tidyr

Lecture 07

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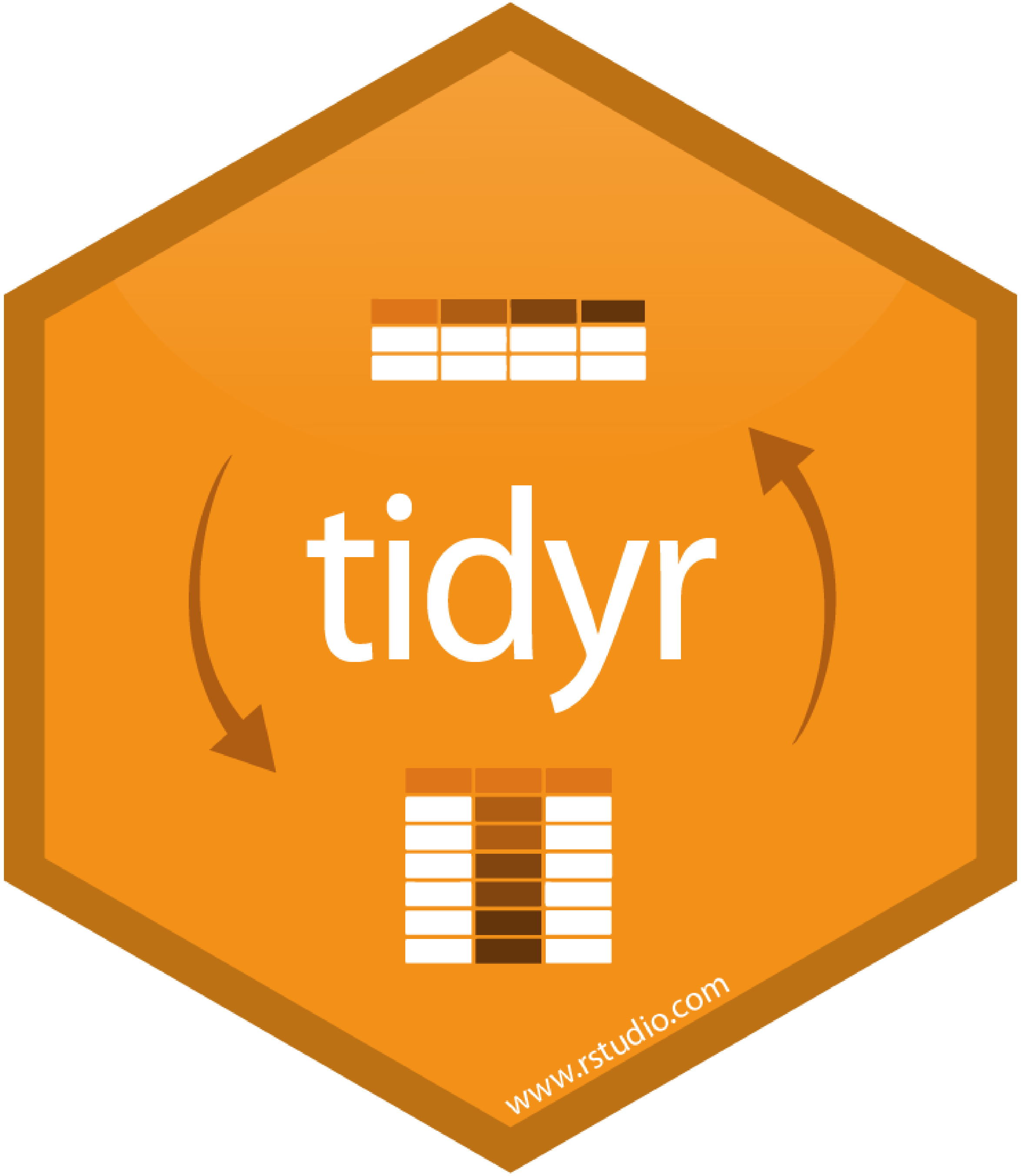
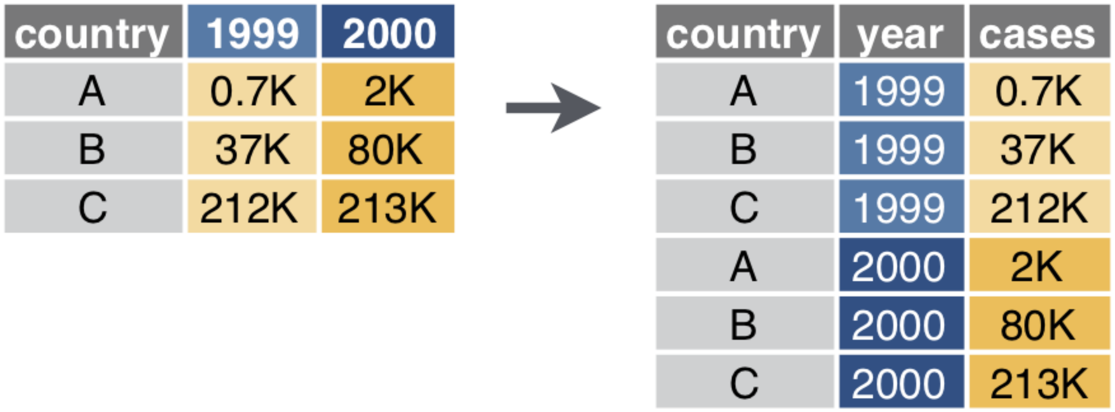

tidyr
www.rstudio.com

Reshaping data (Wide vs. Long)

Wide -> Long



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

`pivot_longer` (previously `gather`)

