```
data_wrangling() &&
("manipulation" %in% R)
```

🐨🐟🌿 %>% 📗 %>% Ⓡ %>% 🤓📊🥰

```
postgraduate_workshop(
  dept = "Biological Sciences",
  presenter = c(
    "Ruan van Mazijk",
    "MSc candidate"
  )
)
```

> face()

> logos()

> introduce()

> introduce()

- BSc + Hons here at UCT

> introduce()

- BSc + Hons here at UCT

- Ecology & evolution
- (Mostly plant) comparative biology
- Biogeography

> introduce()

- BSc + Hons here at UCT

- Ecology & evolution
- (Mostly plant) comparative biology
- Biogeography

- Been working with R for 4½ years
  - Every major project I've done…

> introduce()

Tetraria ustulata
Marloth NR
R. van Mazijk 2018

Tetraria thermalis
Silvermine, Table Mountain NP
R. van Mazijk 2018

Schoenus compar
Silvermine, Table Mountatin NP
R. van Mazijk 2018

```
> workshop$goals
```

> workshop$goals

- More reproducible science

> workshop$goals

- More reproducible science
- Save time by:
  - Automating repetitive tasks
  - Eliminating human error

> workshop$goals

- More reproducible science
- Save time by:
  - Automating repetitive tasks
  - Eliminating human error
- Boost your skills
- Think about your data programmatically

Notes & slides will go up here:

tinyurl.com/r-with-ruan

(But I encourage you to make your own notes!)

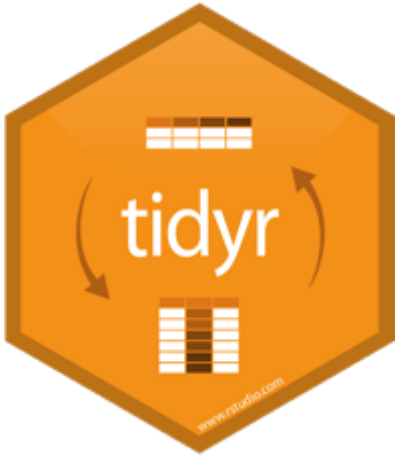
```
> workshop$outline
```

```
> workshop$outline[1:3]
```

`> workshop$outline[1:3]`

DAY 1

Tidy data principles
& `tidyr`



`> workshop$outline[1:3]`

DAY 1

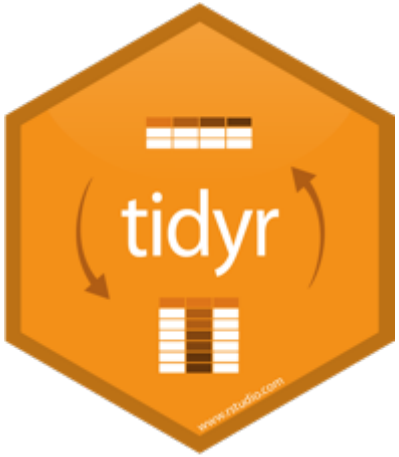
Tidy data principles
& `tidyr`

DAY 2

Manipulating data
& an intro to `dplyr`

DAY 3

Extending your data
with `mutate()`,
`summarise()`
& friends



```
> workshop$outline[-(1:3)]
```

```
> workshop$outline[-(1:3)]
```

2 dialects of R:

`> workshop$outline[-(1:3)]`

2 dialects of R:

`base`

`$` `[]` `[[]]`

`apply()` `which()` `subset()`

`> workshop$outline[-(1:3)]`

2 dialects of R:

`base`

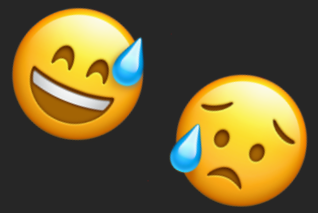
`$` `[]` `[[]]`

`apply()` `which()` `subset()`

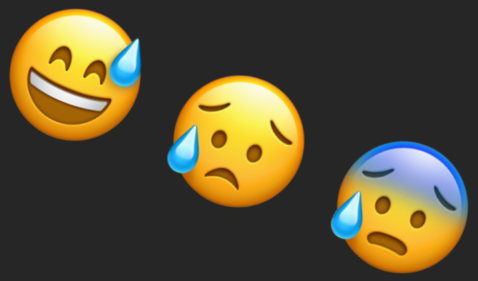
`tidyverse`

```r
data <- read.csv("my-data.csv")
```

```r
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
```



```
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
```



```r
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
data3 <- h(data2, a.setting = TRUE)
```

```r
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
data3 <- h(data2, a.setting = TRUE)
data4 <- data3[data3$a.column == "cough", ]
```

```
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
data3 <- h(data2, a.setting = TRUE)
data4 <- data3[data3$a.column == "cough", ]
```

```r
data <- read.csv("my-data.csv")
```

```r
