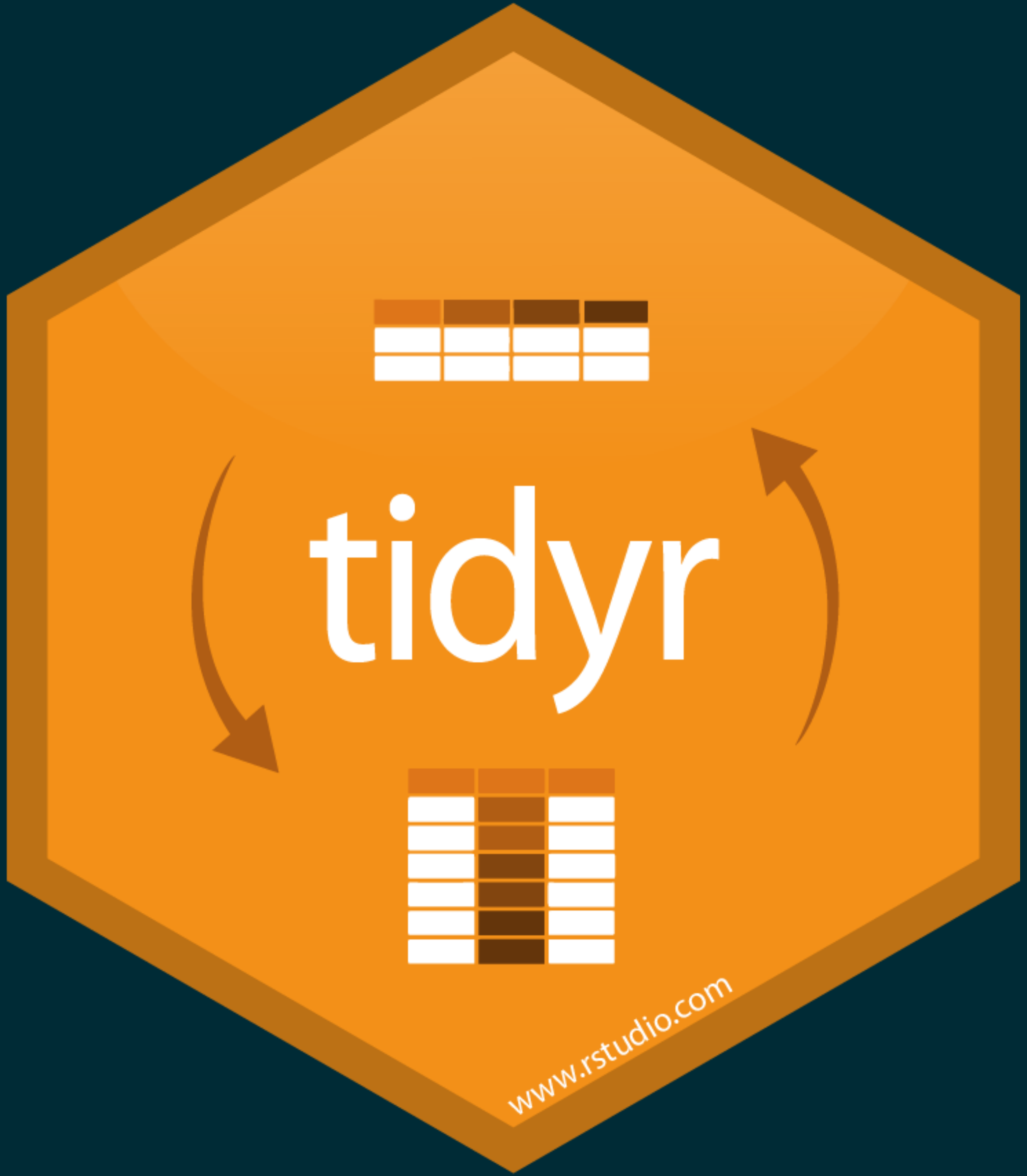
Lec 07 - tidyr

Statistical Programming

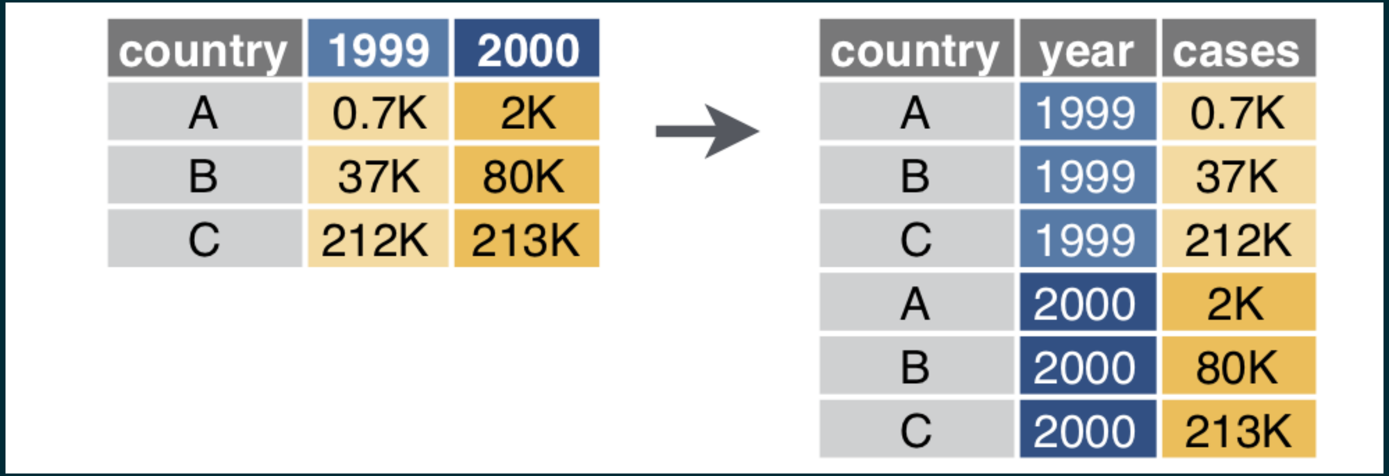
Sem 1, 2020

Dr. Colin Rundel


tidyr
www.rstudio.com

Wide vs. Long

Wide -> Long



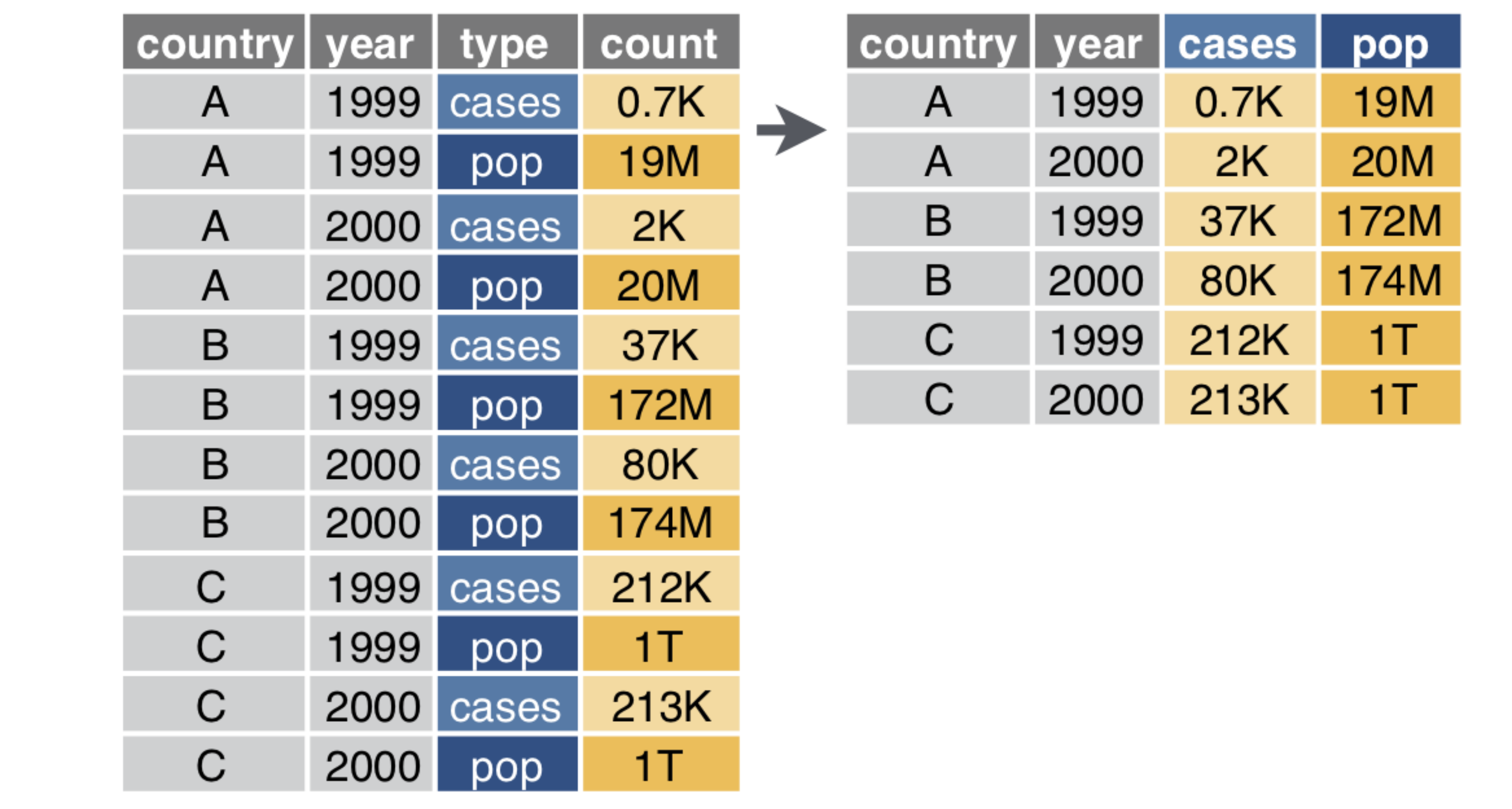