From Data tidying with tidyr

Syntax

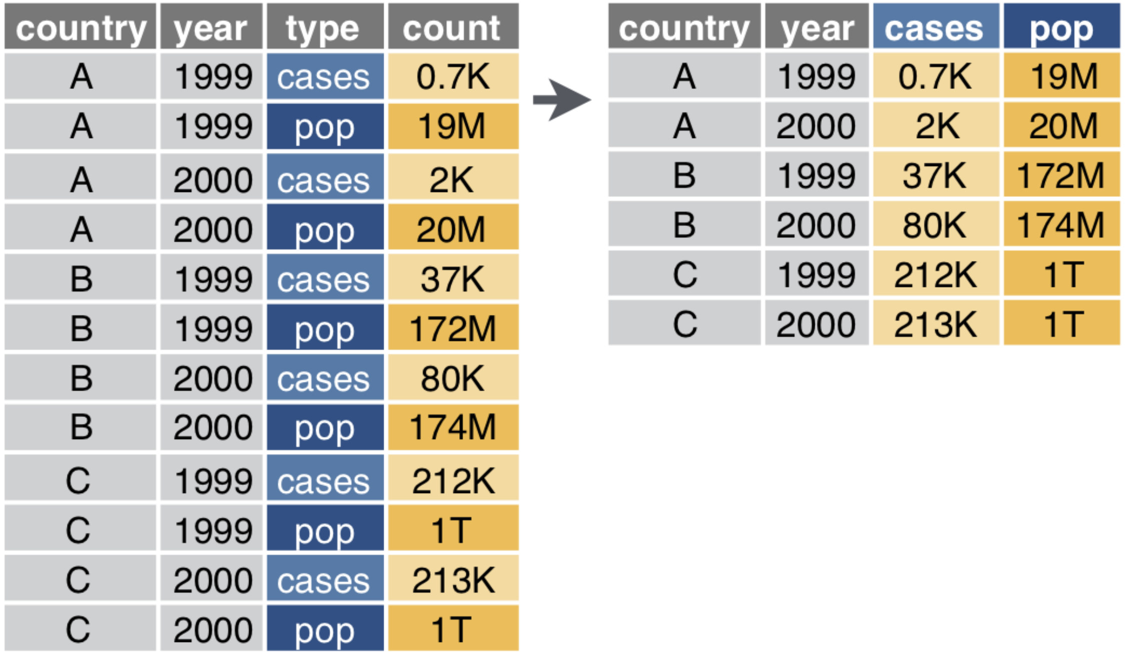
```r
(d = tibble::tribble(
  ~country, ~"1999",  ~"2000",
        "A", "0.7K",      "2K",
        "B",  "37K",     "80K",
        "C", "212K",    "213K"
))
```

```
# A tibble: 3 × 3
  country `1999` `2000`
  <chr>   <chr>  <chr> 
1 A       0.7K   2K    
2 B       37K    80K   
3 C       212K   213K  
```

```r
pivot_longer(
  d,
  cols = "1999":"2000",
  names_to = "year",
  values_to = "cases"
)
```

```
# A tibble: 6 × 3
  country year  cases
  <chr>   <chr> <chr>
1 A       1999  0.7K 
2 A       2000  2K   
3 B       1999  37K  
4 B       2000  80K  
5 C       1999  212K 
6 C       2000  213K 
```

Long -> Wide



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

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

`pivot_wider` (previously `spread`)

From Data tidying with tidyr

Syntax

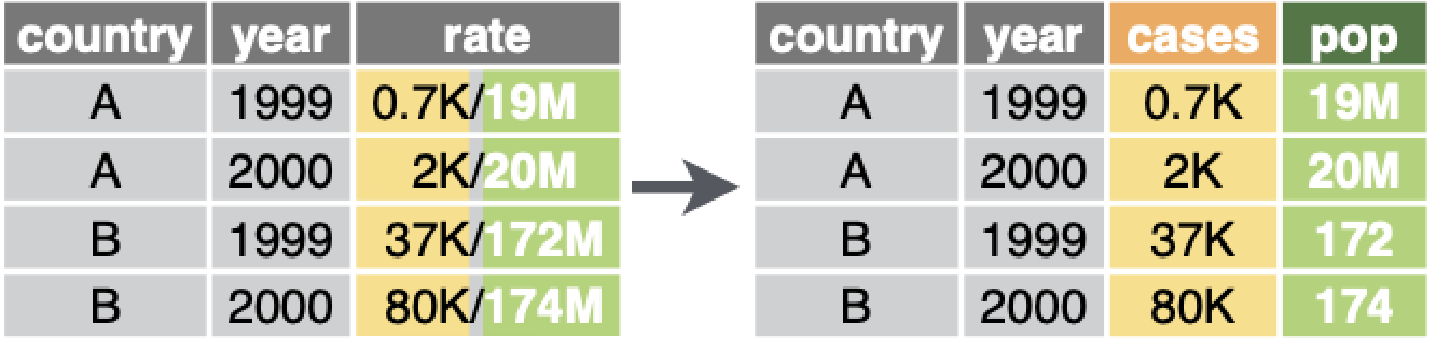
```
( d = tibble::tribble(
    ~country, ~year,   ~type, ~count,
         "A",  1999, "cases", "0.7K",
         "A",  1999,   "pop",  "19M",
         "A",  2000, "cases",   "2K",
         "A",  2000,   "pop",  "20M",
         "B",  1999, "cases",  "37K",
         "B",  1999,   "pop", "172M",
         "B",  2000, "cases", " 80K",
         "B",  2000,   "pop", "174M",
         "C",  1999, "cases", "212K",
         "C",  1999,   "pop",   "1T",
         "C",  2000, "cases", "213K",
         "C",  2000,   "pop",   "1T"
  )
)
```

```
# A tibble: 12 × 4
   country  year type  count
   <chr>   <dbl> <chr> <chr>
 1 A        1999 cases "0.7K"
 2 A        1999 pop   "19M"
 3 A        2000 cases "2K"
 4 A        2000 pop   "20M"
 5 B        1999 cases "37K"
 6 B        1999 pop   "172M"
 7 B        2000 cases " 80K"
 8 B        2000 pop   "174M"
 9 C        1999 cases "212K"
10 C        1999 pop   "1T"
11 C        2000 cases "213K"
12 C        2000 pop   "1T"
```

```
pivot_wider(
  d,
  id_cols = country:year,
  names_from = type,
  values_from = count
)
```

```
# A tibble: 6 × 4
  country  year cases  pop
  <chr>   <dbl> <chr>  <chr>
1 A        1999 "0.7K" 19M
2 A        2000 "2K"   20M
3 B        1999 "37K"  172M
4 B        2000 " 80K" 174M
5 C        1999 "212K" 1T
6 C        2000 "213K" 1T
```

