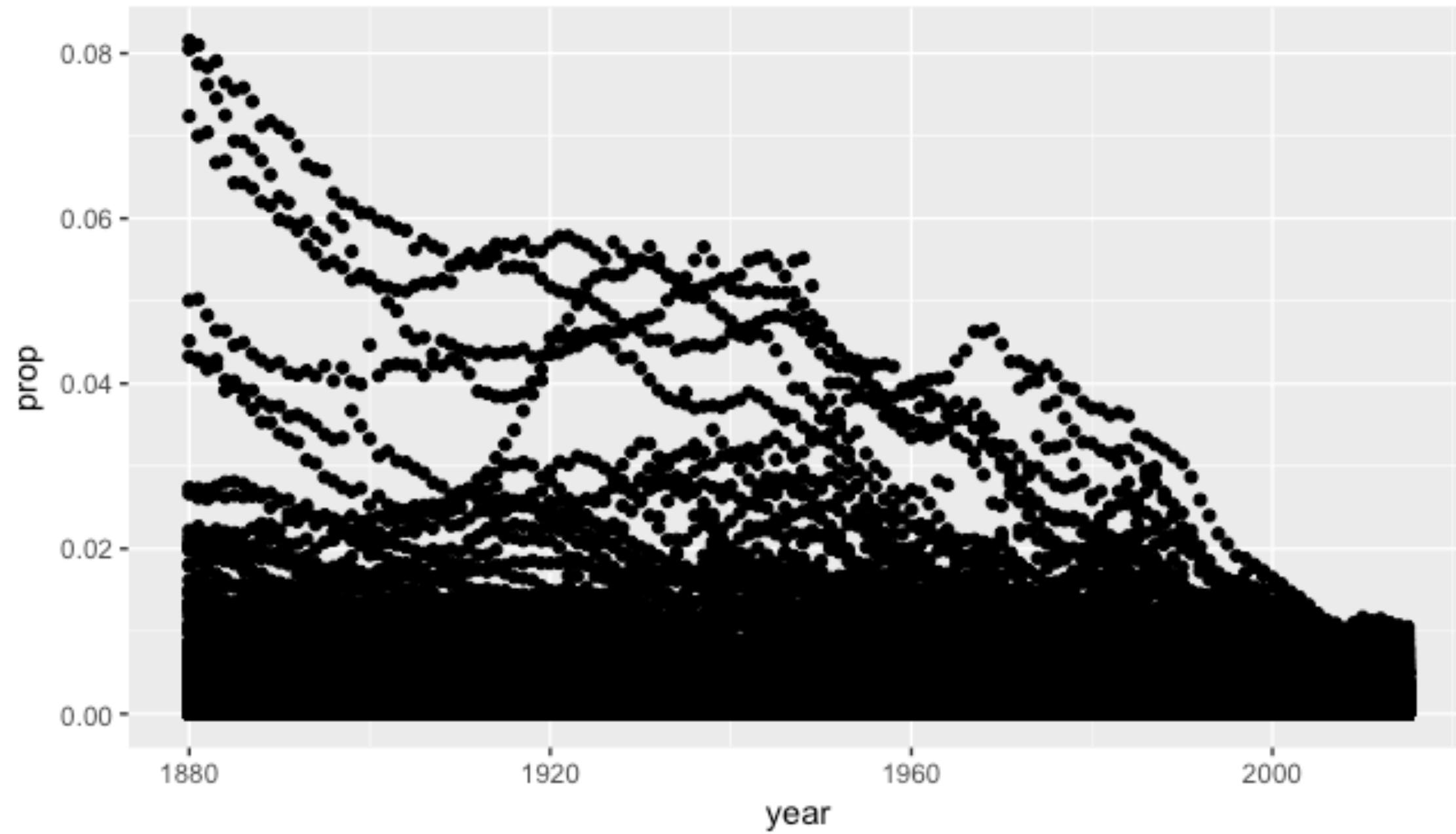
```
ggplot(data = babynames) +  
  geom_line(mapping = aes(x = year, y = prop))
```





```
ggplot(data = babynames) +  
  geom_point(mapping = aes(x = year, y = prop))
```





How to isolate?

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081
1881	M	William	8524	0,0787
1881	M	James	5442	0,0503
1881	M	Charles	4664	0,0431
1881	M	Garrett	7	0,0001
1881	M	Gideon	7	0,0001



year	sex	name	n	prop
1880	M	Garrett	13	0,0001
1881	M	Garrett	7	0,0001
...	...	Garrett

dplyr



dplyr



A package that transforms data.

dplyr implements a *grammar* for transforming tabular data.



Isolating data

select() - extract **variables**

filter() - extract **cases**

arrange() - reorder **cases**

select()



select()

Extract columns by name.

```
select(.data, ...)
```

data frame to transform

name(s) of columns to extract
(or a select helper function)

select()

Extract columns by name.

```
select(babynames, name, prop)
```

babynames

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

name	prop
John	0,0815
William	0,0805
James	0,0501
Charles	0,0451
Garrett	0,0001
John	0,081



Your Turn 2

Alter the code to select just the **n** column:

```
select(babynames, name, prop)
```



```
select(babynames, n)
```

```
#       n  
# <int>  
# 1 7065  
# 2 2604  
# 3 2003  
# 4 1939  
# 5 1746  
# ... ...
```

select() helpers

: - Select range of columns

```
select(mpg, cty:class)
```

-- Select every column but

```
select(mpg, -c(cty, hwy))
```

starts_with() - Select columns that start with...

```
select(mpg, starts_with("c"))
```

ends_with() - Select columns that end with...

```
select(mpg, ends_with("y"))
```

select() helpers

contains() - Select columns whose names contain...

```
select(mpg, contains("d"))
```

matches() - Select columns whose names match regular expression

```
select(mpg, matches("^.{4}$$"))
```

one_of() - Select columns whose names are one of a set

```
select(mpg, one_of(c("fl", "fuel", "Fuel")))
```

num_range() - Select columns named in prefix, number style

```
select(mpg, num_range("x", 1:5))
```

select() helpers

Data Transformation with dplyr :: CHEAT SHEET

dplyr

Manipulate Cases

EXTRACT CASES
Row functions return a subset of rows as a new table.

- `filter(data, ...)` Extract rows that meet logical criteria. `filter(iris, Sepal.Length > 7)`
- `distinct(data, ..., .keep_all = FALSE)` Remove rows with duplicate values. `distinct(iris, Species)`
- `sample_frac(tbl, size = 1, replace = FALSE, weight = NULL, env = parent.frame())` Randomly select fraction of rows. `sample_frac(iris, 0.5, replace = TRUE)`
- `sample_n(tbl, size, replace = FALSE, weight = NULL, env = parent.frame())` Randomly select size rows. `sample_n(iris, 10, replace = TRUE)`
- `slice(data, ...)` Select rows by position. `slice(iris, 10:15)`
- `top_n(x, n, wt)` Select and order top n entries (by group if grouped data). `top_n(iris, 5, Sepal.Width)`

Manipulate Variables

EXTRACT VARIABLES
Column functions return a set of columns as a new vector or table.

- `pull(data, var = -1)` Extract column values as a vector. Choose by name or index. `pull(iris, Sepal.Length)`
- `select(data, ...)` Extract columns as a table. Also `select_if()`. `select(iris, Sepal.Length, Species)`

Use these helpers with `select()`, e.g. `select(iris, starts_with("Sepal"))`

contains(match) **num_range(prefix, range) ::**, e.g. `mpg:cyl`
ends_with(match) **one_of(...)**
matches(match) **starts_with(match) -**, e.g., `-Species`



Quiz

Which of these is NOT a way to select the **name** and **n** columns together?

`select(babynames, -c(year, sex, prop))`

`select(babynames, name:n)`

`select(babynames, starts_with("n"))`

`select(babynames, ends_with("n"))`

Quiz

Which of these is NOT a way to select the **name** and **n** columns together?

`select(babynames, -c(year, sex, prop))`

`select(babynames, name:n)`

`select(babynames, starts_with("n"))`

`select(babynames, ends_with("n"))`

filter()



filter()

Extract rows that meet logical criteria.

```
filter(.data, ...)
```

data frame to transform

one or more logical tests
(filter returns each row for which the test is TRUE)

common syntax

Each function takes a data frame / tibble as its first argument and returns a data frame / tibble.

```
filter(.data, ...)
```

dplyr function

data frame to transform

function specific arguments

filter()

Extract rows that meet logical criteria.

```
filter(babynames, name == "Garrett")
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

year	sex	name	n	prop
1880	M	Garrett	13	0,0001
1881	M	Garrett	7	0,0001
...	...	Garrett

filter()

Extract rows that meet logical criteria.

