Lec 07 - tidyr

Statistical Programming

Fall 2021

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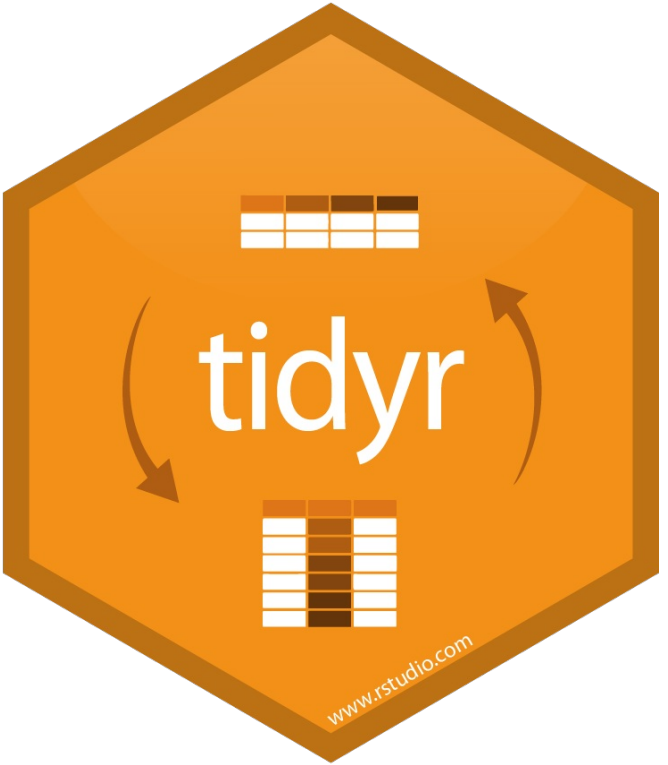

tidyr
www.rstudio.com

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 import cheatsheet

Syntax

```
(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
```

```
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
```

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 import cheatsheet

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"
)
```

```
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
```

Separate

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

```
separate(d, rate, sep = "/", into = c("cases", "pop"))
```

From data import cheatsheet

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

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

From data import cheatsheet

Example 1 - tidy grades

Is the following data tidy?

```
(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
))
```

```
## # A tibble: 4 × 7
##   name   hw_1  hw_2  hw_3  hw_4 proj_1 proj_2
##   <chr> <dbl> <dbl> <dbl> <dbl>  <dbl>  <dbl>
## 1 Alice    19    19    18    20     89     95
## 2 Bob      18    20    18    16     77     88
## 3 Carol    18    20    18    17     96     99
## 4 Dave     19    19    18    19     86     82
```

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

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

Semi-tidy approach

```
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)

```
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
## # … with 14 more rows
```

What does this get us?

```
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
## # … with 14 more rows
```

Tidy approach?

```
grades %>%
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) %>%
  group_by(name, type) %>%
  summarize(
    total = sum(score),
    .groups = "drop"
  )
```

```
## # 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)

```
grades %>%
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) %>%
  group_by(name, type) %>%
  summarize(
    total = sum(score),
    .groups = "drop"
  ) %>%
  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

```
grades %>%
  tidyr::pivot_longer(
    cols = hw_1:proj_2,
    names_to = c("type", "id"),
    names_sep = "_",
    values_to = "score"
  ) %>%
  group_by(name, type) %>%
  summarize(
    total = sum(score),
    .groups = "drop"
  ) %>%
  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
```