Separate - wider



country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M

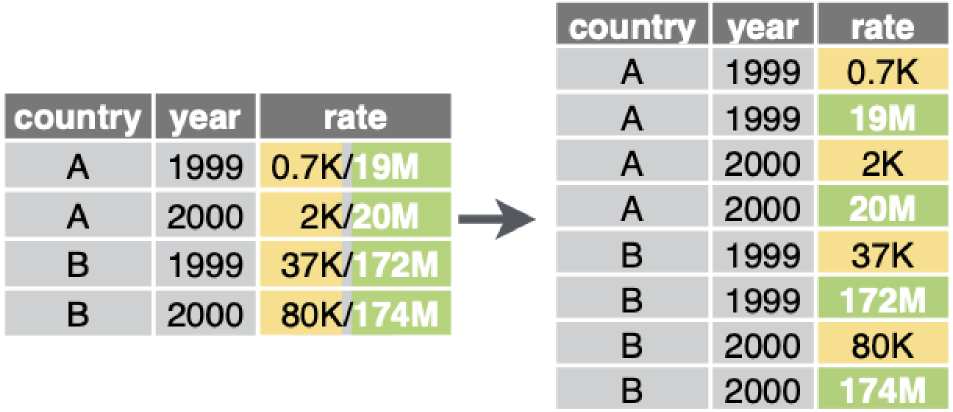
country	year	cases	pop
A	1999	0.7K	19M
A	2000	2K	20M
B	1999	37K	172
B	2000	80K	174

```r
separate_wider_delim(d, rate, delim = "/", names = c("cases", "pop"))
```

```
# A tibble: 6 × 4
  country  year cases pop  
  <chr>   <dbl> <chr> <chr>
1 A        1999 0.7K  19M  
2 A        2000 2K    20M  
3 B        1999 37K   172M 
4 B        2000 80K   174M 
5 C        1999 212K  1T   
6 C        2000 213K  1T   
```

From Data tidying with tidyr

Separate - longer



country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M

country	year	rate
A	1999	0.7K
A	1999	19M
A	2000	2K
A	2000	20M
B	1999	37K
B	1999	172M
B	2000	80K
B	2000	174M

```r
separate_longer_delim(d, rate, delim = "/")
```

```
# A tibble: 12 × 3
   country  year rate 
   <chr>   <dbl> <chr>
 1 A        1999 0.7K 
 2 A        1999 19M  
 3 A        2000 2K   
 4 A        2000 20M  
 5 B        1999 37K  
 6 B        1999 172M 
 7 B        2000 80K  
 8 B        2000 174M 
 9 C        1999 212K 
10 C        1999 1T   
11 C        2000 213K 
12 C        2000 1T   
```

From Data tidying with tidyr

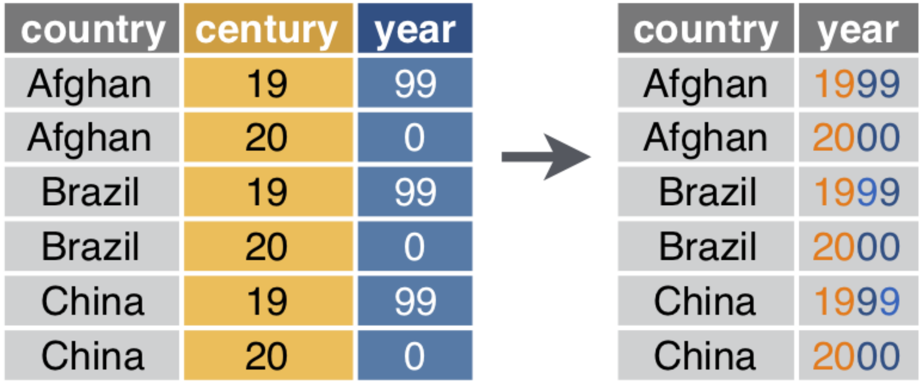
Other separates

In previous versions of tidyr there was a single catch-all `separate()` function. This still exists and is available in the package but it is **superseded**.

Other helpful separate functions:

- `separate_longer_position()`
- `separate_wider_position()`
- `separate_wider_regex()`

Unite



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
unite(d, century, year, col = "year", sep = "")
```

```
# A tibble: 6 × 2
  country year
  <chr>   <chr>
1 Afghan  1999
2 Afghan  2000
3 Brazil  1999
4 Brazil  2000
5 China   1999
6 China   2000
```

From Data tidying with tidyr

Example 1 - tidy grades

Is the following data tidy?

```r
grades = tibble::tribble(
  ~name,    ~hw_1, ~hw_2, ~hw_3, ~hw_4, ~proj_1, ~proj_2,
  "Alice",     19,    19,    18,    20,      89,      95,
  "Bob",       18,    20,    18,    16,      77,      88,
  "Carol",     18,    20,    18,    17,      96,      99,
  "Dave",      19,    19,    18,    19,      86,      82
)
```

How would we calculate a final score based on the following formula,

$$\text{score} = 0.5 \, \frac{\sum_i \text{hw}_i}{80} + 0.5 \, \frac{\sum_j \text{proj}_j}{200}$$

Semi-tidy approach

```r
grades |>
  mutate(
    hw_avg = (hw_1+hw_2+hw_3+hw_4)/4,
    proj_avg = (proj_1+proj_2)/2
  ) |>
  mutate(
    overall = 0.5*(proj_avg/100) + 0.5*(hw_avg/20)
  )
```

```
# A tibble: 4 × 10
  name   hw_1  hw_2  hw_3  hw_4 proj_1 proj_2 hw_avg proj_avg overall
  <chr> <dbl> <dbl> <dbl> <dbl>  <dbl>  <dbl>  <dbl>    <dbl>   <dbl>
1 Alice    19    19    18    20     89     95   19       92     0.935
2 Bob      18    20    18    16     77     88   18       82.5   0.862
3 Carol    18    20    18    17     96     99   18.2     97.5   0.944
4 Dave     19    19    18    19     86     82   18.8     84     0.889
```

pivot_longer (Wide -> Long)

```r
tidyr::pivot_longer(
  grades,
  cols = hw_1:proj_2,
  names_to = "assignment",
  values_to = "score"
)
```

```
# A tibble: 24 × 3
   name  assignment score
   <chr> <chr>      <dbl>
 1 Alice hw_1          19
 2 Alice hw_2          19
 3 Alice hw_3          18
 4 Alice hw_4          20
 5 Alice proj_1        89
 6 Alice proj_2        95
 7 Bob   hw_1          18
 8 Bob   hw_2          20
 9 Bob   hw_3          18
10 Bob   hw_4          16
# ℹ 14 more rows
```

Split type and id

```r
tidyr::pivot_longer(
  grades,
  cols = hw_1:proj_2,
  names_to = c("type", "id"),
  names_sep = "_",
  values_to = "score"
)
```

```
# A tibble: 24 × 4
   name  type  id    score
   <chr> <chr> <chr> <dbl>
 1 Alice hw    1        19
 2 Alice hw    2        19
 3 Alice hw    3        18
 4 Alice hw    4        20
 5 Alice proj  1        89
 6 Alice proj  2        95
 7 Bob   hw    1        18
 8 Bob   hw    2        20
 9 Bob   hw    3        18
10 Bob   hw    4        16
# ℹ 14 more rows
```

Tidy approach?