```
filter(babynames, name == "Garrett")
```

babynames					
year	sex	name	n	prop	
1880	M	John	9655	0,0815	
1880	M	William	9532	0,0805	
1880	M	James	5927	0,0501	
1880	M	Charles	5348	0,0451	
1880	M	Garrett	13	0,0001	
1881	M	John	8769	0,081	

= sets

(returns nothing)

== tests if equal

(returns TRUE or FALSE)

Logical tests

?Comparison

$x < y$	Less than
$x > y$	Greater than
$x == y$	Equal to
$x <= y$	Less than or equal to
$x >= y$	Greater than or equal to
$x != y$	Not equal to
$x \%in\% y$	Group membership

```
x <- 1  
x >= 2  
# FALSE
```

```
x <- c(1, 2, 3)  
x >= 2  
# FALSE TRUE TRUE
```

Pop Quiz

What might NA stand for?

1

"1"

"one"

NA

Pop Quiz

What might NA stand for?

1

"1"

"one"

NA

**MISSING VALUE
(NOT AVAILABLE)**

Pop Quiz

What is the result?

1 == 1

Pop Quiz

What is the result?

`1 == 1`

TRUE

Pop Quiz

What is the result?

1 == NA

Pop Quiz

What is the result?

1 == NA

NA

Pop Quiz

What is the result?

NA == NA

Pop Quiz

What is the result?

NA == NA

NA

Pop Quiz

What is the result?

`is.na(NA)`

TRUE

Logical tests

?Comparison

<code>x < y</code>	Less than
<code>x > y</code>	Greater than
<code>x == y</code>	Equal to
<code>x <= y</code>	Less than or equal to
<code>x >= y</code>	Greater than or equal to
<code>x != y</code>	Not equal to
<code>x %in% y</code>	Group membership
<code>is.na(x)</code>	Is NA
<code>!is.na(x)</code>	Is not NA

Your Turn 3

Use filter, babynames, and the logical operators to find:

- All of the rows where **prop** is greater than or equal to 0.08
- All of the children named “Sea”



```
filter(babynames, prop >= 0.08)
```

```
#   year sex name    n      prop
# 1 1880 M  John 9655 0.08154630
# 2 1880 M William 9531 0.08049899
# 3 1881 M  John 8769 0.08098299
```

```
filter(babynames, name == "Sea")
```

```
#   year sex name    n      prop
# 1 1982 F  Sea     5 2.756771e-06
# 2 1985 M  Sea     6 3.119547e-06
# 3 1986 M  Sea     5 2.603512e-06
# 4 1998 F  Sea     5 2.580377e-06
```

Two common mistakes

1. Using `=` instead of `==`

```
filter(babynames, name = "Sea")  
filter(babynames, name == "Sea")
```

2. Forgetting quotes

```
filter(babynames, name == Sea)  
filter(babynames, name == "Sea")
```

filter()

Extract rows that meet *every* logical criteria.

```
filter(babynames, name == "Garrett", year == 1880)
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081



year	sex	name	n	prop
1880	M	Garrett	13	0,0001

filter()

Extract rows that meet *every* logical criteria.

```
filter(babynames, name == "Garrett" & year == 1880)
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

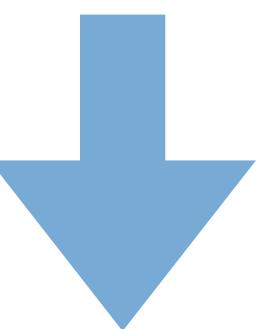


year	sex	name	n	prop
1880	M	Garrett	13	0,0001

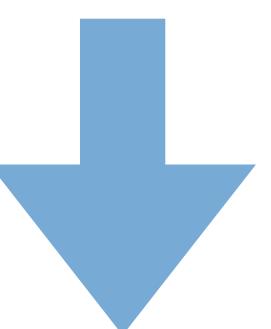
Boolean operators

?base::Logic

a & b	and
a b	or
xor(a,b)	exactly or
!a	not
()	To group tests . & evaluates before

$x \geq 2 \ \& \ x < 3$ 

TRUE & TRUE



TRUE

Your Turn 4

Use Boolean operators to alter the code below to return only the rows that contain:

- Boys named Sue
- Names that were used by exactly 5 or 6 children in 1880
- Names that are one of Acura, Lexus, or Yugo

```
filter(babynames, name == "Sea" | name == "Anemone")
```



```
filter(babynames, name == "Sue", sex == "M")
```

```
#   year sex name n prop
# 1 1917 M Sue 7 0.0000073
# 2 1927 M Sue 5 0.0000043
# ... ... ... ... ...
```

```
filter(babynames, (n == 5 | n == 6) & year == 1880)
```

```
#   year sex name n prop
# 1 1880 F Abby 6 6.147289e-05
# 2 1880 F Aileen 6 6.147289e-05
# ... ... ... ... ...
```

PARENTHESES
MATTER

```
filter(babynames, name == "Acura" | name == "Lexus" | name == "Yugo")
```

```
#   year sex name n prop
# 1 1990 F Lexus 36 1.752932e-05
# 2 1990 M Lexus 12 5.579156e-06
# ... ... ... ... ...
```

Two more common mistakes

3. Collapsing multiple tests into one

```
filter(babynames, 10 < n < 20)  
filter(babynames, 10 < n, n < 20)
```

4. Stringing together many tests (when you could use %in%)

```
filter(babynames, n == 5 | n == 6 | n == 7 | n == 8)  
filter(babynames, n %in% c(5, 6, 7, 8))
```

```
filter(babynames, name == "Sue", sex == "M")
```

```
#   year sex name    n      prop
# 1 1917 M  Sue     7 0.0000073
# 2 1927 M  Sue     5 0.0000043
# ... ... ... ... ... ...
```

```
filter(babynames, (n == 5 | n == 6) & year == 1880)
```

```
#   year sex name    n      prop
# 1 1880 F  Abby    6 6.147289e-05
# 2 1880 F  Aileen  6 6.147289e-05
# ... ... ... ... ... ...
```

```
filter(babynames, name == "Acura" | name == "Lexus" | name == "Yugo")
```

```
#   year sex name    n      prop
# 1 1990 F  Lexus  36 1.752932e-05
# 2 1990 M  Lexus  12 5.579156e-06
# ... ... ... ... ...
```

arrange()



arrange()

Order rows from smallest to largest values.

```
arrange(.data, ...)
```

data frame to transform

one or more columns to order by
(additional columns will be used as tie breakers)

arrange()

Order rows from smallest to largest values.

```
arrange(babynames, n)
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

year	sex	name	n	prop
1880	M	Garrett	13	0,0001
1880	M	Charles	5348	0,0451
1880	M	James	5927	0,0501
1881	M	John	8769	0,081
1880	M	William	9532	0,0805
1880	M	John	9655	0,0815

desc()

Changes ordering to largest to smallest.

```
arrange(babynames, desc(n))
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1881	M	John	8769	0,081
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001

Help me

What is the smallest value of n ?

What is the largest?

arrange(babynames, n, prop)

```
#   year sex      name    n      prop
# 1 2007 M     Aaban 5 2.259872e-06
# 2 2007 M     Aareon 5 2.259872e-06
# 3 2007 M     Aaris 5 2.259872e-06
# 4 2007 M     Abd 5 2.259872e-06
# 5 2007 M Abdulazeez 5 2.259872e-06
# 6 2007 M Abdulhadi 5 2.259872e-06
# 7 2007 M Abdulhamid 5 2.259872e-06
# 8 2007 M Abdulkadir 5 2.259872e-06
# 9 2007 M Abdulraheem 5 2.259872e-06
# 10 2007 M Abdulrahim 5 2.259872e-06
# ... with 1,924,655 more rows
```

```
arrange(babynames, desc(n))
```

```
#   year sex name n      prop
# 1 1947 F Linda 99680 0.05483609
# 2 1948 F Linda 96211 0.05521159
# 3 1947 M James 94763 0.05102057
# 4 1957 M Michael 92726 0.04238659
# 5 1947 M Robert 91646 0.04934237
# 6 1949 F Linda 91010 0.05184281
# 7 1956 M Michael 90623 0.04225479
# 8 1958 M Michael 90517 0.04203881
# 9 1948 M James 88588 0.04969679
# 10 1954 M Michael 88493 0.04279403
# ... with 1,924,655 more rows
```

| >



Steps

```
boys_2015 <- filter(babynames, year == 2015, sex == "M")
boys_2015 <- select(boys_2015, name, n)
boys_2015 <- arrange(boys_2015, desc(n))
boys_2015
```

1. Filter babynames to just boys born in 2015
2. Select the name and n columns from the result
3. Arrange those columns so that the most popular names appear near the top.

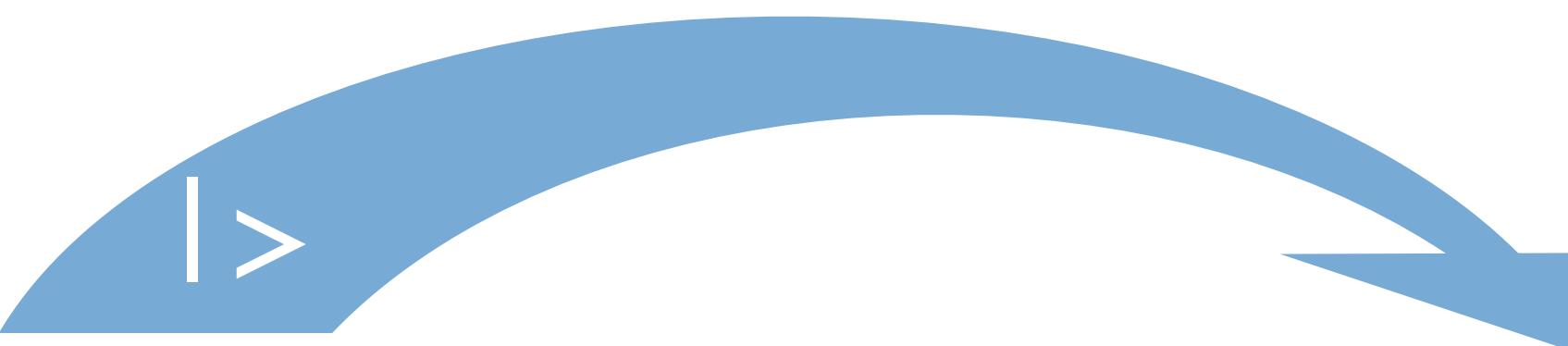
Steps

```
boys_2015 <- filter(babynames, year == 2015, sex == "M")
boys_2015 <- select(boys_2015, name, n)
boys_2015 <- arrange(boys_2015, desc(n))
boys_2015
```

Steps

```
arrange(select(filter(babynames, year == 2015,  
sex == "M"), name, n), desc(n))
```

The pipe operator |>



```
babynames |> filter(_____, n == 99680)
```

Passes result on left into first argument of function on right.
So, for example, these do the same thing. Try it.