country	1999	2000
A	0.7K	2K
B	37K	80K
C	212K	213K

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

`gather` or `pivot_longer`

From data import cheatsheet

Long -> Wide ()



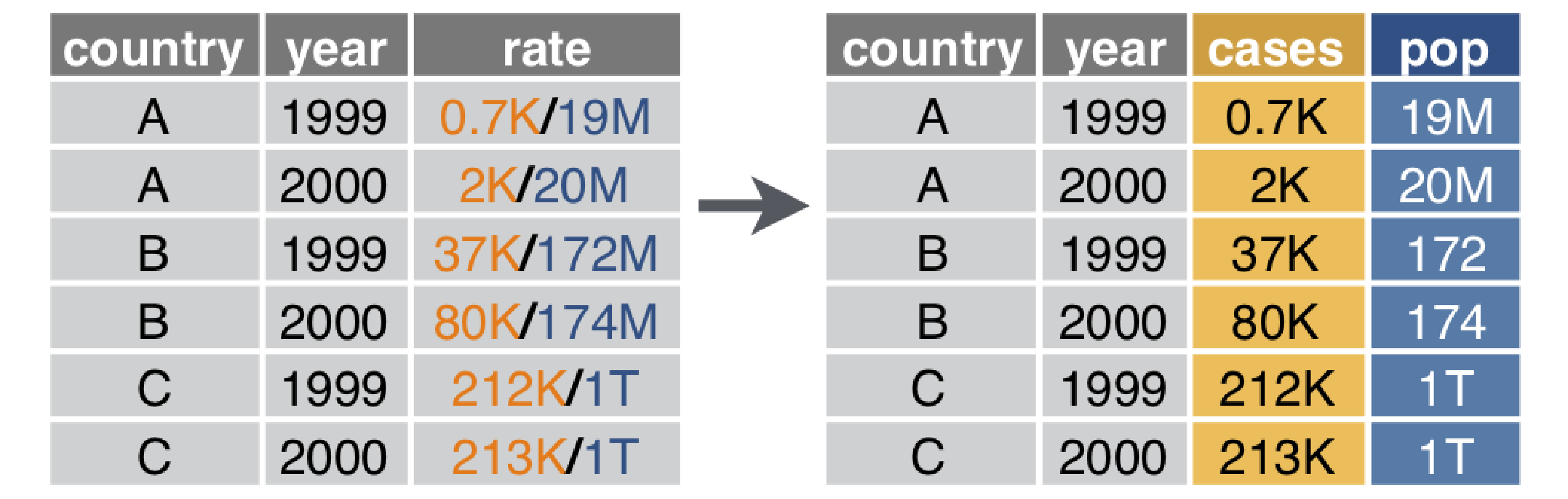
country	year	type	count
A	1999	cases	0.7K
A	1999	pop	19M
A	2000	cases	2K
A	2000	pop	20M
B	1999	cases	37K
B	1999	pop	172M
B	2000	cases	80K
B	2000	pop	174M
C	1999	cases	212K
C	1999	pop	1T
C	2000	cases	213K
C	2000	pop	1T