```r
grades |>
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) |>
  summarize(
    total = sum(score),
    .by = c(name, type)
  )
```

```
# A tibble: 8 × 3
  name  type  total
  <chr> <chr> <dbl>
1 Alice hw       76
2 Alice proj    184
3 Bob   hw       72
4 Bob   proj    165
5 Carol hw       73
6 Carol proj    195
7 Dave  hw       75
8 Dave  proj    168
```

pivot_wider - (Long -> Wide)

```r
grades |>
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) |>
  summarize(
    total = sum(score),
    .by = c(name, type)
  ) |>
  tidyr::pivot_wider(
    names_from = type,
    values_from = total
  )
```

```
# A tibble: 4 × 3
  name     hw  proj
  <chr> <dbl> <dbl>
1 Alice    76   184
2 Bob      72   165
3 Carol    73   195
4 Dave     75   168
```

Wrapping up

```r
grades |>
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) |>
  summarize(
    total = sum(score),
    .by = c(name, type)
  ) |>
  tidyr::pivot_wider(
    names_from = type,
    values_from = total
  ) |>
  mutate(
    score = 0.5*(hw/80) + 0.5*(proj/200
  )
```

```
# A tibble: 4 × 4
  name     hw  proj score
  <chr> <dbl> <dbl> <dbl>
1 Alice    76   184 0.935
2 Bob      72   165 0.862
3 Carol    73   195 0.944
4 Dave     75   168 0.889
```

Exercise 1

The `palmerpenguin` package contains measurement data on various penguin species on islands near Palmer Station in Antarctica. The code below shows the # of each species measured on each of the three islands (missing island, penguin pairs implies that species does not occur on that island).

```r
palmerpenguins::penguins |>
  count(island, species)
```

```
# A tibble: 5 × 3
  island    species       n
  <fct>     <fct>     <int>
1 Biscoe    Adelie       44
2 Biscoe    Gentoo      124
3 Dream     Adelie       56
4 Dream     Chinstrap    68
5 Torgersen Adelie       52
```

Starting from these data construct a contingency table of counts for island (rows) by species (columns) using the pivot functions we've just discussed.

05:00

Rectangling

Star Wars & repurrrsive

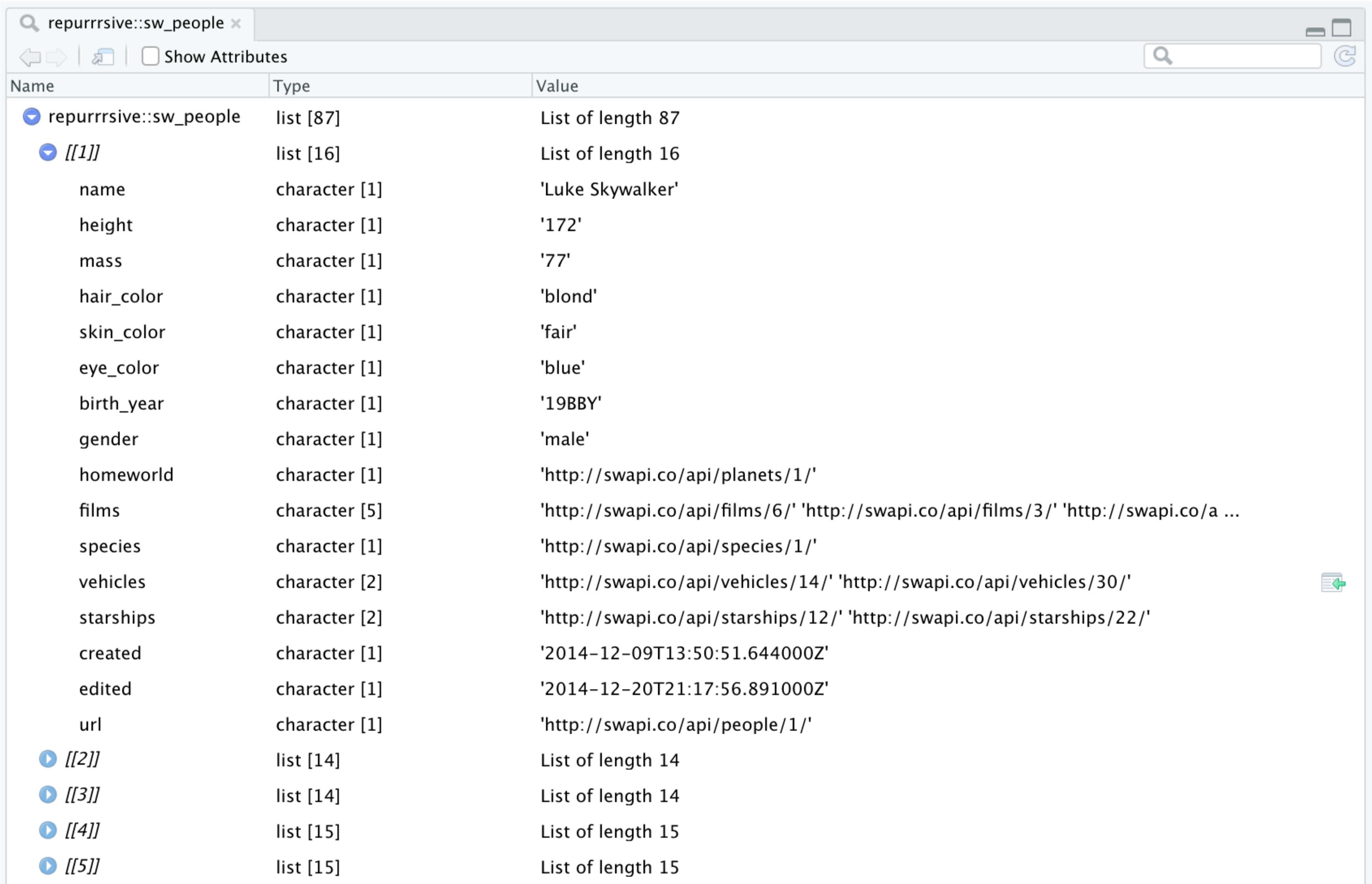
`repurrrsive` is a package that contains a number of interesting example data sets that are stored in a hierarchical format. Many come from web-based APIs which provide results as JSON.