```
filter(babynames, n == 99680)  
babynames |> filter(n == 99680)
```

Pipes

```
babynames  
boys_2015 <- filter(babynames, year == 2015, sex == "M")  
boys_2015 <- select(boys_2015, name, n)  
boys_2015 <- arrange(boys_2015, desc(n))  
boys_2015
```

```
babynames |>  
  filter(year == 2015, sex == "M") |>  
  select(name, n) |>  
  arrange(desc(n))
```

Shortcut to type |>

Cmd + Shift + M

(Mac)

Ctrl + Shift + M

(Windows)

Your Turn 5

Use `|>` to write a sequence of functions that:

1. Filters babynames to the girls that were born in 2017, *then...*
2. Selects the **name** and **n** columns, *then...*
3. Arranges the results so that the most popular names are near the top.



```
babynames |>  
  filter(year == 2017, sex == "F") |>  
  select(name, n) |>  
  arrange(desc(n))
```

```
#      name        n  
# 1  Emma    19738  
# 2 Olivia   18632  
# 3 Ava     15902  
# 4 Isabella 15100  
# 5 Sophia   14831  
# 6 Mia      13437  
# 7 Charlotte 12893  
# 8 Amelia   11800  
# 9 Evelyn   10675  
## ... with 20,170 more rows
```

Payoff!

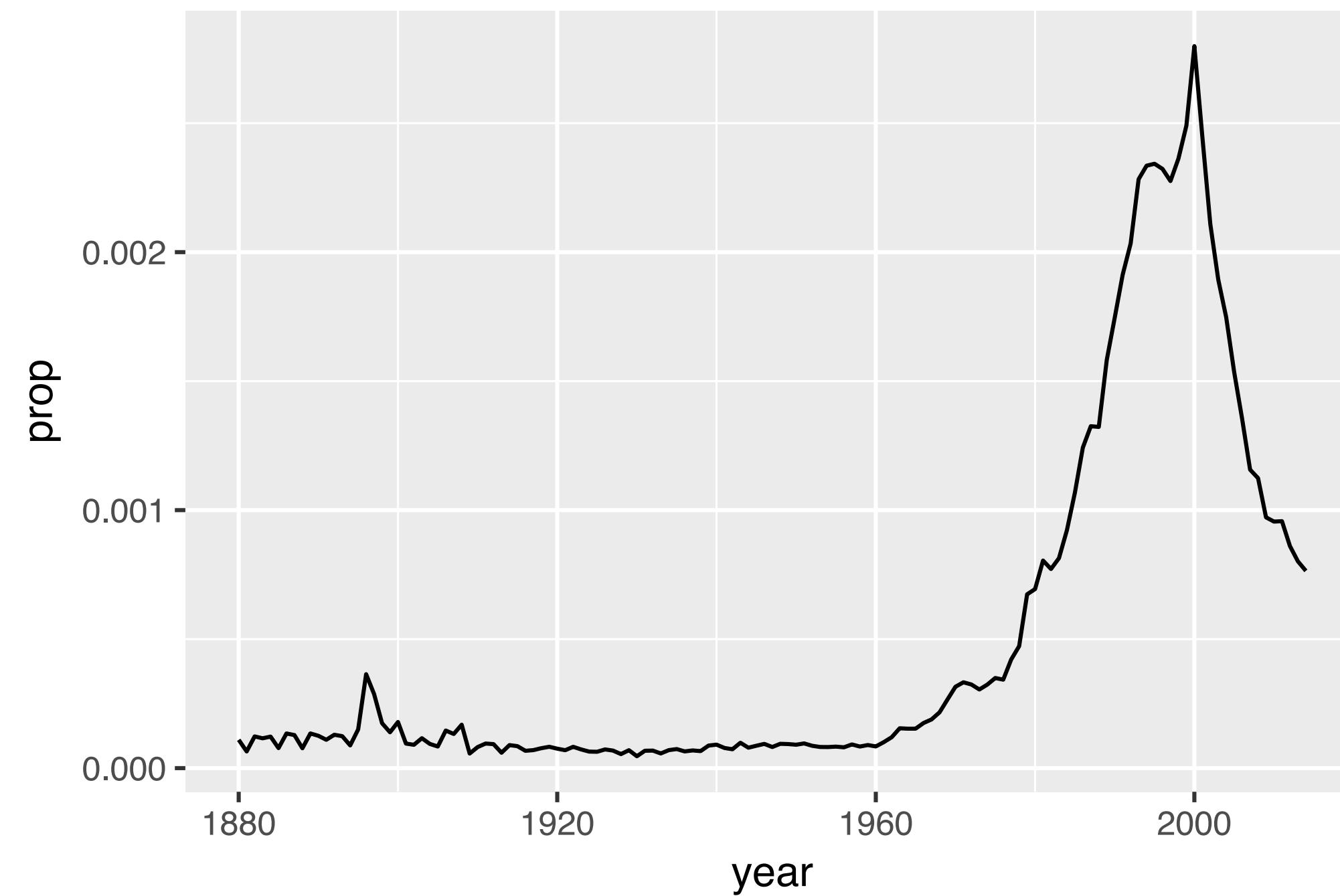


Your Turn 6

1. Pick a **name** and **sex**
2. Trim babynames to just the rows that contain this **name** and **sex**
3. Trim the result to just the columns that will appear in your graph
(not strictly necessary, but useful practice)
4. Plot the results as a line graph with **year** on the x axis
and **prop** on the y axis



```
babynames |>  
  filter(name == "Garrett", sex == "M") |>  
  select(year, prop) |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = prop))
```

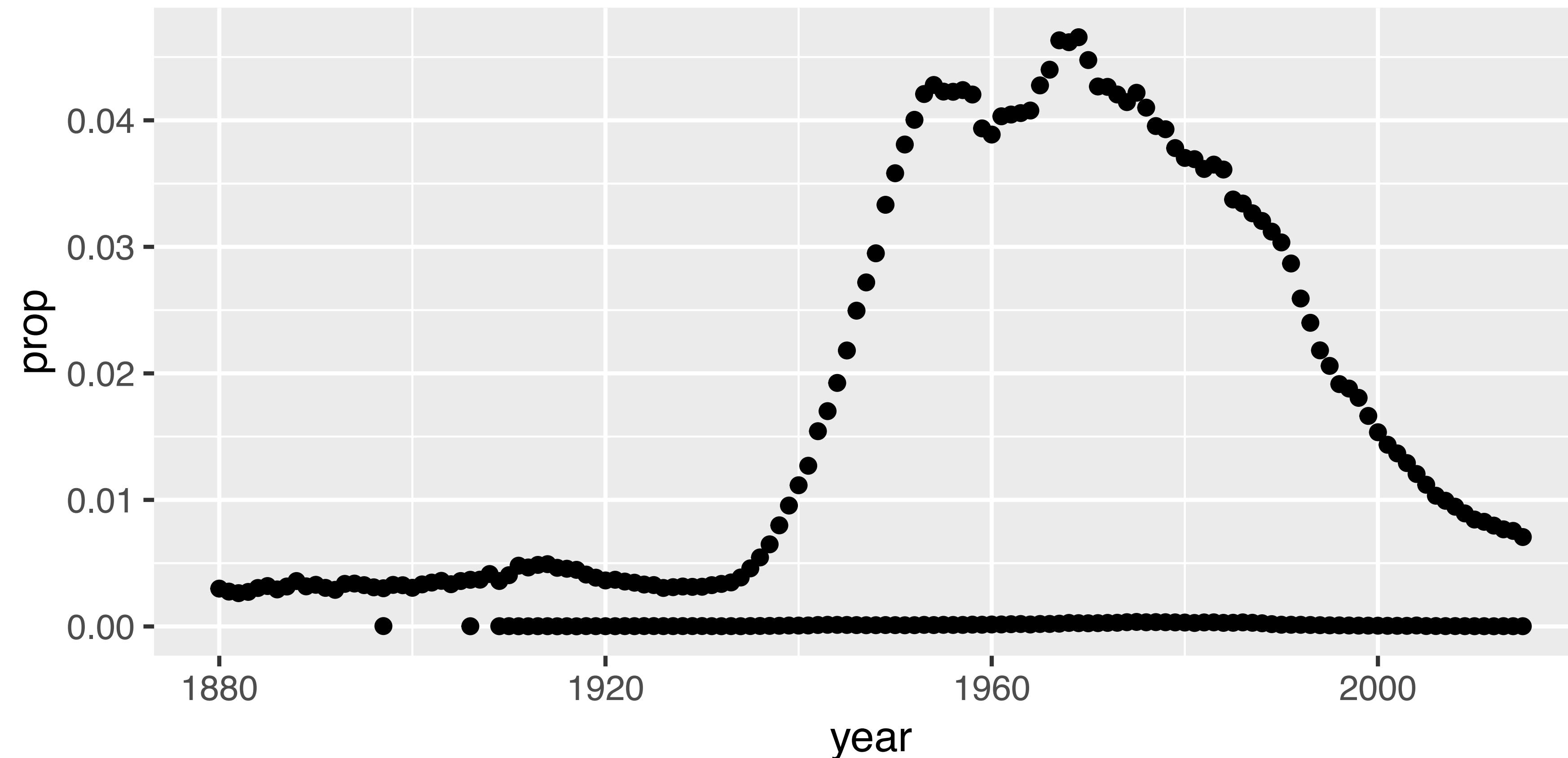


Plotting groups

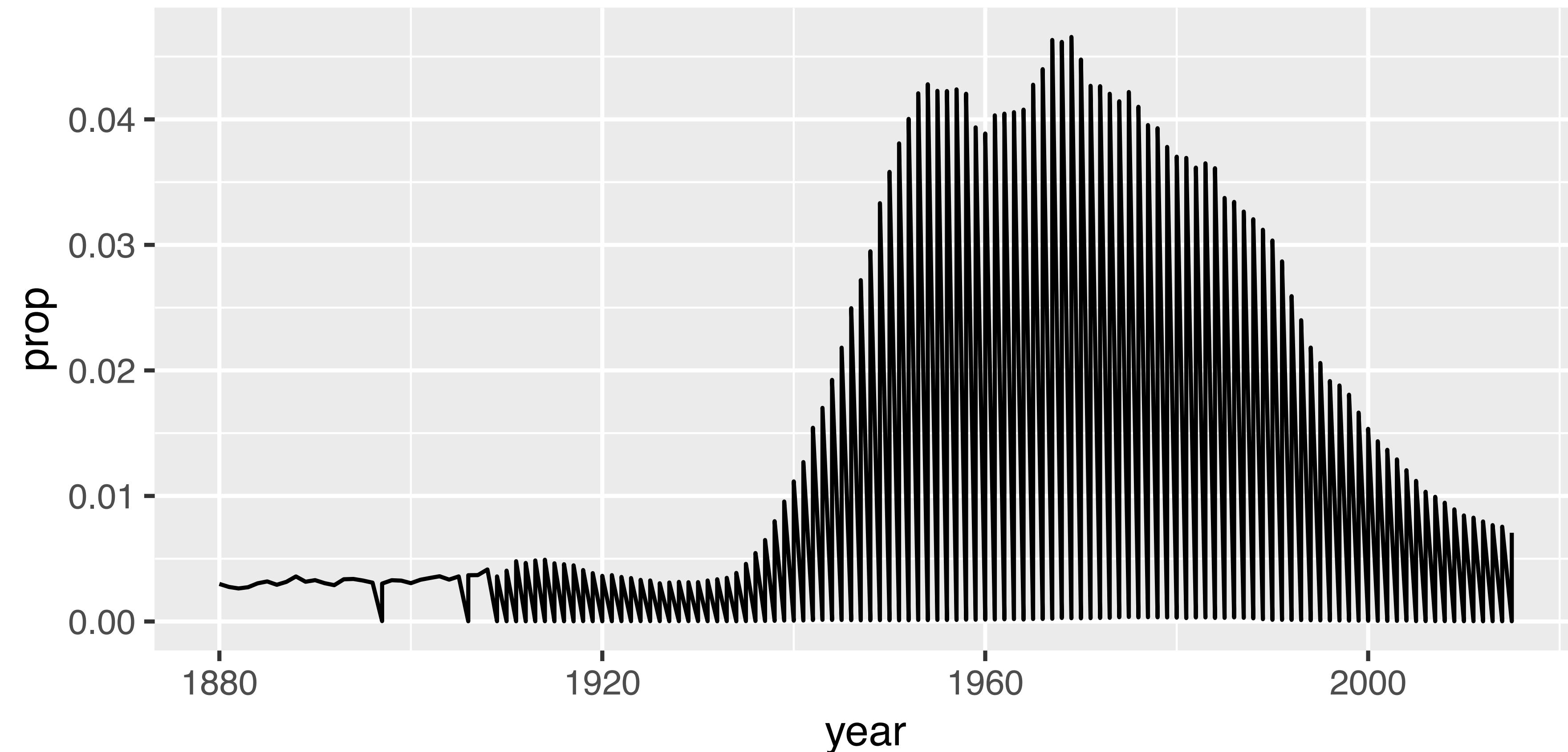
A faint watermark of the R logo is visible in the bottom right corner, consisting of two interlocking curved arrows forming a circular shape.