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

`spread` or `pivot_wider`

From data import cheatsheet

Separate

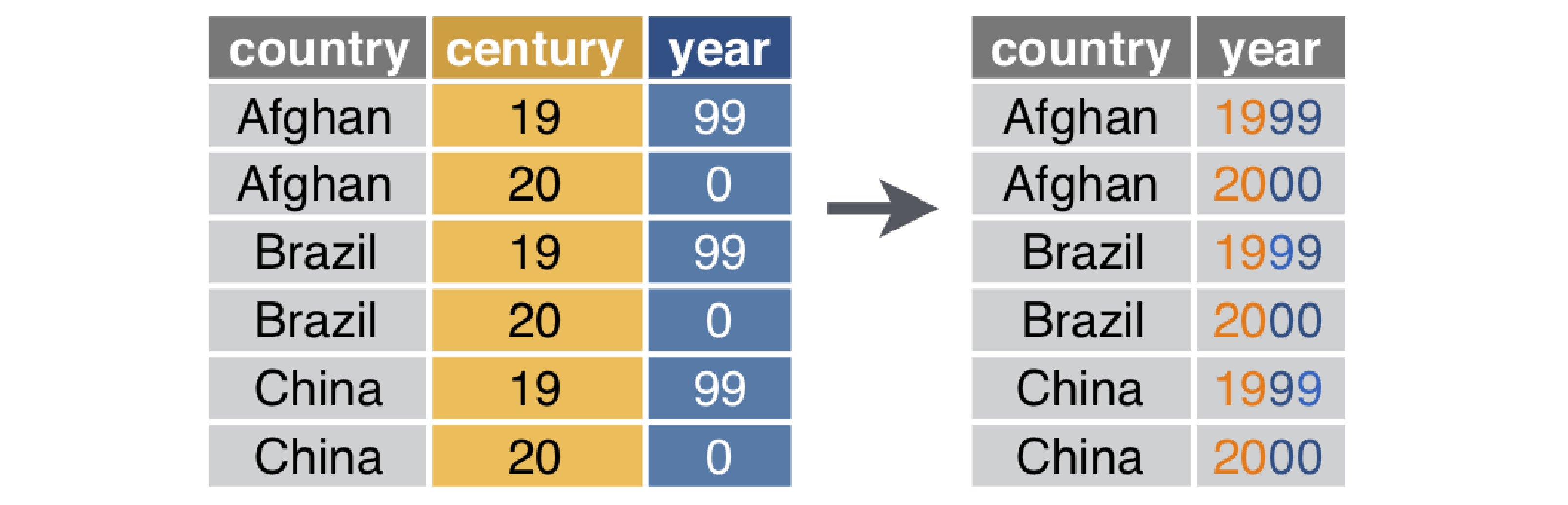


country	year	rate
A	1999	0.7K/19M
A	2000	2K/20M
B	1999	37K/172M
B	2000	80K/174M
C	1999	212K/1T
C	2000	213K/1T

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

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

From data import cheatsheet

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 x 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,

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

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 x 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 x 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
```

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