```r
str(repurrrsive::sw_people)
```

```
List of 87
 $ :List of 16
  ..$ name      : chr "Luke Skywalker"
  ..$ height    : chr "172"
  ..$ mass      : chr "77"
  ..$ hair_color: chr "blond"
  ..$ skin_color: chr "fair"
  ..$ eye_color : chr "blue"
  ..$ birth_year: chr "19BBY"
  ..$ gender    : chr "male"
  ..$ homeworld : chr "http://swapi.co/api/planets/1/"
  ..$ films     : chr [1:5] "http://swapi.co/api/films/6/" "http://swapi.co/api/films/3/"
"http://swapi.co/api/films/2/" "http://swapi.co/api/films/1/" ...
  ..$ species   : chr "http://swapi.co/api/species/1/"
```

RStudio data viewer

```r
View(repurrrsive::sw_people)
```



Name	Type	Value
repurrrsive::sw_people	list [87]	List of length 87
[[1]]	list [16]	List of length 16
name	character [1]	'Luke Skywalker'
height	character [1]	'172'
mass	character [1]	'77'
hair_color	character [1]	'blond'
skin_color	character [1]	'fair'
eye_color	character [1]	'blue'
birth_year	character [1]	'19BBY'
gender	character [1]	'male'
homeworld	character [1]	'http://swapi.co/api/planets/1/'
films	character [5]	'http://swapi.co/api/films/6/' 'http://swapi.co/api/films/3/' 'http://swapi.co/a ...
species	character [1]	'http://swapi.co/api/species/1/'
vehicles	character [2]	'http://swapi.co/api/vehicles/14/' 'http://swapi.co/api/vehicles/30/'
starships	character [2]	'http://swapi.co/api/starships/12/' 'http://swapi.co/api/starships/22/'
created	character [1]	'2014-12-09T13:50:51.644000Z'
edited	character [1]	'2014-12-20T21:17:56.891000Z'
url	character [1]	'http://swapi.co/api/people/1/'
[[2]]	list [14]	List of length 14
[[3]]	list [14]	List of length 14
[[4]]	list [15]	List of length 15
[[5]]	list [15]	List of length 15

Tidy data from nested lists

Recent versions of `tidyr` have added several functions that are designed to aide in the tidying of hierarchical data. Since they are part of `tidyr` all of the following functions work with data frames.

From `hoist()`, `unnest_longer()`, and `unnest_wider()` provide tools for rectangling, collapsing deeply nested lists into regular columns.

Lists as columns

```
(sw_df = tibble::tibble(
  people = repurrrsive::sw_people
))
```

```
# A tibble: 87 × 1
   people
   <list>
 1 <named list [16]>
 2 <named list [14]>
 3 <named list [14]>
 4 <named list [15]>
 5 <named list [15]>
 6 <named list [14]>
 7 <named list [14]>
 8 <named list [14]>
 9 <named list [15]>
10 <named list [16]>
# ℹ 77 more rows
```

```
is.data.frame(sw_df)
```

```
[1] TRUE
```

```
as.data.frame(sw_df) |> head()
```

```
people
1 Luke Skywalker, 172, 77, blond, fair, blue,
19BBY, male, http://swapi.co/api/planets/1/,
http://swapi.co/api/films/6/,
http://swapi.co/api/films/3/,
http://swapi.co/api/films/2/,
http://swapi.co/api/films/1/,
http://swapi.co/api/films/7/,
http://swapi.co/api/species/1/,
http://swapi.co/api/vehicles/14/,
http://swapi.co/api/vehicles/30/,
http://swapi.co/api/starships/12/,
http://swapi.co/api/starships/22/, 2014-12-
09T13:50:51.644000Z, 2014-12-20T21:17:56.891000Z,
http://swapi.co/api/people/1/
2
```

```
nrow(sw_df)
```

```
[1] 87
```

Unnesting

```r
sw_df |>
  unnest_wider(people)
```

```
# A tibble: 87 × 16
   name               height mass  hair_color skin_color eye_color birth_year gender
   <chr>              <chr>  <chr> <chr>      <chr>      <chr>     <chr>      <chr>
 1 Luke Skywalker 172    77    blond      fair       blue      19BBY      male
 2 C-3PO              167    75    n/a        gold       yellow    112BBY     n/a
 3 R2-D2              96     32    n/a        white, bl… red       33BBY      n/a
 4 Darth Vader        202    136   none       white      yellow    41.9BBY    male
 5 Leia Organa        150    49    brown      light      brown     19BBY      female
 6 Owen Lars          178    120   brown, gr… light      blue      52BBY      male
 7 Beru Whitesun… 165    75    brown      light      blue      47BBY      female
 8 R5-D4              97     32    n/a        white, red red       unknown    n/a
 9 Biggs Darklig… 183    84    black      light      brown     24BBY      male
10 Obi-Wan Kenobi 182    77    auburn, w… fair       blue-gray 57BBY      male
# ℹ 77 more rows
```

More list columns

```r
sw_df |>
  unnest_wider(people) |>
  select(name, starships)
```

```
# A tibble: 87 × 2
   name               starships
   <chr>              <list>
 1 Luke Skywalker     <chr [2]>
 2 C-3PO              <NULL>
 3 R2-D2              <NULL>
 4 Darth Vader        <chr [1]>
 5 Leia Organa        <NULL>
 6 Owen Lars          <NULL>
 7 Beru Whitesun lars <NULL>
 8 R5-D4              <NULL>
 9 Biggs Darklighter  <chr [1]>
10 Obi-Wan Kenobi     <chr [5]>
# ℹ 77 more rows
```

```r
sw_df |>
  unnest_wider(people) |>
  select(name, starships) |>
  pull(starships) |>
  str()
```

```
List of 87
 $ : chr [1:2]
"http://swapi.co/api/starships/12/"
"http://swapi.co/api/starships/22/"
 $ : NULL
 $ : NULL
 $ : chr
"http://swapi.co/api/starships/13/"
 $ : NULL
 $ : NULL
 $ : NULL
 $ : NULL
 $ : chr
"http://swapi.co/api/starships/12/"
```

Unnest Longer