```
babynames |>  
  filter(name == "Michael") |>  
  ggplot() +  
  geom_point(mapping = aes(x = year, y = prop))
```

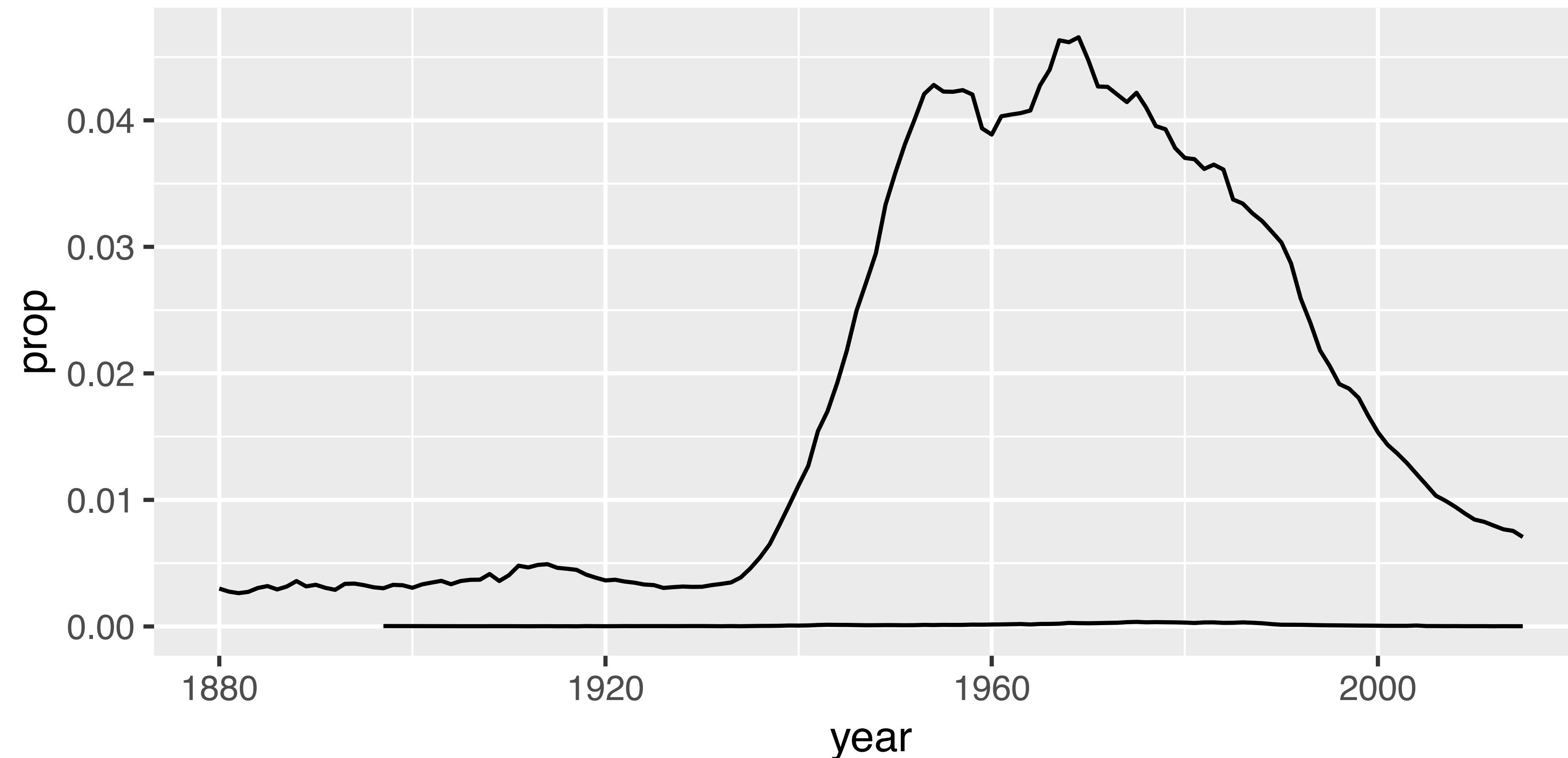
DID NOT FILTER
ON SEX



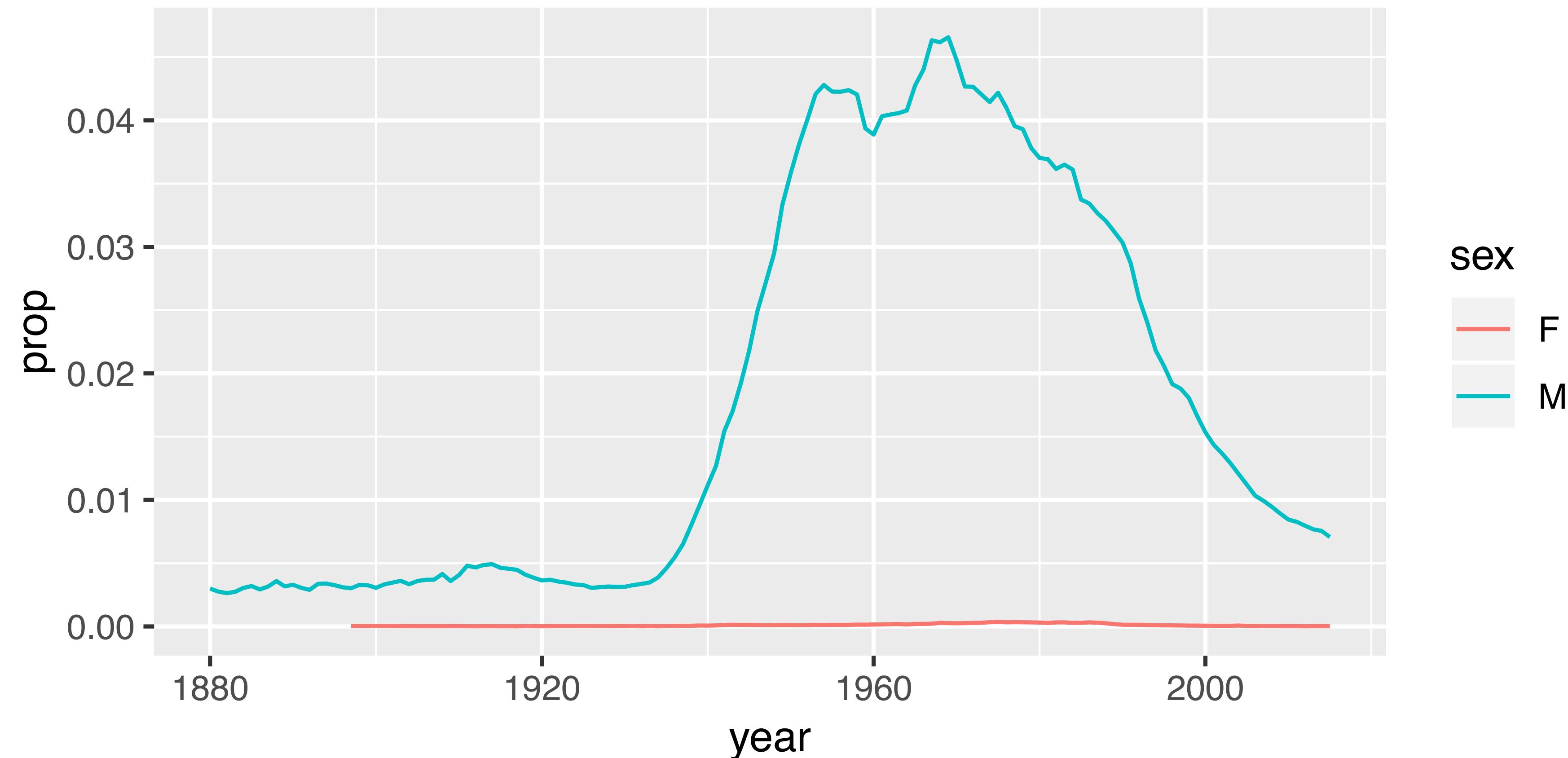
```
babynames |>  
  filter(name == "Michael") |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = prop))
```



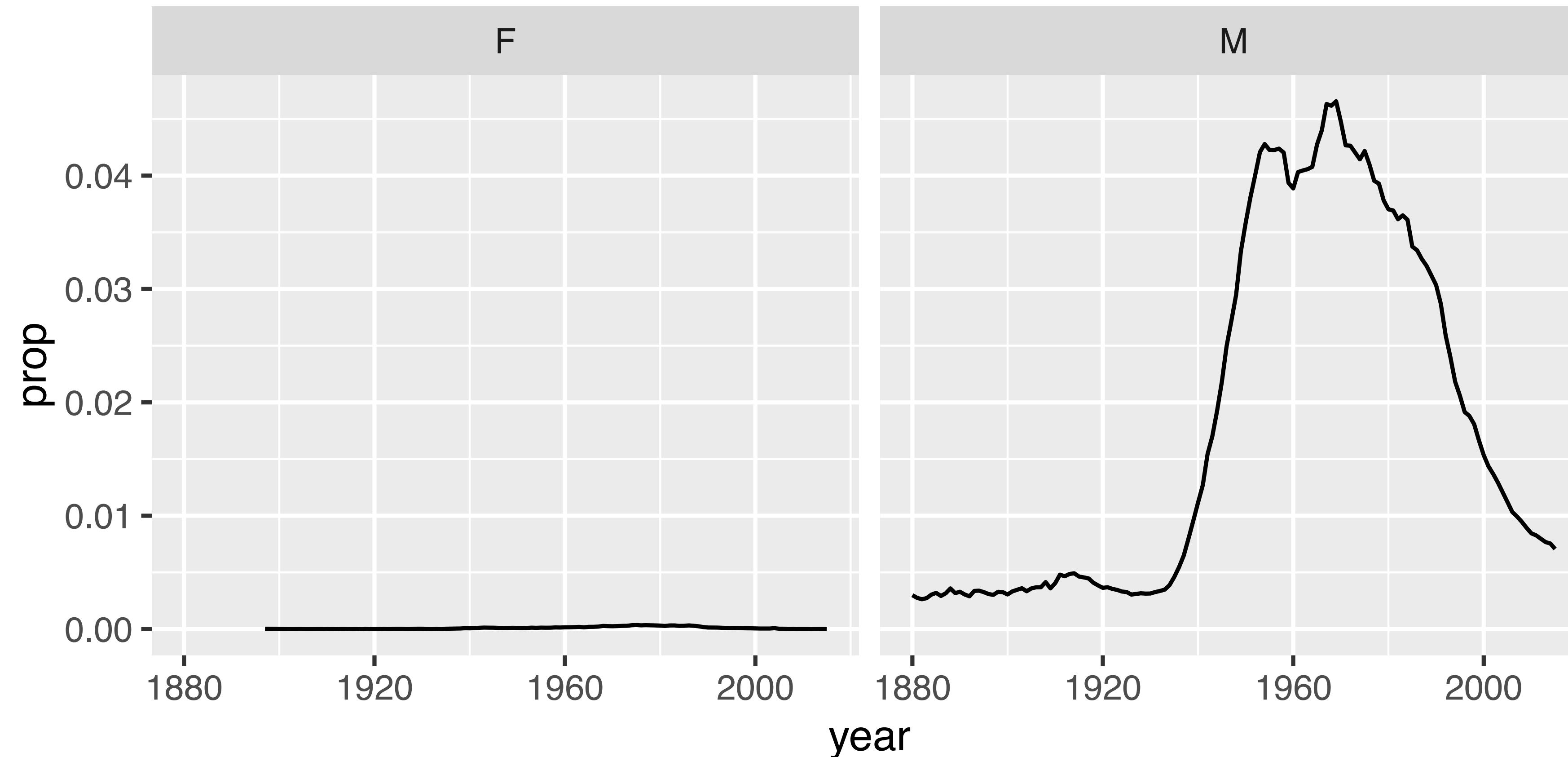
```
babynames |>  
  filter(name == "Michael") |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = prop, group = sex))
```