data <- read.csv("my-data.csv")

data <-

        data
```

```r
data <- read.csv("my-data.csv")

data <-

      f(data, arg1 = "something")
```

```r
data <- read.csv("my-data.csv")

data <-

    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    )
```

```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

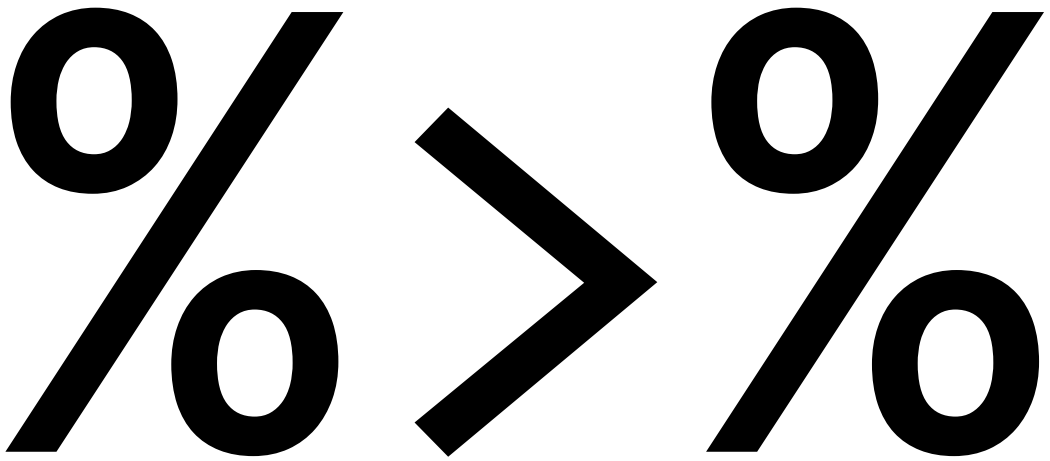
```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- data[data$a.column == "cough", ]
```

Solution: the pipe!



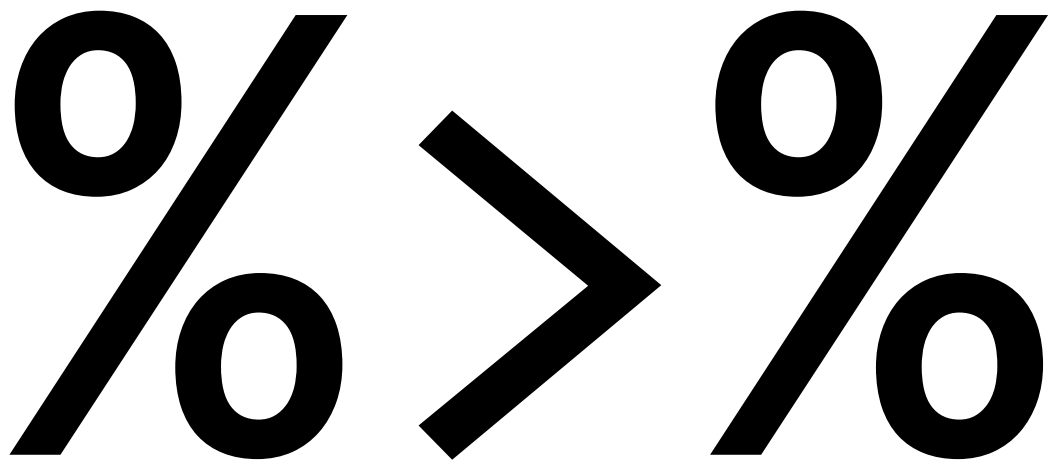
Solution: the pipe!

%>%

{ } [ ] [[ ]] <- = ( ) , " " ' '

Read: “then”

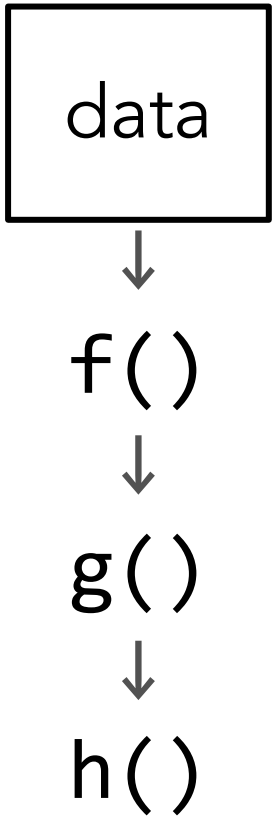
Solution: the pipe!

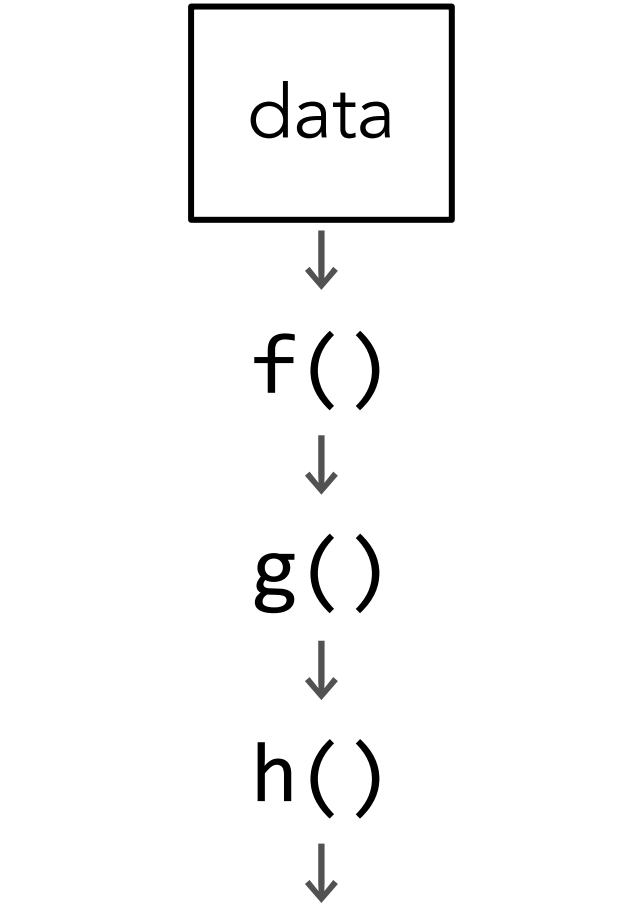


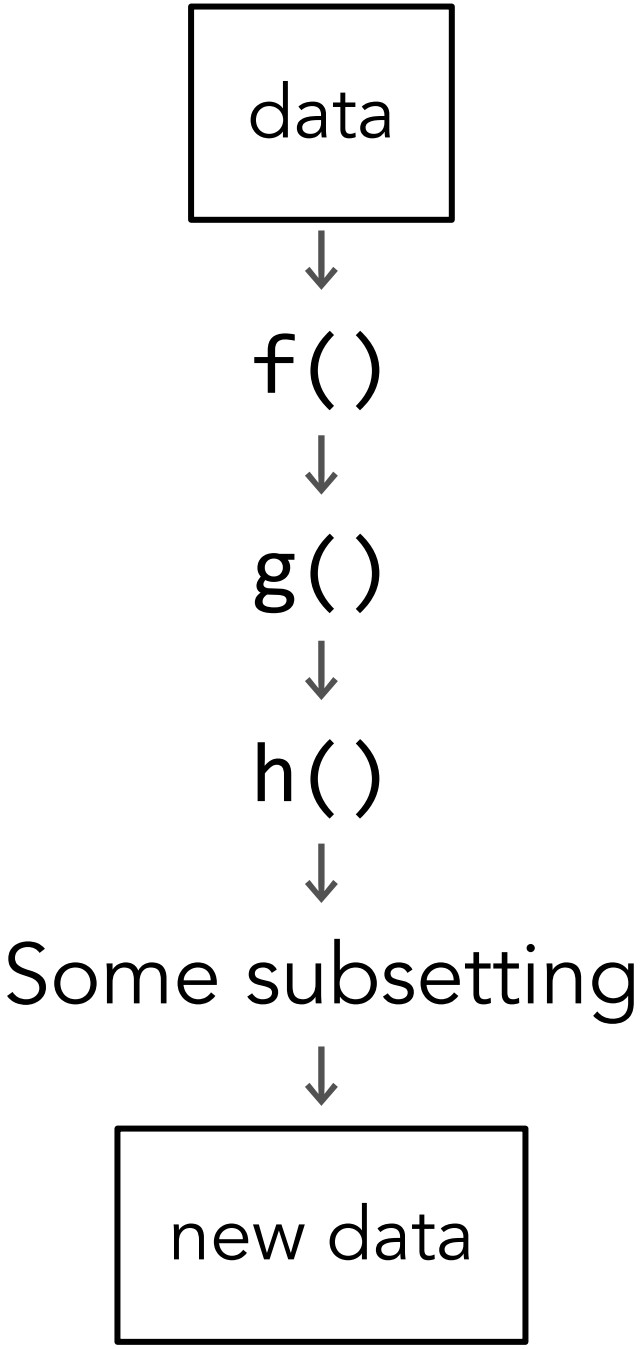
{ } [ ] [[ ]] <- = ( ) , " " ' '