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).

```
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.

Rectangling

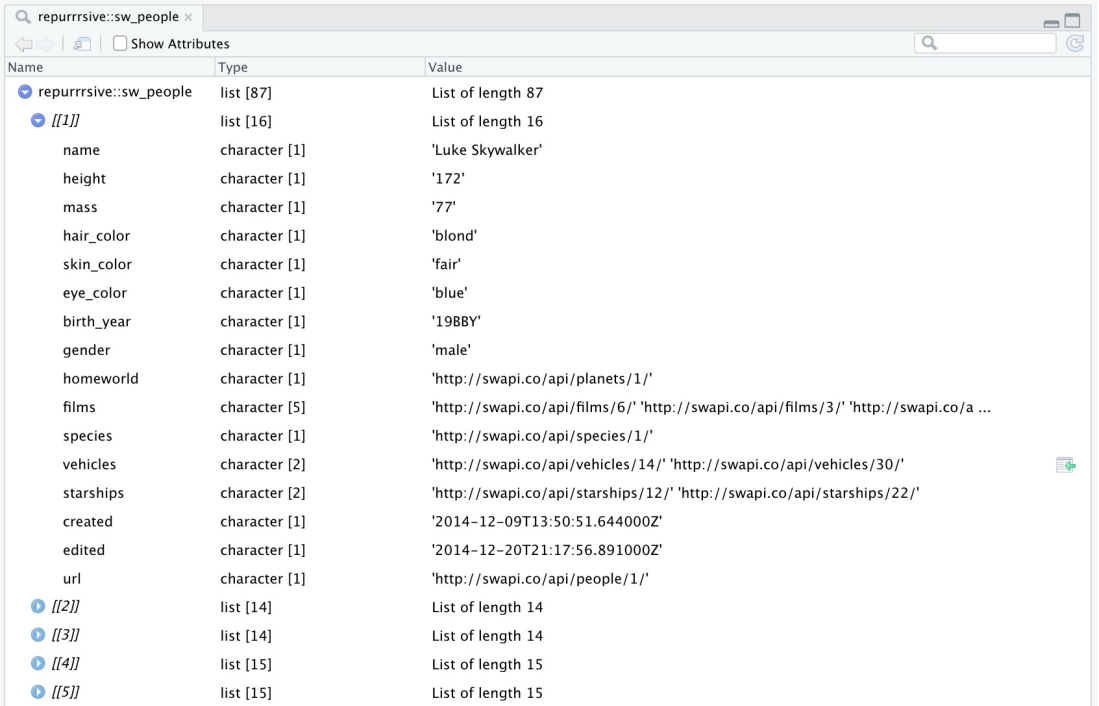
Star Wars & repurrrsive

`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.

```
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/ap
##   ..$ species   : chr "http://swapi.co/api/species/1/"
##   ..$ vehicles  : chr [1:2] "http://swapi.co/api/vehicles/14/" "http://swapi.co/api/vehicles/30/"
##   ..$ starships : chr [1:2] "http://swapi.co/api/starships/12/" "http://swapi.co/api/starships/22/"
##   ..$ created   : chr "2014-12-09T13:50:51.644000Z"
##   ..$ edited    : chr "2014-12-20T21:17:56.891000Z"
```

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



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 `tidyr` - `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]>
## # … with 77 more rows
```

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

```
##
## 1 Luke Skywalker, 172, 77, blond, fair, blue, 19BBY,
## 2
## 3
## 4
## 5
## 6
```

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

```
## [1] TRUE
```

Unnesting

```
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 Skywal… 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, grey  light      blue      52BBY      male
##  7 Beru Whites… 165    75    brown        light      blue      47BBY      female
##  8 R5-D4        97     32    n/a          white, red red       unknown    n/a
##  9 Biggs Darkl… 183    84    black        light      brown     24BBY      male
## 10 Obi-Wan Ken… 182    77    auburn, whi… fair       blue-gray 57BBY      male
## # … with 77 more rows, and 8 more variables: homeworld <chr>, films <list>,
## #   species <chr>, vehicles <list>, starships <list>, created <chr>,
## #   edited <chr>, url <chr>
```

More list columns

```
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]>
## # … with 77 more rows
```