```
babynames |>  
  filter(name == "Michael") |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = prop, color = sex))
```



```
babynames |>  
  filter(name == "Michael") |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = prop)) +  
  facet_wrap(vars(sex))
```



What are the most
popular names?

Quiz

Do we have enough information to:

1. Calculate the total number of children with each name?

Deriving information

summarise() - summarise **variables**

group_by() - group **cases**

mutate() - create new **variables**

summarise()

A faint watermark of the R logo is visible in the bottom right corner, consisting of a circular arrow with the letter 'R' inside.

summarise()

Compute table of summaries.

```
babynames |> summarise(total = sum(n), max = max(n))
```

babynames

year	sex	name	n	prop	
1880	M	John	9655	0,0815	
1880	M	William	9532	0,0805	
1880	M	James	5927	0,0501	
1880	M	Charles	5348	0,0451	
1880	M	Garrett	13	0,0001	
1881	M	John	8769	0,081	

→

total	max
348120517	99686

Your Turn 7

Complete the code to extract the rows where **name == "Khaleesi"**. Then use **summarise()** and **sum()** and **min()** to find:

1. The total number of children named Khaleesi
2. The first **year** Khaleesi appeared in the data



```
babynames |>  
  filter(name == "Khaleesi") |>  
  summarise(total = sum(n), first = min(year))  
  
#   total first  
# 1 1964  2011
```

Summary functions

Take a vector as input.
Return a single value as output.

Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function →

COUNTS
`dplyr::n()` - number of values/rows
`dplyr::n_distinct()` - # of uniques
`sum(!is.na())` - # of non-NA's

LOCATION
`mean()` - mean, also `mean(!is.na())`
`median()` - median

LOGICALS
`mean()` - Proportion of TRUE's
`sum()` - # of TRUE's

POSITION/ORDER
`dplyr::first()` - first value
`dplyr::last()` - last value
`dplyr::nth()` - value in nth location of vector

RANK
`quantile()` - nth quantile
`min()` - minimum value
`max()` - maximum value

SPREAD
`IQR()` - Inter-Quartile Range
`mad()` - median absolute deviation
`sd()` - standard deviation
`var()` - variance

Vector Functions

TO USE WITH MUTATE ()

mutate() and **transmute()** apply vectorized functions to columns to create new columns. Vectorized functions take vectors as input and return vectors of the same length as output.

vectorized function →

Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function →

Combine Tables

COMBINE VARIABLES

COMBINE CASES

dplyr

ON BACK

RStudio® is a trademark of RStudio, Inc. • CC BY SA RStudio • info@rstudio.com • 844-448-1212 • rstudio.com • Learn more with browseVignettes(package = c("dplyr", "tibble")) • dplyr 0.7.0 • tibble 1.2.0 • Updated: 2017-03



n()

The number of rows in a dataset/group

```
babynames |> summarise(n = n())
```

babynames				
year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

n
1924665

101



n_distinct()

The number of distinct values in a variable

```
babynames |> summarise(n = n(), nname = n_distinct(name))
```

babynames

year	sex	name	n	prop	n	nname
1880	M	John	9655	0,0815	1924665	97310
1880	M	William	9532	0,0805		
1880	M	James	5927	0,0501		
1880	M	Charles	5348	0,0451		
1880	M	Garrett	13	0,0001		
1881	M	John	8769	0,081		

How should we define popularity?

A name is popular if:

1. **Sums** - a large number of children have the name when you sum across years