```
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
data3 <- h(data2, a.setting = TRUE)
data4 <- data3[data3$a.column == "cough", ]
```


data


data
f()
g()
h()


data
f()
g()
h()
Some subsetting


data
f()
g()
h()
Some subsetting
new data

$f(x)$

```
f(x)
```

```
sort(1:10)
```

```
f(x)
```

```
sort(1:10)
```

```
x %>% f()
```

```
f(x)                    sort(1:10)

x %>% f()               1:10 %>% sort()
```

```
f(x, y)
```

```
t.test(data$x, data$y)
```

```
f(x, y)
```

```
t.test(data$x, data$y)
```

```
x %>% f(y)
```

```
data$x %>% t.test(data$y)
```

```
data <- read.csv("my-data.csv")

data1 <- f(data, arg1 = "something")
data2 <- g(data1, another.thing = "blah")
data3 <- h(data2, a.setting = TRUE)
data4 <- data3[data3$a.column == "cough", ]
```

```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- data[data$a.column == "cough", ]
```

```
h(g(f(x)))
```

```
h(g(f(x)))
```

```
x %>%
```

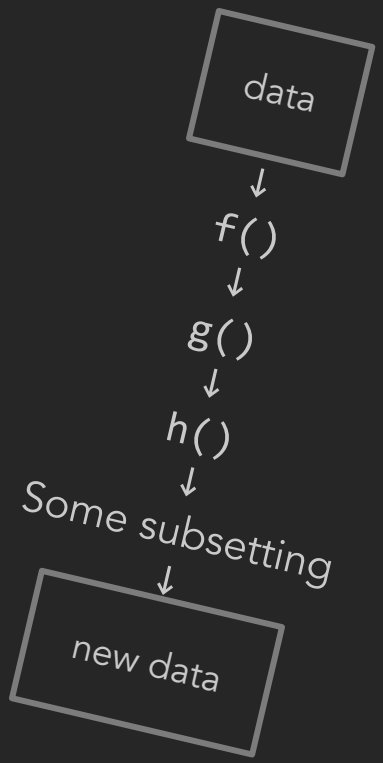
```
h(g(f(x)))

x %>%
   f() %>%
```

```
h(g(f(x)))
```

```
x %>%
  f() %>%
  g() %>%
```

```
h(g(f(x)))
```

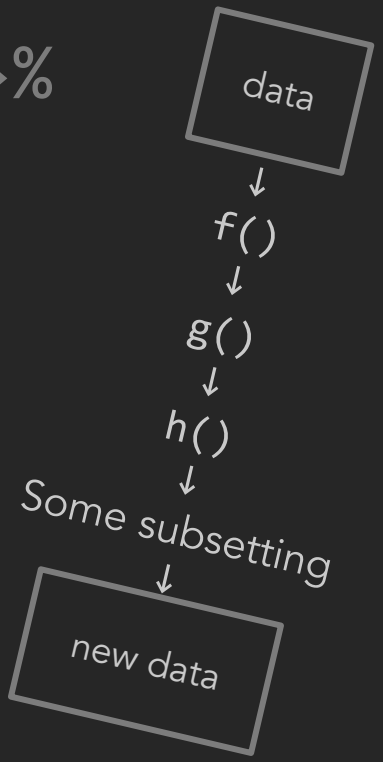
```
x %>%
  f() %>%
  g() %>%
  h()
```