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

```
## List of 87
##  $ : chr [1:2] "http://swapi.co/api/starships/12/" "
##  $ : NULL
##  $ : NULL
##  $ : chr "http://swapi.co/api/starships/13/"
##  $ : NULL
##  $ : NULL
##  $ : NULL
##  $ : NULL
##  $ : chr "http://swapi.co/api/starships/12/"
##  $ : chr [1:5] "http://swapi.co/api/starships/48/" "
##  $ : chr [1:3] "http://swapi.co/api/starships/59/" "
##  $ : NULL
##  $ : chr [1:2] "http://swapi.co/api/starships/10/" "
##  $ : chr [1:2] "http://swapi.co/api/starships/10/" "
##  $ : NULL
##  $ : NULL
```

Unnest Longer

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

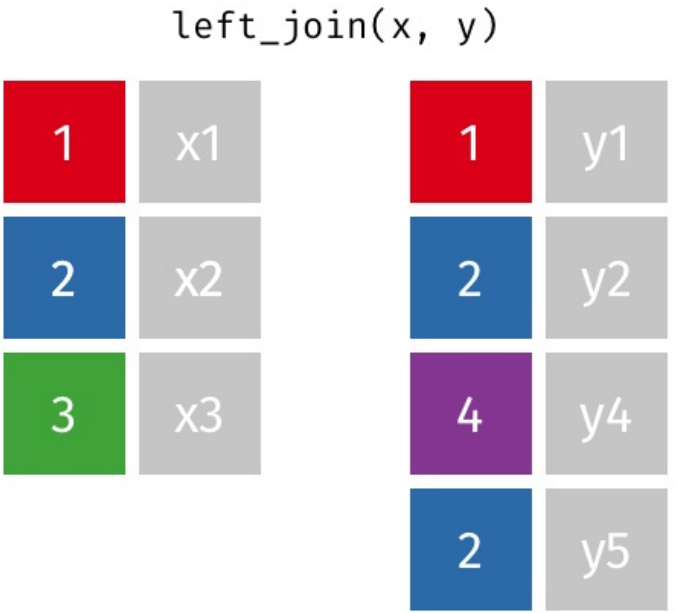
```
## # A tibble: 98 × 2
##    name               starships
##    <chr>              <chr>
##  1 Luke Skywalker     http://swapi.co/api/starships/12/
##  2 Luke Skywalker     http://swapi.co/api/starships/22/
##  3 C-3PO              <NA>
##  4 R2-D2              <NA>
##  5 Darth Vader        http://swapi.co/api/starships/13/
##  6 Leia Organa        <NA>
##  7 Owen Lars          <NA>
##  8 Beru Whitesun lars <NA>
##  9 R5-D4              <NA>
## 10 Biggs Darklighter  http://swapi.co/api/starships/12/
## # … with 88 more rows
```

Aside - sw_starships

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

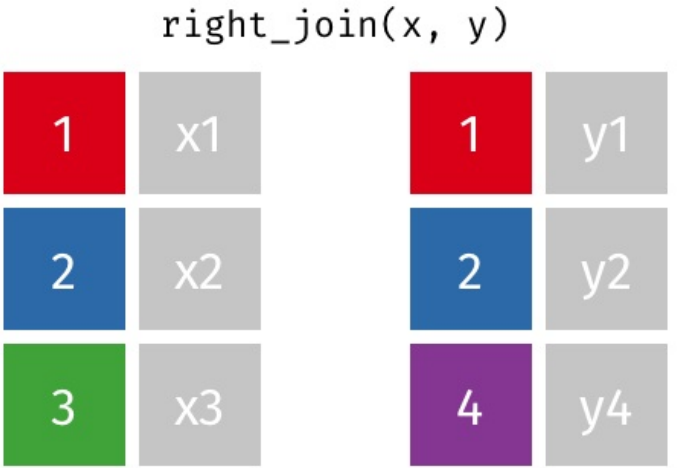
```
## # A tibble: 37 × 2
##    ship                           url
##    <chr>                          <chr>
##  1 Sentinel-class landing craft   http://swapi.co/api/starships/5/
##  2 Death Star                     http://swapi.co/api/starships/9/
##  3 Millennium Falcon              http://swapi.co/api/starships/10/
##  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/
## # … with 27 more rows
```