```
babynames |>  
  filter(name == "Khaleesi" & sex == "F")
```

##	year	sex	name	n	prop
## 1	2011	F	Khaleesi	28	0.0000145
## 2	2012	F	Khaleesi	146	0.0000754
## 3	2013	F	Khaleesi	243	0.000126
## 4	2014	F	Khaleesi	369	0.000189
## 5	2015	F	Khaleesi	341	0.000175
## 6	2016	F	Khaleesi	371	0.000192
## 7	2017	F	Khaleesi	466	0.000249

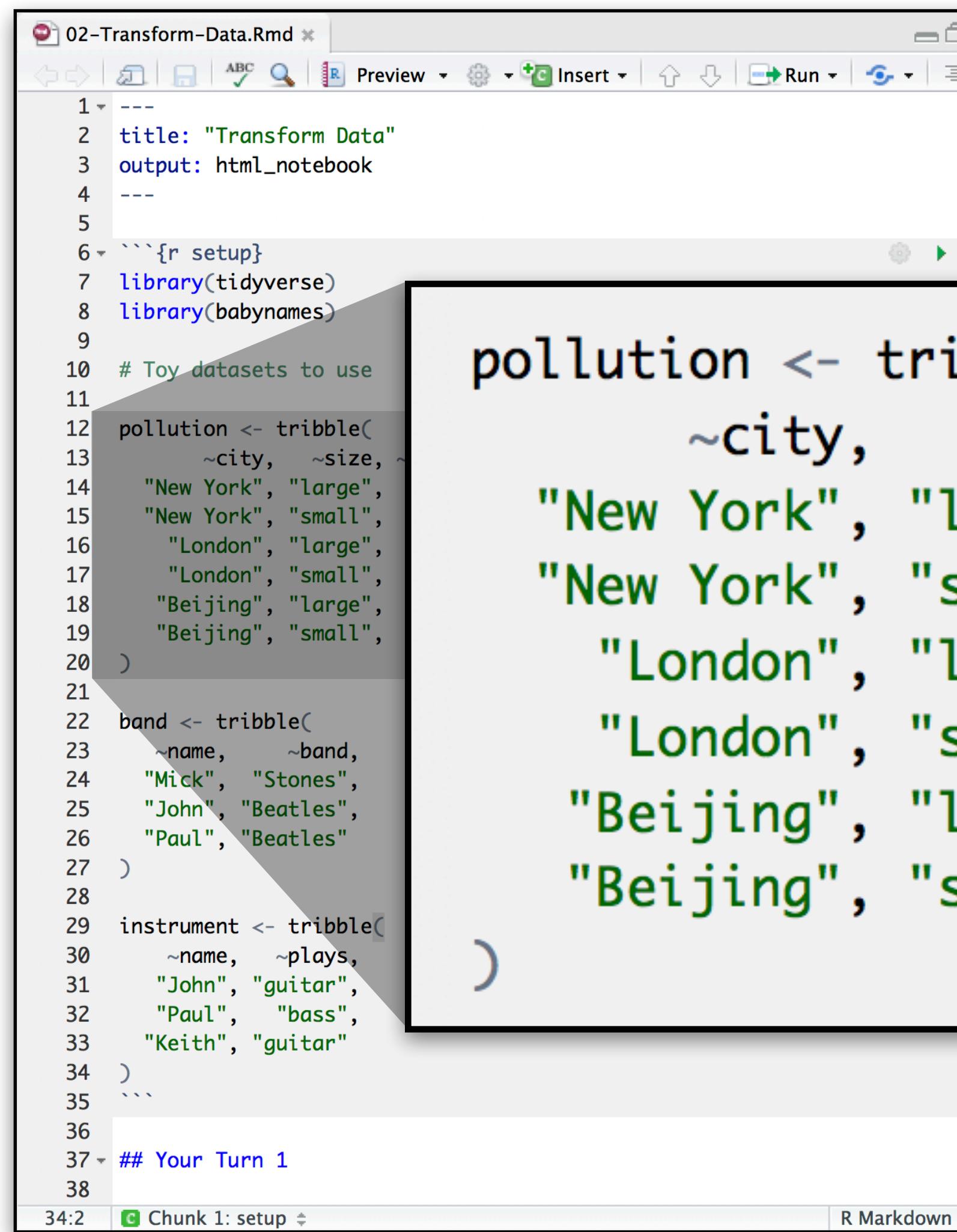
```
babynames |>  
  filter(name == "Khaleesi" & sex == "F") |>  
  summarise(total = sum(n))  
##     total  
## 1 1964
```

Can we do this for
each name?

Grouping cases



03-Transform-Exercises.qmd



```
1 ---  
2 title: "Transform Data"  
3 output: html_notebook  
4 ---  
5  
6 ```{r setup}  
7 library(tidyverse)  
8 library(babynames)  
9  
10 # Toy datasets to use  
11  
12 pollution <- tribble(  
13   ~city, ~size, ~amount,  
14   "New York", "large", 23,  
15   "New York", "small", 14,  
16   "London", "large", 22,  
17   "London", "small", 16,  
18   "Beijing", "large", 121,  
19   "Beijing", "small", 56  
20 )  
21  
22 band <- tribble(  
23   ~name, ~band,  
24   "Mick", "Stones",  
25   "John", "Beatles",  
26   "Paul", "Beatles"  
27 )  
28  
29 instrument <- tribble(  
30   ~name, ~plays,  
31   "John", "guitar",  
32   "Paul", "bass",  
33   "Keith", "guitar"  
34 )  
35  
36  
37 ## Your Turn 1  
38
```

```
pollution <- tribble(  
  ~city, ~size, ~amount,  
  "New York", "large", 23,  
  "New York", "small", 14,  
  "London", "large", 22,  
  "London", "small", 16,  
  "Beijing", "large", 121,  
  "Beijing", "small", 56
```

Toy data sets to practice with



pollution

```
pollution <- tribble(  
  ~city, ~size, ~amount,  
  "New York", "large", 23,  
  "New York", "small", 14,  
  "London", "large", 22,  
  "London", "small", 16,  
  "Beijing", "large", 121,  
  "Beijing", "small", 56  
)
```

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56



mean	sum	n
42	252	6

```
pollution |>  
summarise(mean = mean(amount), sum = sum(amount), n = n())
```

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

mean	sum	n
42	252	6



city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

mean	sum	n
42	252	6



city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14



mean	sum	n
18,5	37	2

London	large	22
London	small	16



19,0	38	2
------	----	---

Beijing	large	121
Beijing	small	56



88,5	177	2
------	-----	---

group_by() + summarise()



group_by()

Groups cases by common values of one or more columns.

```
pollution |>  
  group_by(city)
```

```
# A tibble: 6 × 3  
# Groups:   city [3]  
  city     size    amount  
  <chr>    <chr>   <dbl>  
1 New York large      23  
2 New York small      14  
3 Boston   large      22
```



group_by()

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14

London	large	22
London	small	16

Beijing	large	121
Beijing	small	56

city	mean	sum	n
New York	18,5	37	2
London	19,0	38	2
Beijing	88,5	177	2

```
pollution |>
  group_by(city) |>
  summarise(mean = mean(amount), sum = sum(amount), n = n())
```

group_by()

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

city	particle size	amount ($\mu\text{g}/\text{m}^3$)
New York	large	23
New York	small	14
London	large	22
London	small	16
Beijing	large	121
Beijing	small	56

city	particle size	mean	sum	n
New York	large	23	23	1
New York	small	14	14	1
London	large	22	22	1
London	small	16	16	1
Beijing	large	121	121	1
Beijing	small	56	56	1

```
pollution >
  group_by(city, size) >
  summarise(mean = mean(amount), sum = sum(amount), n = n())
```

group_by()

Groups cases by common values.

```
babynames |>  
  group_by(sex) |>  
  summarise(total = sum(n))
```

sex	total
F	172371079
M	175749438

ungroup()

Removes grouping criteria from a data frame.

```
babynames |>  
  group_by(sex) |>  
  ungroup() |>  
  summarise(total = sum(n))
```

total
348120517

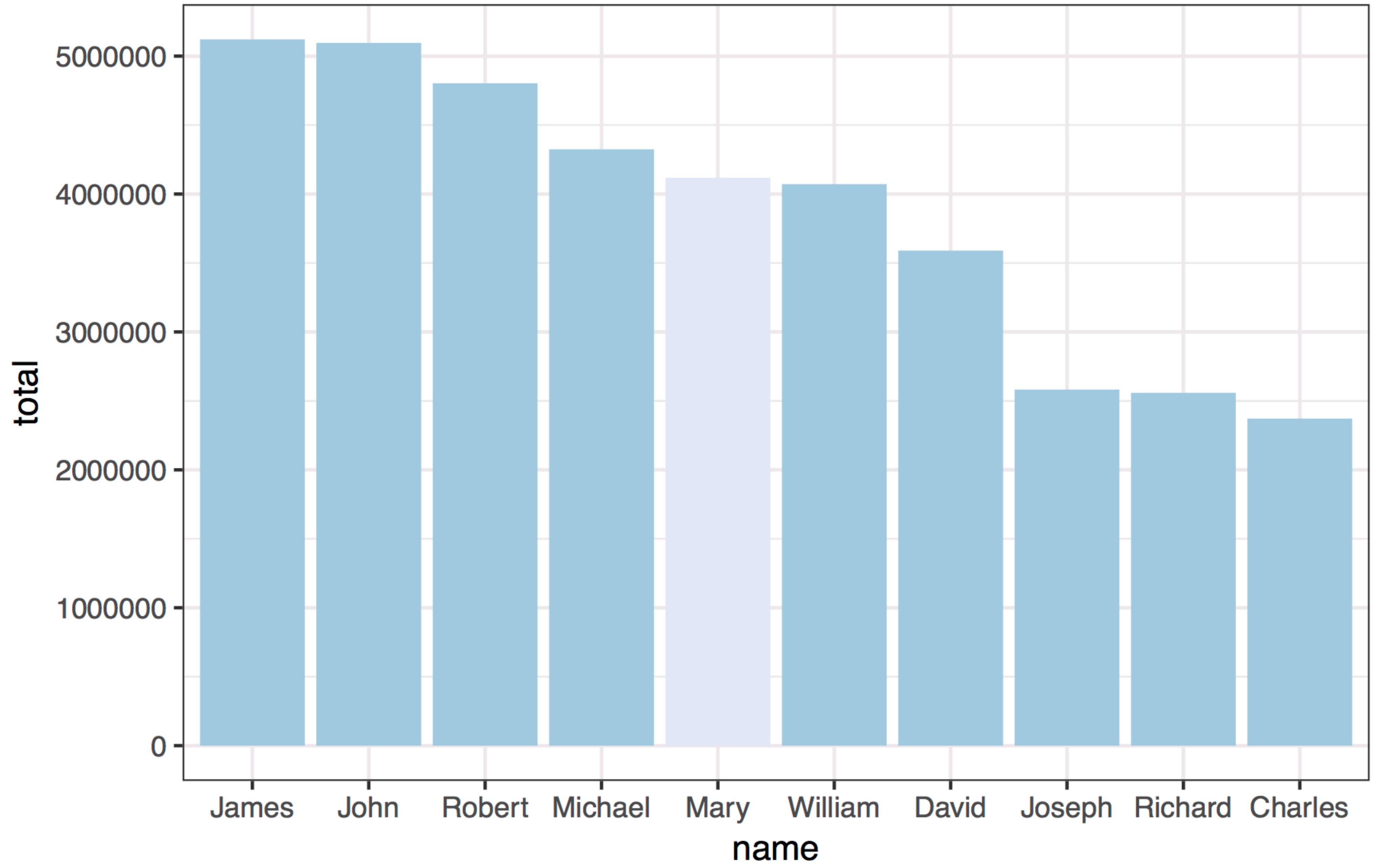
Your Turn 8

Complete the code with **group_by()**, **summarise()**, and **arrange()** to display the ten most popular **name** and **sex** combinations. Compute popularity as the *total* number of children with a given name and sex.