```r
unnest_wider(sw_df, people) |>
  select(name, starships) |>
  unnest_longer(starships)
```

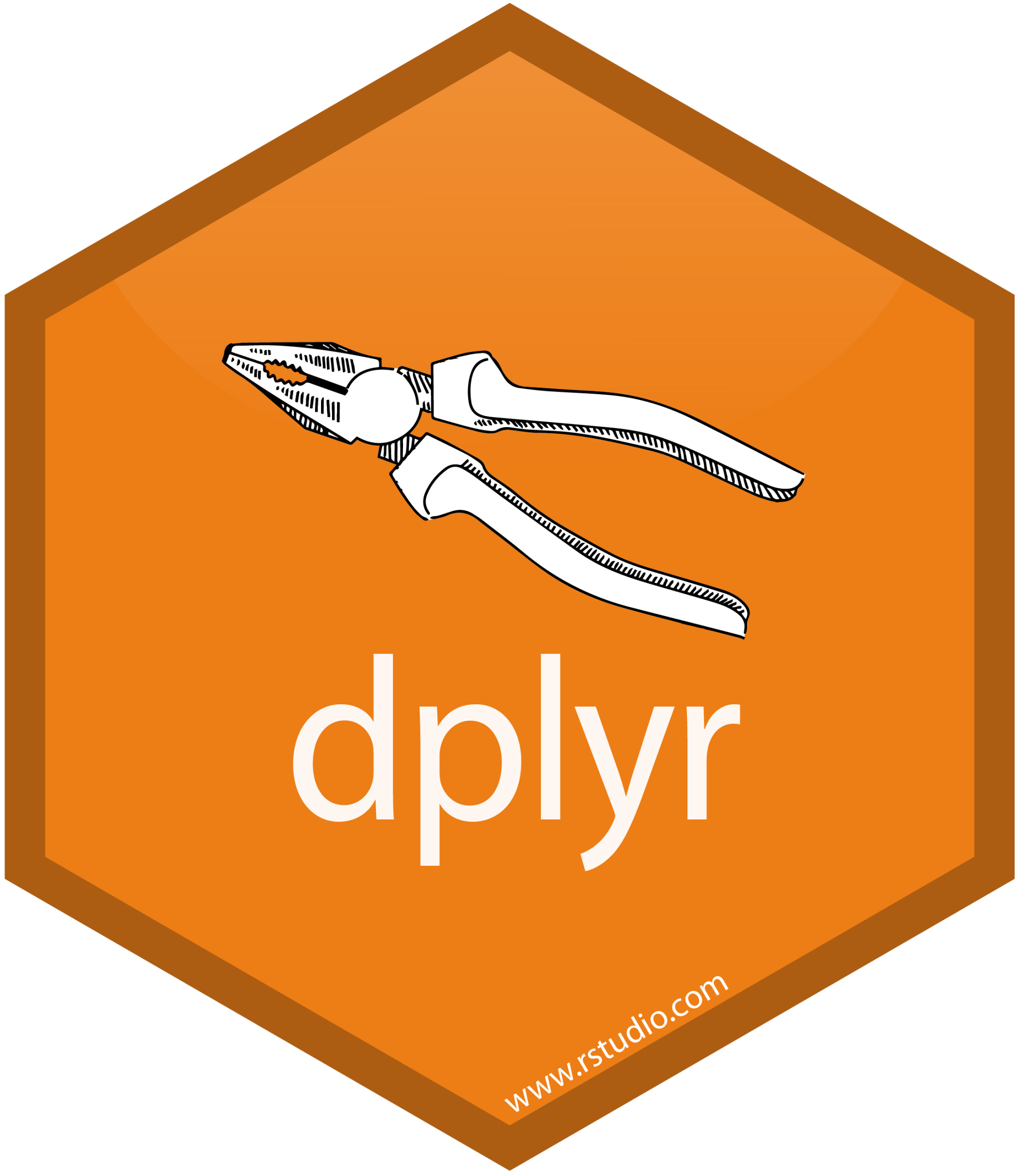
```
# A tibble: 31 × 2
   name              starships
   <chr>             <chr>
 1 Luke Skywalker    http://swapi.co/api/starships/12/
 2 Luke Skywalker    http://swapi.co/api/starships/22/
 3 Darth Vader       http://swapi.co/api/starships/13/
 4 Biggs Darklighter http://swapi.co/api/starships/12/
 5 Obi-Wan Kenobi    http://swapi.co/api/starships/48/
 6 Obi-Wan Kenobi    http://swapi.co/api/starships/59/
 7 Obi-Wan Kenobi    http://swapi.co/api/starships/64/
 8 Obi-Wan Kenobi    http://swapi.co/api/starships/65/
 9 Obi-Wan Kenobi    http://swapi.co/api/starships/74/
10 Anakin Skywalker  http://swapi.co/api/starships/59/
# ℹ 21 more rows
```

Aside - sw_starships

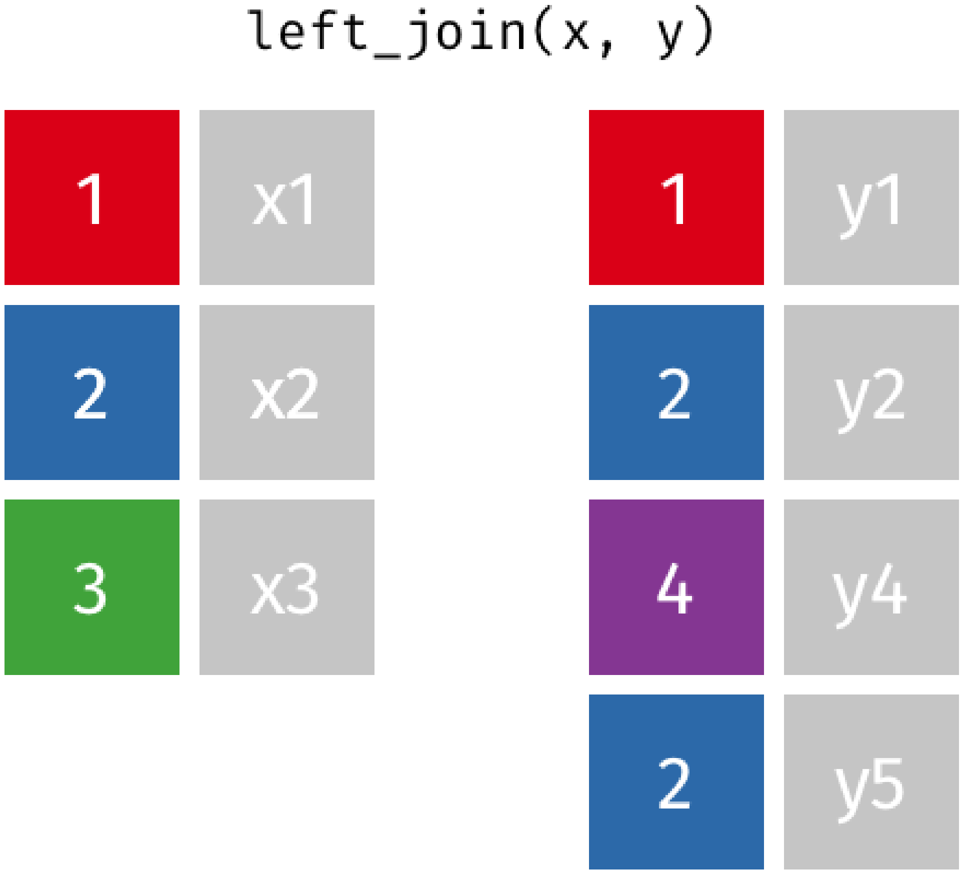
```r
(ships = tibble(ships = repurrrsive::sw_starships) |>
   unnest_wider(ships) |>
   select(ship = name, url)
)
```