Joins (left)



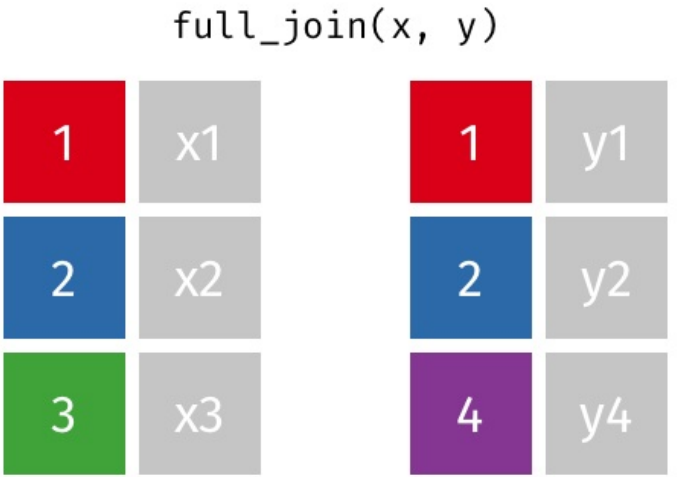
From gadenbuie/tidyexplain

Joins (right)



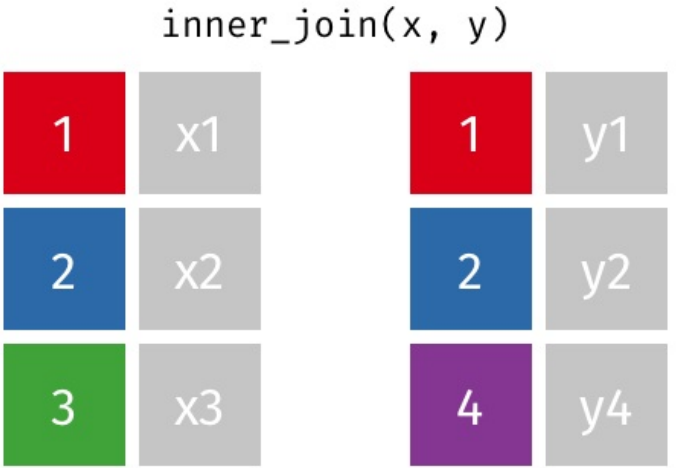
From gadenbuie/tidyexplain

Joins (full / outer)



From gadenbuie/tidyexplain

Joins (inner)



From gadenbuie/tidyexplain

Joining people and starships

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

```
## # A tibble: 98 × 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 C-3PO              <NA>                               <NA>
##  4 R2-D2              <NA>                               <NA>
##  5 Darth Vader        http://swapi.co/api/starships/13/ TIE Advanced x1
##  6 Leia Organa        <NA>                               <NA>
##  7 Owen Lars          <NA>                               <NA>
##  8 Beru Whitesun lars <NA>                               <NA>
##  9 R5-D4              <NA>                               <NA>
## 10 Biggs Darklighter  http://swapi.co/api/starships/12/ X-wing
## # … with 88 more rows
```

Putting it together

```
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]>
##  9 Grievous          <chr [1]>
## 10 Han Solo          <chr [2]>
## 11 Jek Tono Porkins  <chr [1]>
## 12 Lando Calrissian  <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
## 11 Jek Tono Porkins  X-wing
## 12 Lando Calrissian  Millennium Falcon
## 13 Luke Skywalker    X-wing, Imperial shuttle
## 14 Nien Nunb         Millennium Falcon
## 15 Obi-Wan Kenobi    Jedi starfighter, Trade Federation cruiser, Naboo star ski…
```

Exercise 2

1. Which planet appeared in the most starwars film (according to the data in `sw_planet`)?

1. Which planet was the homeworld of the most characters in the starwars films?