```
babynames |>  
  group_by(name, sex) |>  
  summarise(total = sum(n)) |>  
  arrange(desc(total))
```

```
#          name   sex total  
# 1      James     M 5120990  
# 2      John     M 5095674  
# 3    Robert     M 4803068  
# 4  Michael     M 4323928  
# 5      Mary     F 4118058  
# 6  William     M 4071645  
# 7      David     M 3589754  
# 8    Joseph     M 2581785  
# 9  Richard     M 2558165  
# 10  Charles     M 2371621  
# ... with 107,963 more rows
```



```
babynames |>
  group_by(name, sex) |>
  summarise(total = sum(n)) |>
  arrange(desc(total)) |>
  ungroup() |>
  slice(1:10) |>
  ggplot() +
  geom_col(mapping = aes(
    x = fct_reorder(name, desc(total)),
    y = total,
    fill = sex
  )) +
  theme_bw() +
  scale_fill_brewer() +
  labs(x = "name")
```

```
babynames |>  
  filter(name == "Khaleesi" & sex == "F") |>  
  summarise(total = sum(n))  
##     total  
## 1 1964
```

Can we do this for
each name?

```
babynames |>  
  filter(name == "Khaleesi" & sex == "F") |>  
  summarise(total = sum(n))  
##     total  
## 1 1964
```

```
babynames |>  
  group_by(name, sex) |>  
  summarise(total = sum(n)) |>  
  arrange(desc(total))
```

```
babynames |>  
  filter(name == "Khaleesi" & sex == "F") |>  
  summarise(total = sum(n))
```

```
babynames |>  
  group_by(name, sex) |>  
  summarise(total = sum(n))
```

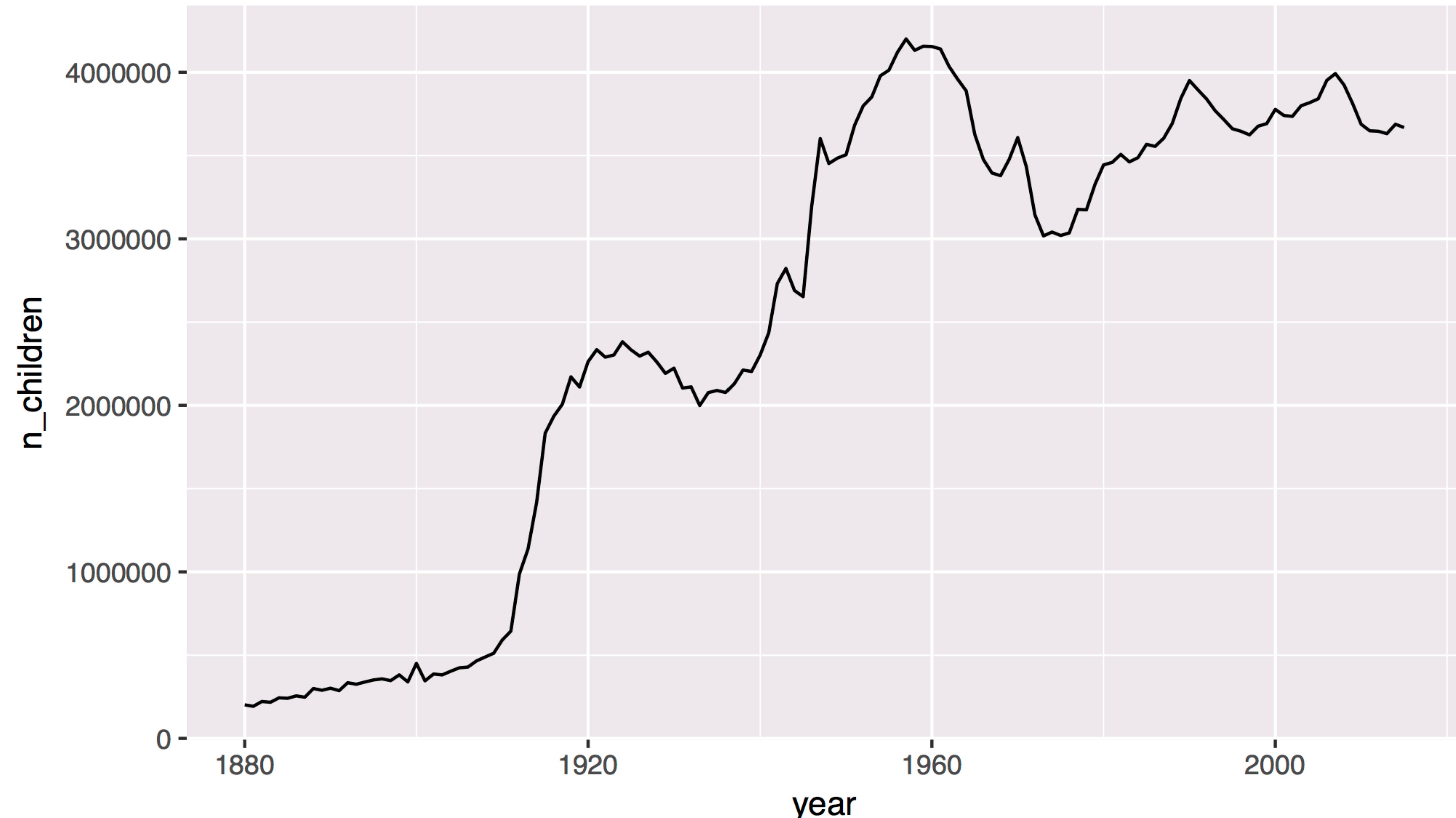
**GROUP BY THE
VARIABLES YOU USED TO
GET YOUR TEST CASE**

Your Turn 9

Use `group_by()` to calculate the total number of children born **for every year**.

Plot the results as a line graph: total vs. year.

```
babynames |>  
  group_by(year) |>  
  summarise(n_children = sum(n)) |>  
  ggplot() +  
  geom_line(mapping = aes(x = year, y = n_children))
```



What was the top ranked
name for each year?

Quiz

Do we have enough information to:

1. Rank names within each year?

mutate()



mutate()

Create new columns.

```
babynames |>  
  mutate(percent = round(prop * 100, 2))
```

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081



year	sex	name	n	prop	percent
1880	M	John	9655	0,0815	8,15
1880	M	William	9532	0,0805	8,05
1880	M	James	5927	0,0501	5,01
1880	M	Charles	5348	0,0451	4,51
1880	M	Garrett	13	0,0001	0,01
1881	M	John	8769	0,081	8,1



mutate()

Create new columns.

```
babynames |>  
  mutate(percent = round(prop * 100, 2), nper = round(percent))
```

babynames						
year	sex	name	n	prop	percent	nper
1880	M	John	9655	0,0815	8,15	8
1880	M	William	9532	0,0805	8,05	8
1880	M	James	5927	0,0501	5,01	5
1880	M	Charles	5348	0,0451	4,51	5
1880	M	Garrett	13	0,0001	0,01	0
1881	M	John	8769	0,081	8,1	8