```r
data <- read.csv("my-data.csv")

data <-
  h(
    g(
      f(data, arg1 = "something"),
      another.thing = "blah"
    ),
    a.setting = TRUE
  )
```

```r
data <- read.csv("my-data.csv")

data <- data %>%
  f(arg1 = "something") %>%
  g(another.thing = "blah") %>%
  h(a.setting = TRUE)
```

```r
data <- read.csv("my-data.csv")

data <- data %>%
  f(arg1 = "something") %>%
  g(another.thing = "blah") %>%
  h(a.setting = TRUE)
```



```r
data <- read.csv("my-data.csv")

data <- data %>%
  f(arg1 = "something") %>%
  g(another.thing = "blah") %>%
  h(a.setting = TRUE)
```

```r
data <- data[data$a.column == "cough", ]
```

???????

`> workshop$outline[1:3]`

DAY 1

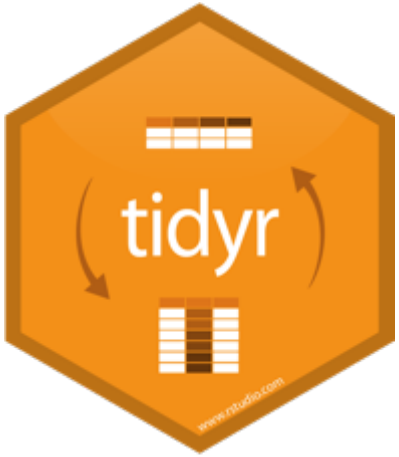
Tidy data principles
& `tidyr`

DAY 2

Manipulating data
& an intro to `dplyr`

DAY 3

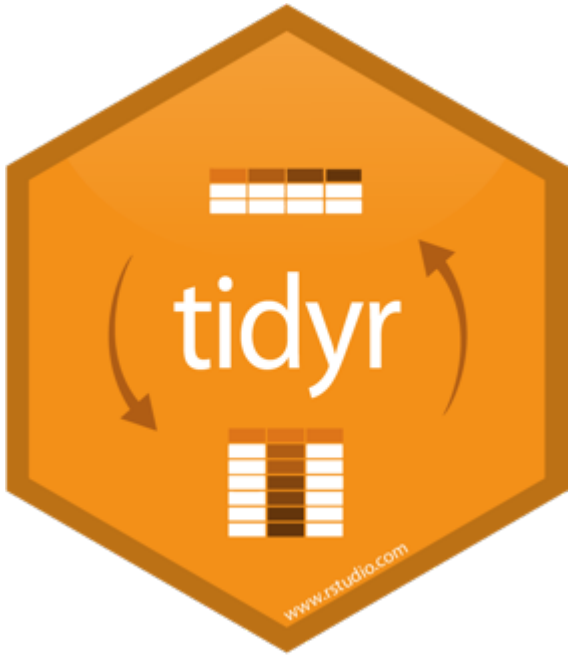
Extending your data
with `mutate()`,
`summarise()`
& friends



`> workshop$outline[[1]]`

DAY 1

Tidy data principles
& `tidyr`



`> workshop$outline[[1]]`

DAY 1

Tidy data principles
& `tidyr`

A motivating example…


Kogelberg NR,
R. van Mazijk