```
# A tibble: 37 × 2
   ship                          url
   <chr>                         <chr>
 1 Sentinel-class landing craft  http://swapi.co/api/starships/5/
 2 Death Star                    http://swapi.co/api/starships/9/
 3 Millennium Falcon             http://swapi.co/api/starships/10/
 4 Y-wing                        http://swapi.co/api/starships/11/
 5 X-wing                        http://swapi.co/api/starships/12/
 6 TIE Advanced x1               http://swapi.co/api/starships/13/
 7 Executor                      http://swapi.co/api/starships/15/
 8 Slave 1                       http://swapi.co/api/starships/21/
 9 Imperial shuttle              http://swapi.co/api/starships/22/
10 EF76 Nebulon-B escort frigate http://swapi.co/api/starships/23/
# ℹ 27 more rows
```

Aside - Joins



Joins (left)



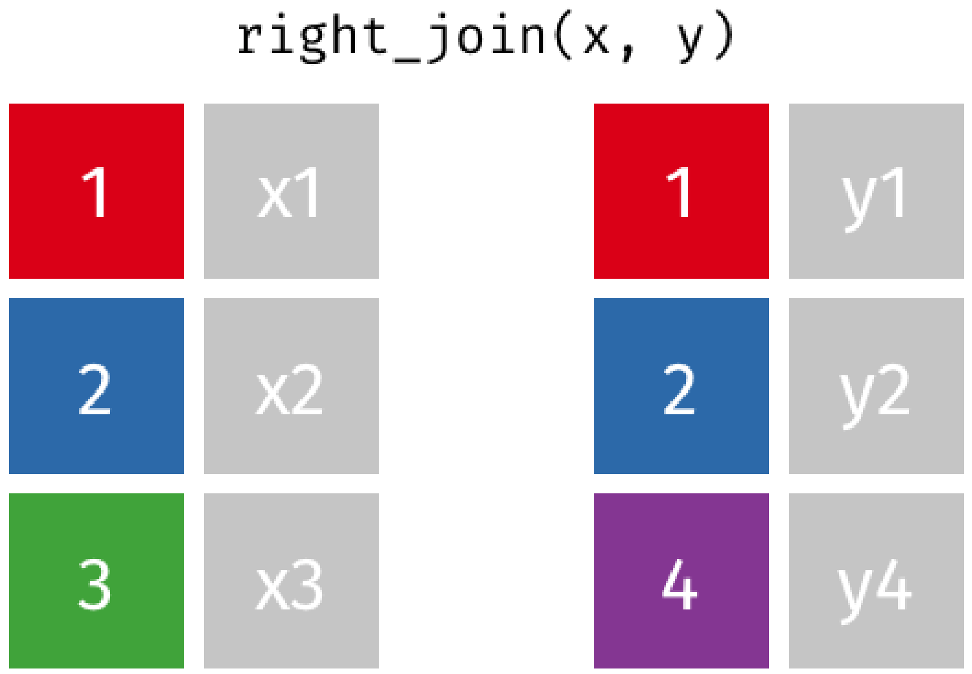
```
left_join(x, y)
```

1	x1
2	x2
3	x3

1	y1
2	y2
4	y4
2	y5

From gadenbuie/tidyexplain

Joins (right)



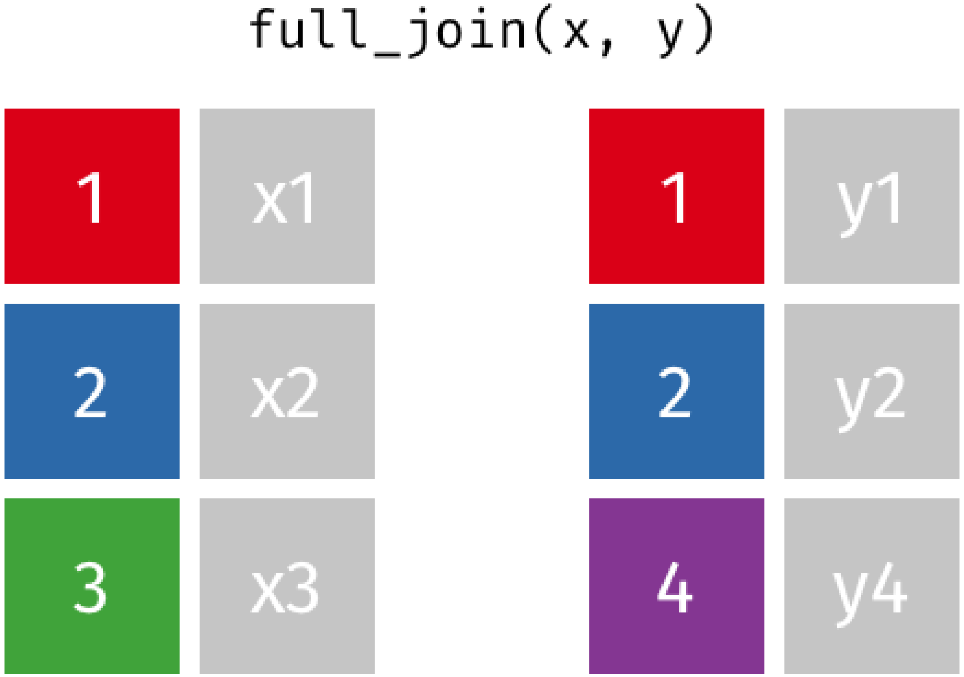
```
right_join(x, y)
```

1	x1
2	x2
3	x3

1	y1
2	y2
4	y4

From gadenbuie/tidyexplain

Joins (full / outer)



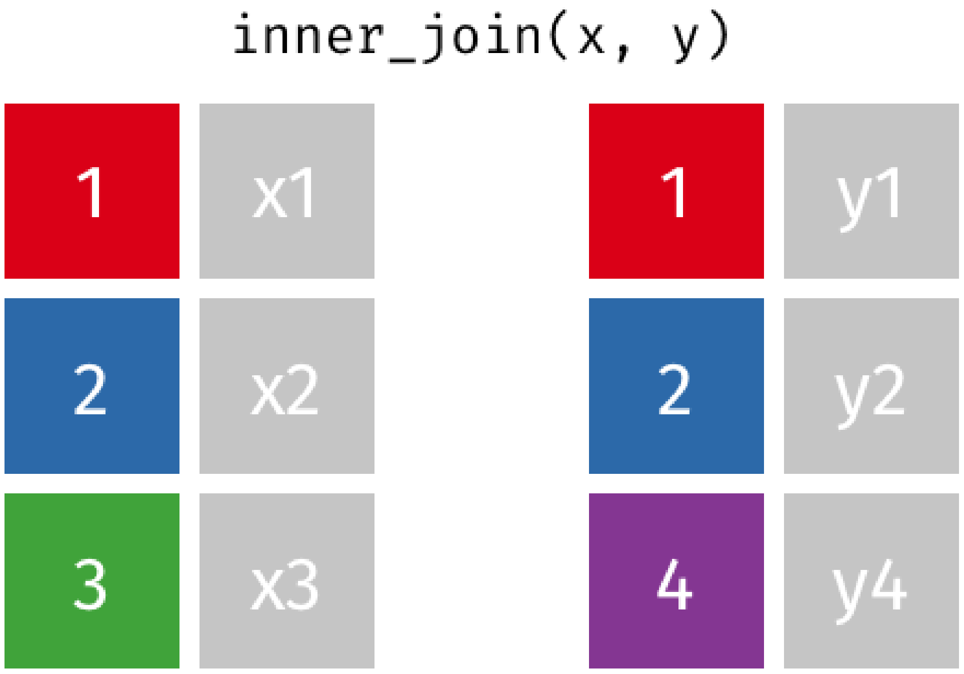
`full_join(x, y)`

1	x1
2	x2
3	x3

1	y1
2	y2
4	y4

From gadenbuie/tidyexplain

Joins (inner)