```
babynames |>  
  mutate(rank = ? )
```

Vectorized functions

Take a vector as input.
Return a vector of the same length as output.

Vector Functions

TO USE WITH MUTATE ()

mutate() and **transmute()** apply vectorized functions to columns to create new columns. Vectorized functions take vectors as input and return vectors of the same length as output.

vectorized function →

OFFSETS

dplyr::lag() - Offset elements by 1
dplyr::lead() - Offset elements by -1

CUMULATIVE AGGREGATES

dplyr::cumall() - Cumulative all()
dplyr::cumany() - Cumulative any()
cummax() - Cumulative max()
dplyr::cummean() - Cumulative mean()
cummin() - Cumulative min()
cumprod() - Cumulative prod()
cumsum() - Cumulative sum()

RANKINGS

dplyr::cume_dist() - Proportion of all values <= dplyr::dense_rank() - rank with ties = min, no gaps
dplyr::min_rank() - rank with ties = min
dplyr::ntile() - bins into n bins
dplyr::percent_rank() - min_rank scaled to [0,1]
dplyr::row_number() - rank with ties = "first"

MATH

+, -, *, /, ^, %/%, %% - arithmetic ops
log(), log2(), log10() - logs
<, <=, >, >=, !=, == - logical comparisons
dplyr::between() - x >= left & x <= right
dplyr::near() - safe == for floating point numbers

MISC

dplyr::case_when() - multi-case if_else()
dplyr::coalesce() - first non-NA values by element across a set of vectors
dplyr::if_else() - element-wise if() + else()
dplyr::na_if() - replace specific values with NA
pmax() - element-wise max()
pmin() - element-wise min()
dplyr::recode() - Vectorized switch()
dplyr::recode_factor() - Vectorized switch() for factors

Vector Functions

TO USE WITH MUTATE ()

mutate() and transmute() apply vectorized functions to columns to create new columns. Vectorized functions take vectors as input and return vectors of the same length as output.

vectorized function →

OFFSETS

dplyr::lag() - Offset elements by 1
dplyr::lead() - Offset elements by -1

CUMULATIVE AGGREGATES

dplyr::cumall() - Cumulative all()
dplyr::cumany() - Cumulative any()
cummax() - Cumulative max()
dplyr::cummean() - Cumulative mean()
cummin() - Cumulative min()
cumprod() - Cumulative prod()
cumsum() - Cumulative sum()

RANKINGS

dplyr::cume_dist() - Proportion of all values <= dplyr::dense_rank() - rank with ties = min, no gaps
dplyr::min_rank() - rank with ties = min
dplyr::ntile() - bins into n bins
dplyr::percent_rank() - min_rank scaled to [0,1]
dplyr::row_number() - rank with ties = "first"

MATH

+, -, *, /, ^, %/%, %% - arithmetic ops
log(), log2(), log10() - logs
<, <=, >, >=, !=, == - logical comparisons

dplyr::between() - x >= left & x <= right

dplyr::near() - safe == for floating point numbers

MISC

dplyr::case_when() - multi-case if_else()
dplyr::coalesce() - first non-NA values by element across a set of vectors
dplyr::if_else() - element-wise if() + else()
dplyr::na_if() - replace specific values with NA
pmax() - element-wise max()
pmin() - element-wise min()
dplyr::recode() - Vectorized switch()
dplyr::recode_factor() - Vectorized switch() for factors



Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function →

COUNTS

dplyr::n() - number of values/rows
dplyr::n_distinct() - # of uniques
sum(is.na()) - # of non-NA's

LOCATION

mean() - mean, also mean(is.na())
median() - median

LOGICALS

mean() - Proportion of TRUE's
sum() - # of TRUE's

POSITION/ORDER

dplyr::first() - first value
dplyr::last() - last value
dplyr::nth() - value in nth location of vector

RANK

quantile() - nth quantile
min() - minimum value
max() - maximum value

SPREAD

IQR() - Inter-Quartile Range
mad() - median absolute deviation
sd() - standard deviation
var() - variance

Row Names

Tidy data does not use rownames, which store a variable outside of the columns. To work with the rownames, first move them into a column.

A B C A B C
1 2 3 1 2 3
| | | | | |
a b c a b c
rownames_to_column()
Move row names into col.
g <- rownames_to_column(iris, var = "C")

A B C A B C
1 2 3 1 2 3
| | | | | |
a b c a b c
column_to_rownames()
Move col in row names.
column_to_rownames(a, var = "C")

Also has_rownames(), remove_rownames()

RStudio® is a trademark of RStudio, Inc. • CC BY SA RStudio • info@rstudio.com • 844-448-1212 • rstudio.com • Learn more with browseVignettes(package = c("dplyr", "tibble")) • dplyr 0.7.0 • tibble 1.2.0 • Updated: 2017-03

Combine Tables

COMBINE VARIABLES

x y
A B C + A B D = A B C A B D
a b c + a b d = a b c a b d
c v 3 2 w 1

Use bind_cols() to paste tables beside each other as they are.

bind_cols(...)
Returns tables placed side by side as a single table.
BE SURE THAT ROWS ALIGN.

Use a "Mutating Join" to join one table to columns from another, matching values with the rows that they correspond to. Each join retains a different combination of values from the tables.

A B C left_join(x, y, by = NULL,
copy = FALSE, suffix = c("x", "y"), ...)
Join matching values from y to x.

A B C right_join(x, y, by = NULL, copy =
FALSE, suffix = c("x", "y"), ...)
Join matching values from x to y.

A B C inner_join(x, y, by = NULL, copy =
FALSE, suffix = c("x", "y"), ...)
Join data. Retain only rows with matches.

A B C full_join(x, y, by = NULL,
copy = FALSE, suffix = c("x", "y"), ...)
Join data. Retain all values, all rows.

A B C A B C
1 2 3 1 2 3
| | | | | |
a b c a b c
use by = c("col1", "col2", ...)
to specify one or more common
columns to match on.
left_join(x, y, by = "A")

A B C A B C
1 2 3 1 2 3
| | | | | |
a b c a b c
rowname_to_column()
Match on columns that have
different names in each table.
left_join(x, y, by = "C")

A B C A B C
1 2 3 1 2 3
| | | | | |
a b c a b c
column_to_rownames()
Give to unmatched columns that
have the same name in both tables.
left_join(x, y, by = c("C" = "D"), suffix =
c("1", "2"))

Also has_rownames(), remove_rownames()

RStudio® is a trademark of RStudio, Inc. • CC BY SA RStudio • info@rstudio.com • 844-448-1212 • rstudio.com • Learn more with browseVignettes(package = c("dplyr", "tibble")) • dplyr 0.7.0 • tibble 1.2.0 • Updated: 2017-03

COMBINE CASES

x y
A B C + A B C = A B C A B C
a b c + a b c = a b c a b c
c v 3 2 w 1

Use bind_rows() to paste tables below each other as they are.

bind_rows(...)
Returns tables one on top of the other
as a single table. Set id to a column
name to add a column of the original
table names (as pictured)

A B C intersect(x, y, ...)
Rows that appear in both x and y.

A B C setdiff(x, y, ...)
Rows that appear in x but not y.

A B C union(x, y, ...)
Rows that appear in x or y.
(Duplicates removed). union_all()
keeps duplicates.

use setequal() to test whether two data sets
contain the exact same rows (in any order).

EXTRACT ROWS

x y
A B C + A B C = A B C A B C
a b c + a b c = a b c a b c
c v 3 2 w 1

Use a "Filtering Join" to filter one table against
the rows of another.

semi_join(x, y, by = NULL, ...)
Return rows of x that have a match in y.
USEFUL TO SEE WHAT WILL BE JOINED.

anti_join(x, y, by = NULL, ...)
Return rows of x that do not have a
match in y. USEFUL TO SEE WHAT WILL
NOT BE JOINED.



ON BACK



min_rank()

A go-to ranking function (ties share the lowest rank)

```
min_rank(c(50, 100, 100, 1000))  
# [1] 1 2 2 4
```

```
min_rank(desc(c(50, 100, 100, 1000)))  
# [1] 4 2 2 1
```

Your Turn 10

Use **mutate()** and **min_rank()** to rank each row in babynames from largest **n** to lowest **n**.



```
babynames |>  
  mutate(rank = min_rank(desc(prop)))
```

```
## # A tibble: 1,924,665 x 6  
#   year sex   name      n    prop   rank  
# 1 1880 F   Mary  7065 0.0724     14  
# 2 1880 F   Anna  2604 0.0267    709  
# 3 1880 F   Emma  2003 0.0205   1131  
# 4 1880 F Elizabeth 1939 0.0199  1192  
# 5 1880 F   Minnie 1746 0.0179  1427  
# 6 1880 F   Margaret 1578 0.0162  1683  
## ... with 1,924,659 more rows
```

Your Turn 11

Group babynames by **year** and then re-rank the data. Filter the results to just rows where **rank == 1**.



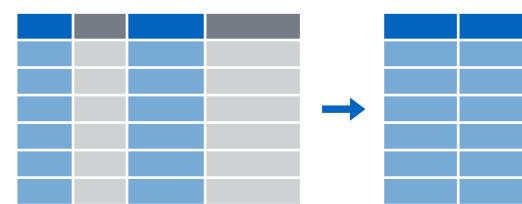
```
babynames |>  
  group_by(year) |>  
  mutate(rank = min_rank(desc(prop))) |>  
  filter(rank == 1)
```

```
# A tibble: 138 x 6  
# Groups:   year [138]
```

	year	sex	name	n	prop	rank
1	1880	M	John	9655	0.0815	1
2	1881	M	John	8769	0.0810	1
3	1882	M	John	9557	0.0783	1

```
# ... with 135 more rows
```

Recap: Single table verbs



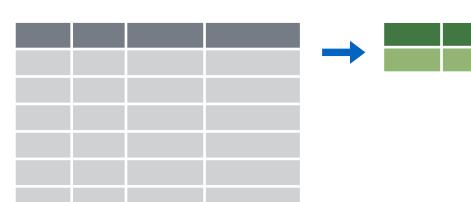
Extract variables with **select()**



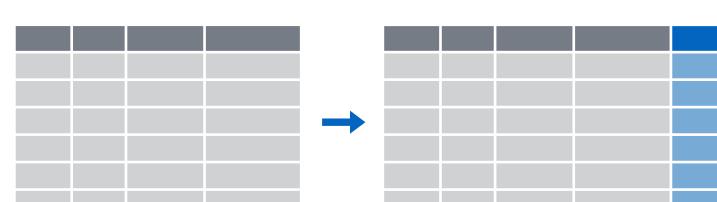
Extract cases with **filter()**



Arrange cases, with **arrange()**.



Make tables of summaries with **summarise()**.



Make new variables, with **mutate()**.

\$

R

select()

Extract columns by name.

```
select(babynames, n)
```

babynames

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→

n
9655
9532
5927
5348
13
8769

**STILL A
DATAFRAME**



\$

Extract column contents as a vector.

babynames\$n

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→ 9655 9532 5927 5348 ...



\$

Extract column contents as a vector.

`babynames$n`

data
frame

\$

column name
(no quotes)

pull()

Pipe friendly version of \$

```
babynames |> pull(n)
```

babynames

year	sex	name	n	prop
1880	M	John	9655	0,0815
1880	M	William	9532	0,0805
1880	M	James	5927	0,0501
1880	M	Charles	5348	0,0451
1880	M	Garrett	13	0,0001
1881	M	John	8769	0,081

→ 9655 9532 5927 5348 ...



Transform Data with