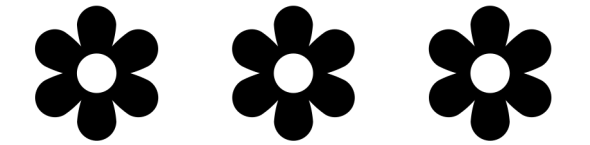

Observation Pk,
R. van Mazijk 2018

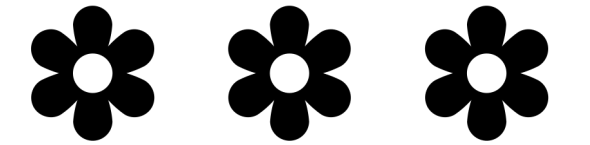

Near Pearly Beach, Agulhas Plains,
R. van Mazijk 2018

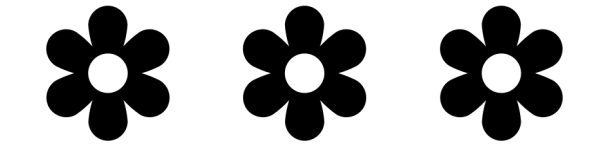
An example data-collection scenario in biology

An example data-collection scenario in biology

An example data-collection scenario in biology



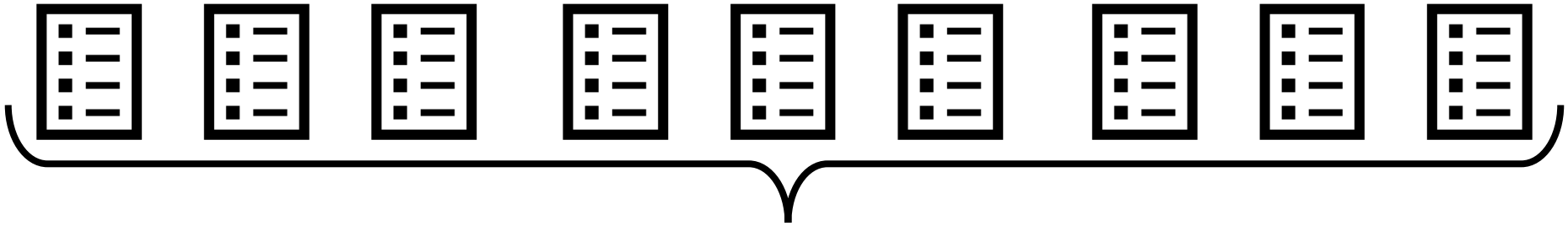


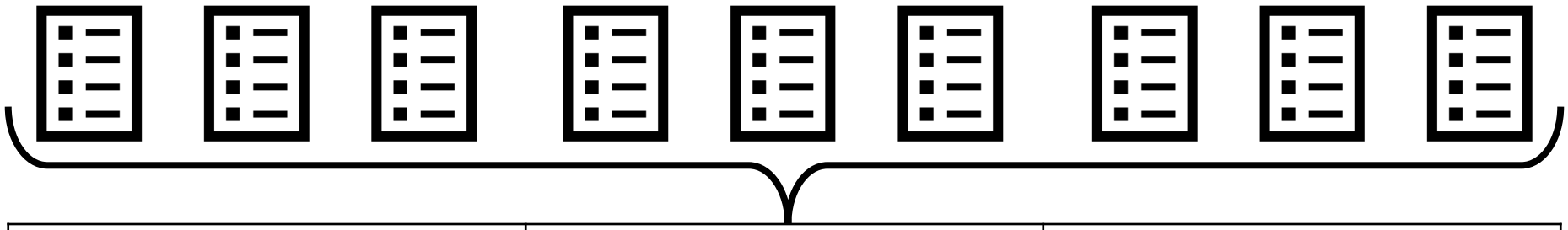


An example data-collection scenario in biology

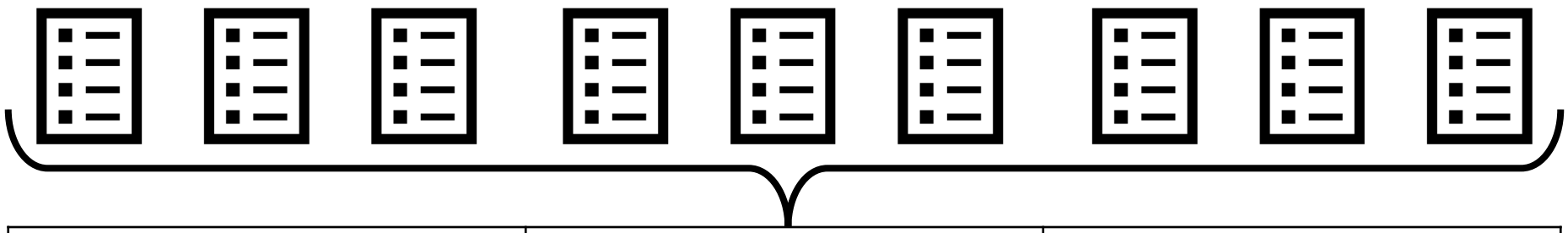
An example data-collection scenario in biology

(A good way to *collect* your data!)



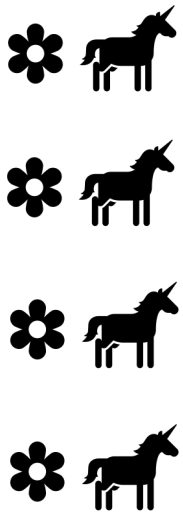
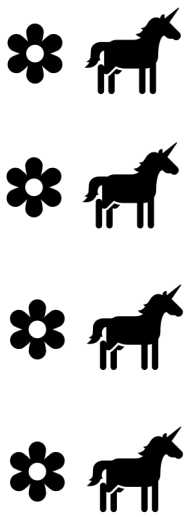
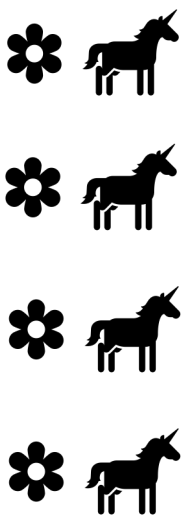
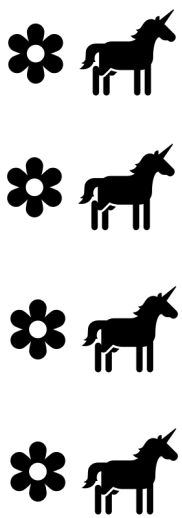
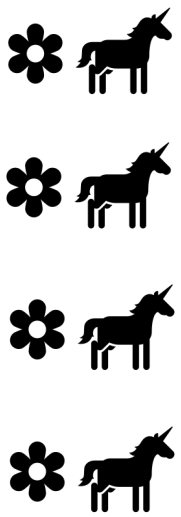
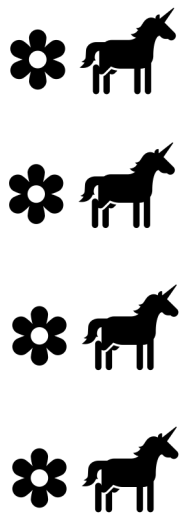
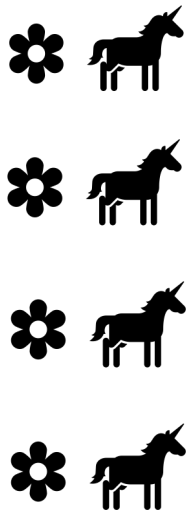
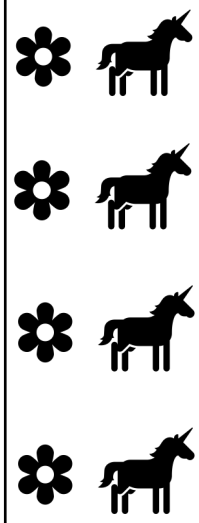
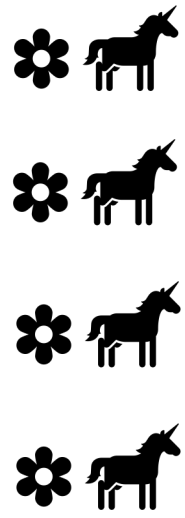


Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3

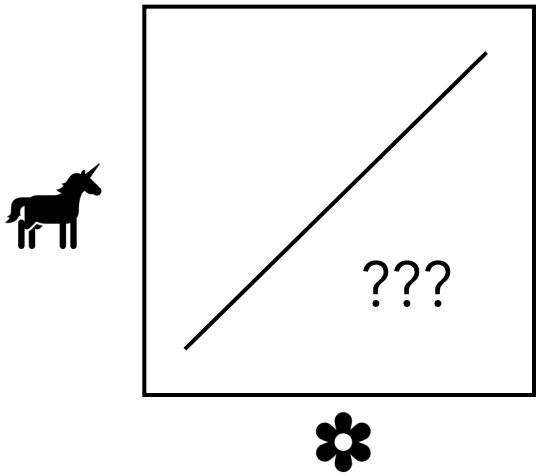


Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3

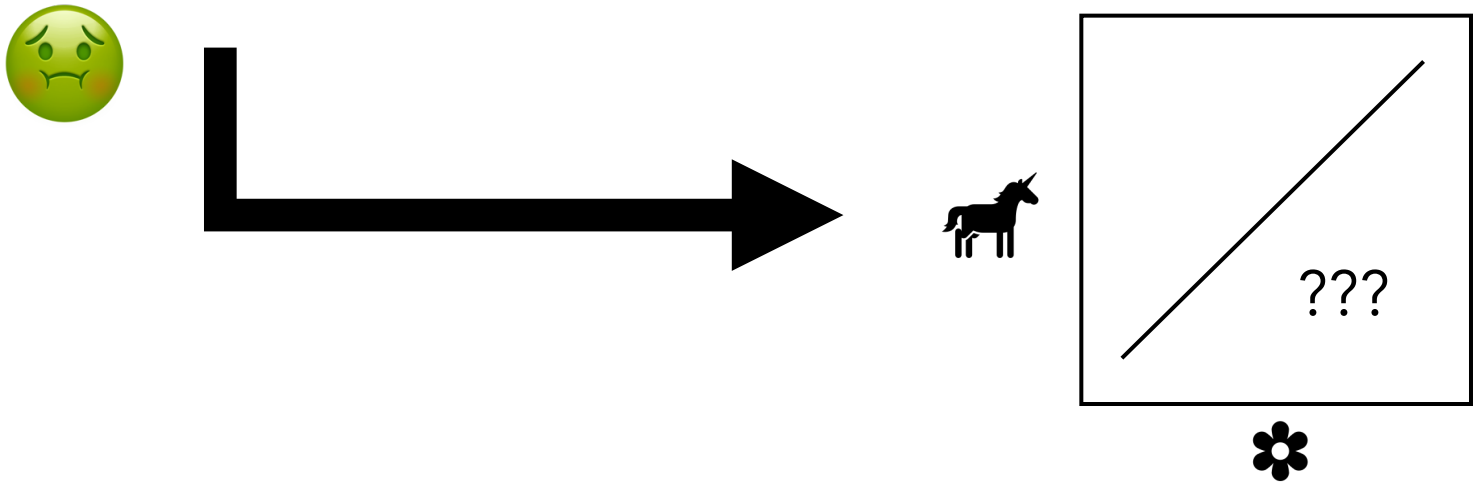
One way to lay out your collected data…

Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3
								

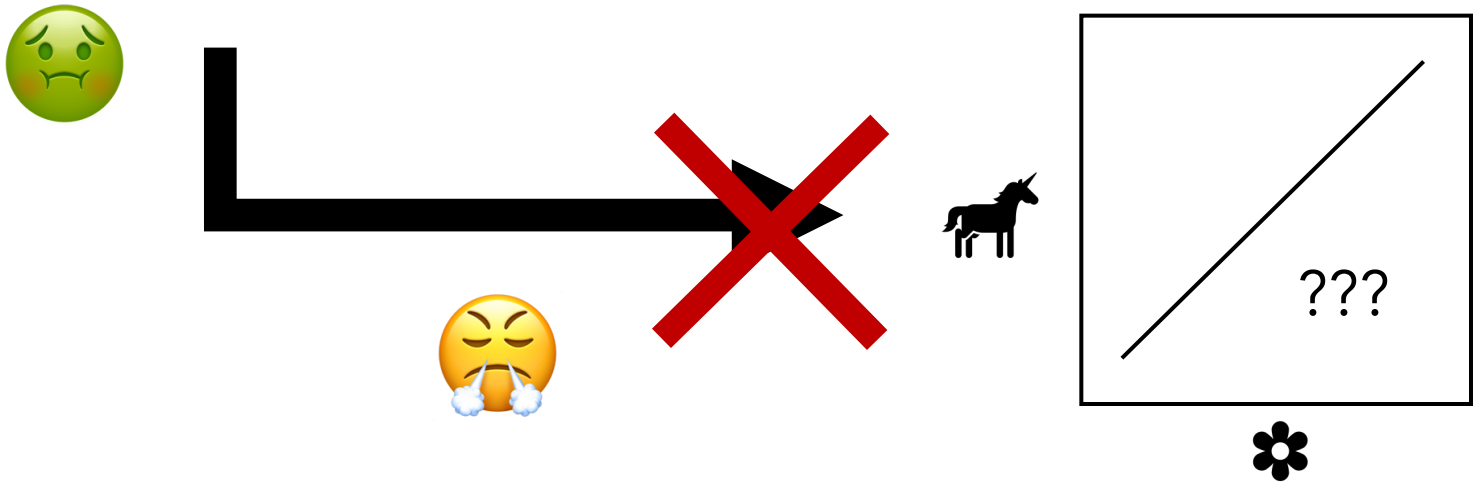
Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3



Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3



Site 1			Site 2			Site 3		
Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3	Sp 1	Sp 2	Sp 3



	Site 1		Site 2		Site 3	
Sp						

Another way… 

Sp	Site	✿	

The “best” way.
(Will make your life easiest in the long-term.)

TIDY DATA

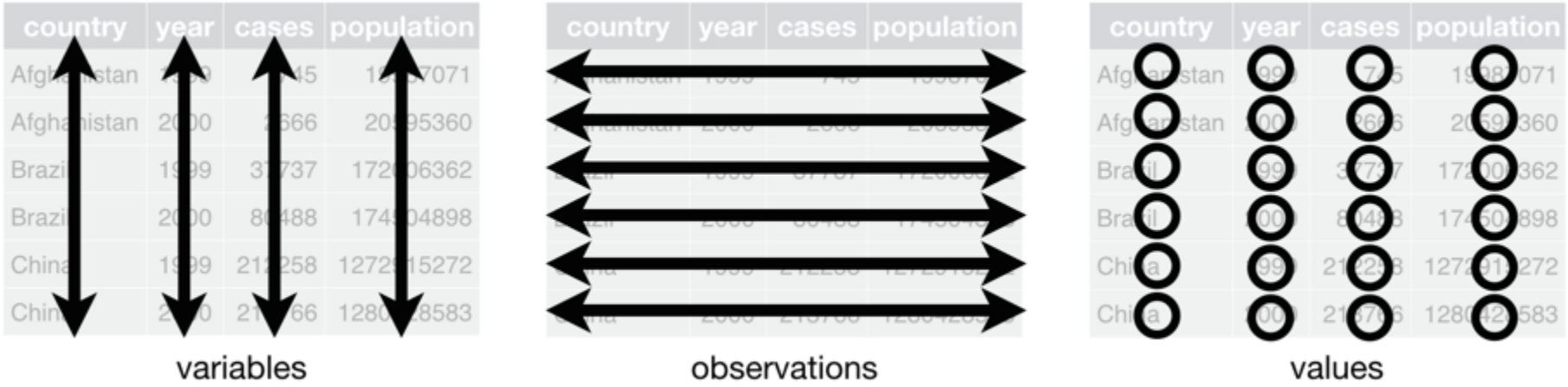
Sp	Site	✿	

The “best” way.
(Will make your life easiest in the long-term.)

TIDY DATA

TIDY DATA

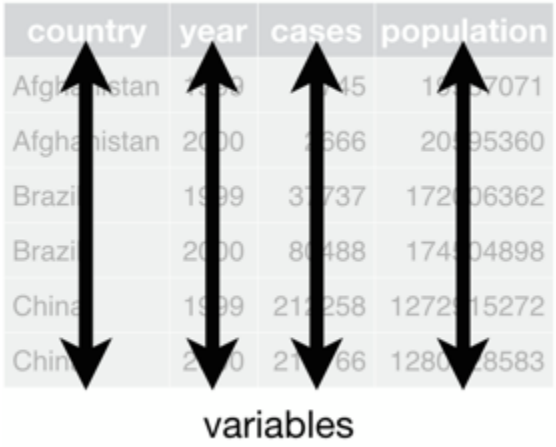
TIDY DATA

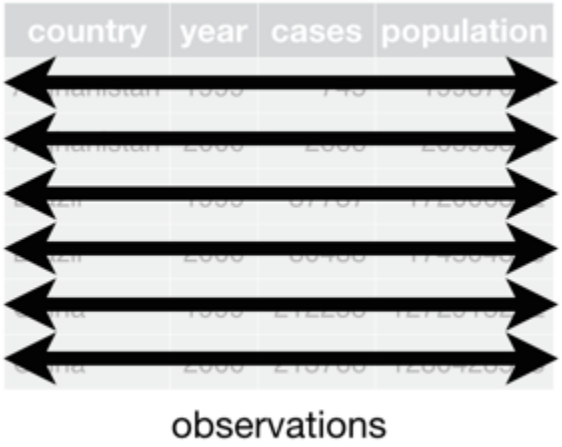


1. Each **variable** must have its own **column**

2. Each **observation** must have its own **row**

3. Each **value**, therefore, must have its own **cell**





`tidyr`

An R-package all about getting to this:

Verbs to tidy your data

Verbs to tidy your data