```
inner_join(x, y)
```

1	x1
2	x2
3	x3

1	y1
2	y2
4	y4

From gadenbuie/tidyexplain

join `by`

By default dplyr’s join functions will join based on matching column names between the two data frames.

To specify the columns to join by (or to handle non-matching names) pass in a character vector of column names (or a named character vector where the names match the left data frame and the values match the right).

More recently more advanced joins have been allowed via the `join_by()` construct which alllows for: equality, inequality, rolling, overlap, and cross joins. See `?join_by` for details.

Joining people and starships

```r
sw_df |>
  unnest_wider(people) |>
  select(name, starships) |>
  unnest_longer(starships) |>
  left_join(ships, by = c("starships" = "url"))
```

```
# A tibble: 31 × 3
   name               starships                        ship
   <chr>              <chr>                            <chr>
 1 Luke Skywalker     http://swapi.co/api/starships/12/ X-wing
 2 Luke Skywalker     http://swapi.co/api/starships/22/ Imperial shuttle
 3 Darth Vader        http://swapi.co/api/starships/13/ TIE Advanced x1
 4 Biggs Darklighter http://swapi.co/api/starships/12/ X-wing
 5 Obi-Wan Kenobi     http://swapi.co/api/starships/48/ Jedi starfighter
 6 Obi-Wan Kenobi     http://swapi.co/api/starships/59/ Trade Federation cruiser
 7 Obi-Wan Kenobi     http://swapi.co/api/starships/64/ Naboo star skiff
 8 Obi-Wan Kenobi     http://swapi.co/api/starships/65/ Jedi Interceptor
 9 Obi-Wan Kenobi     http://swapi.co/api/starships/74/ Belbullab-22 starfighter
10 Anakin Skywalker  http://swapi.co/api/starships/59/ Trade Federation cruiser
```

Putting it together

```r
sw_df |>
  unnest_wider(people) |>
  select(name, starships) |>
  unnest_longer(starships) |>
  inner_join(ships, by = c("starships" = "url")) |>
  select(-starships) |>
  group_by(name) |>
  summarize(ships = list(ship), .groups = "drop")
```

```
# A tibble: 20 × 2
   name              ships
   <chr>             <list>
 1 Anakin Skywalker  <chr [3]>
 2 Arvel Crynyd      <chr [1]>
 3 Biggs Darklighter <chr [1]>
 4 Boba Fett         <chr [1]>
 5 Chewbacca         <chr [2]>
 6 Darth Maul        <chr [1]>
 7 Darth Vader       <chr [1]>
 8 Gregar Typho      <chr [1]>
```

```r
sw_df |>
  unnest_wider(people) |>
  select(name, starships) |>
  unnest_longer(starships) |>
  inner_join(ships, by = c("starships" = "url")) |>
  select(-starships) |>
  group_by(name) |>
  summarize(ships = paste(ship, collapse = ", "), .groups = "drop")
```

```
# A tibble: 20 × 2
   name               ships
   <chr>              <chr>
 1 Anakin Skywalker   Trade Federation cruiser, Jedi Interceptor, Naboo fighter
 2 Arvel Crynyd       A-wing
 3 Biggs Darklighter  X-wing
 4 Boba Fett          Slave 1
 5 Chewbacca          Millennium Falcon, Imperial shuttle
 6 Darth Maul         Scimitar
 7 Darth Vader        TIE Advanced x1
 8 Gregar Typho       Naboo fighter
 9 Grievous           Belbullab-22 starfighter
10 Han Solo           Millennium Falcon, Imperial shuttle
```

Exercise 2

1. Which planet appeared in the most starwars film (according to the data in `sw_planets`)?
2. Which planet was the homeworld of the most characters in the starwars films?

05:00