```
# Untidy observations?
gather()    # if > 1 observation per row
spread()    # if observations live in > 1 row
```

Verbs to tidy your data

```
# Untidy observations?
gather()    # if > 1 observation per row
spread()    # if observations live in > 1 row

# Untidy variables?
separate()  # if > 1 variable per column
unite()     # if variables live in > 1 column
```

Note the following when choosing `tidyr`-verbs:

Note the following when choosing `tidyr`-verbs:

- Be clear on what your **observations** are:
  - Like, what **unit** of your study "counts" as an observation
    - E.g. Leaf traits: plant leaf vs plant individual
    - E.g. Reproductive success: egg size vs clutch size

Note the following when choosing `tidyr`-verbs:

- Be clear on what your **observations** are:
  - Like, what **unit** of your study "counts" as an observation
    - E.g. Leaf traits: plant leaf vs plant individual
    - E.g. Reproductive success: egg size vs clutch size
  - This will depend on your study &/or data!

Note the following when choosing `tidyr`-verbs:

- Be clear on what your **observations** are:
  - Like, what **unit** of your study "counts" as an observation
    - E.g. Leaf traits: plant leaf vs plant individual
    - E.g. Reproductive success: egg size vs clutch size
  - This will depend on your study &/or data!

- **Variables** are discrete, separate ideas!

Note the following when choosing `tidyr`-verbs:

- Be clear on what your **observations** are:
  - Like, what **unit** of your study "counts" as an observation
    - E.g. Leaf traits: plant leaf vs plant individual
    - E.g. Reproductive success: egg size vs clutch size
  - This will depend on your study &/or data!

- **Variables** are discrete, separate ideas!
  - But again, this will depend on your study &/or data!

Verbs to tidy your data

```
# Untidy observations?
gather()    # if > 1 observation per row
spread()    # if observations live in > 1 row

# Untidy variables?
separate()  # if > 1 variable per column
unite()     # if variables live in > 1 column
```

Untidy observations?

```
# Untidy observations?
gather()    # if > 1 observation per row
```

```
# Untidy observations?
gather()    # if > 1 observation per row

data %>%
  gather(key, value, ...)
```

```
# Untidy observations?
gather()    # if > 1 observation per row

data %>%
  gather(key, value, ...)
```

country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

country	year	cases
A	1999	0.7K
B	1999	37K
C	1999	212K
A	2000	2K
B	2000	80K
C	2000	213K

key value

```
# Untidy observations?
gather()    # if > 1 observation per row

data %>%
  gather(key, value, ...)
```

country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

country	year	cases
A	1999	0.7K
B	1999	37K
C	1999	212K
A	2000	2K
B	2000	80K
C	2000	213K

key value

```
# Untidy observations?
gather()    # if > 1 observation per row

data %>%
  gather(year, cases, 1999, 2000)
```

country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

country	year	cases
A	1999	0.7K
B	1999	37K
C	1999	212K
A	2000	2K
B	2000	80K
C	2000	213K

key value

```
# Untidy observations?
spread()    # if observations live in > 1 row
```

```
# Untidy observations?
spread()    # if observations live in > 1 row

data %>%
  spread(key, value)
```

```
# Untidy observations?
spread()    # if observations live in > 1 row

data %>%
  spread(key, value)
```

```
# Untidy observations?
spread()    # if observations live in > 1 row

data %>%
  spread(key, value)
```

country	year	type	count
A	1999	cases	0.7K
A	1999	pop	19M
A	2000	cases	2K
A	2000	pop	20M
B	1999	cases	37K
B	1999	pop	172M
B	2000	cases	80K
B	2000	pop	174M
C	1999	cases	212K
C	1999	pop	1T
C	2000	cases	213K
C	2000	pop	1T

key value

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172M
B	2000	80K	174M
C	1999	212K	1T
C	2000	213K	1T

```
# Untidy observations?
spread()    # if observations live in > 1 row

data %>%
  spread(type, count)
```

country	year	type	count
A	1999	cases	0.7K
A	1999	pop	19M
A	2000	cases	2K
A	2000	pop	20M
B	1999	cases	37K
B	1999	pop	172M
B	2000	cases	80K
B	2000	pop	174M
C	1999	cases	212K
C	1999	pop	1T
C	2000	cases	213K
C	2000	pop	1T

key value

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172M
B	2000	80K	174M
C	1999	212K	1T
C	2000	213K	1T

Untidy variables?

```
# Untidy variables?
separate()  # if > 1 variable per column
```

```
# Untidy variables?
separate()  # if > 1 variable per column

data %>%
  separate(col, into, sep)
```

```r
# Untidy variables?
separate()  # if > 1 variable per column

data %>%
  separate(col, into)
```

```
# Untidy variables?
separate()  # if > 1 variable per column

data %>%
  separate(col, into)
```

country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M
C	1999	212K/1T
C	2000	213K/1T

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172
B	2000	80K	174
C	1999	212K	1T
C	2000	213K	1T

```r
# Untidy variables?
separate()  # if > 1 variable per column

data %>%
  separate(rate, c("cases", "pop"))
```

country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M
C	1999	212K/1T
C	2000	213K/1T

country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172
B	2000	80K	174
C	1999	212K	1T
C	2000	213K	1T

```
# Untidy variables?
unite()     # if variables live in > 1 column
```

```
# Untidy variables?
unite()     # if variables live in > 1 column

data %>%
  unite(col, ..., sep)
```

```
# Untidy variables?
unite()      # if variables live in > 1 column

data %>%
  unite(col, ...)
```

country	century	year
Afghan	19	99
Afghan	20	0
Brazil	19	99
Brazil	20	0
China	19	99
China	20	0

country	year
Afghan	1999
Afghan	2000
Brazil	1999
Brazil	2000
China	1999
China	2000

```r
# Untidy variables?
unite()      # if variables live in > 1 column

data %>%
  unite(year, century, year)
```

country	century	year
Afghan	19	99
Afghan	20	0
Brazil	19	99
Brazil	20	0
China	19	99
China	20	0

country	year
Afghan	1999
Afghan	2000
Brazil	1999
Brazil	2000
China	1999
China	2000

```
> demo()
```