```
## # A tibble: 24 x 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?

```r
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))
```

```
## `summarise()` regrouping output by 'name' (override with `.groups` argument)
```

```
## # A tibble: 8 x 3
## # Groups:   name [4]
##   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)) %>%
  tidyr::pivot_wider(
    names_from = type,
    values_from = total
  )
```

```
## `summarise()` regrouping output by 'name' (override with `.groups` argument)
```

```
## # A tibble: 4 x 3
## # Groups:   name [4]
##   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)) %>%
  tidyr::pivot_wider(
    names_from = type,
    values_from = total
  ) %>%
  mutate(
    score = 0.5*(hw/80) + 0.5*(proj/200)
  )
```

```
## `summarise()` regrouping output by 'name' (override with `.groups` argument)
```

```
## # A tibble: 4 x 4
## # Groups:   name [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
```

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.c
##   ..$ 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"
##   ..$ url       : chr "http://swapi.co/api/people/1/"
##  $ :List of 14
##   ..$ name      : chr "C-3PO"
##   ..$ height    : chr "167"
```

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.

Unnesting

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

```
## # A tibble: 87 x 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
```

```
unnest_wider(sw_df, people)
```

```
## # A tibble: 87 x 16
##    name  height mass  hair_color skin_color eye_color birth_year gender
##    <chr> <chr>  <chr> <chr>      <chr>      <chr>     <chr>      <chr>
##  1 Luke… 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
```

List columns

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

```
## # A tibble: 87 x 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
```

```
unnest_wider(sw_df, 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
```

Unnest Longer

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

```
## # A tibble: 98 x 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)
)
```

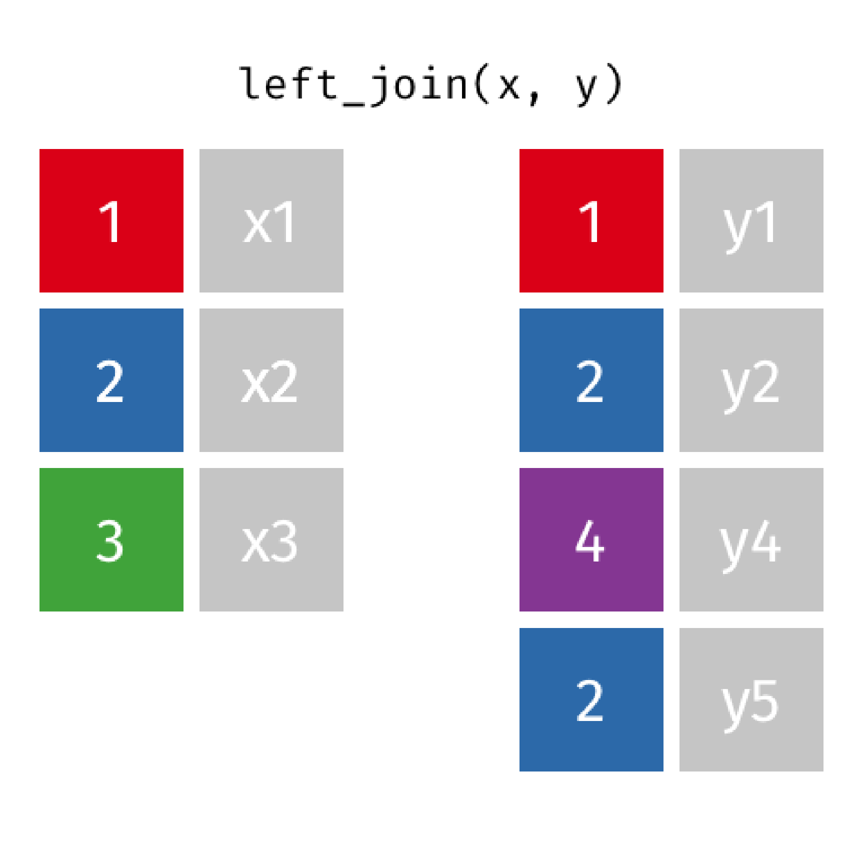
```
## # A tibble: 37 x 2
##    ship                          url
##    <chr>                         <chr>
##  1 Sentinel-class landing craft  http://swapi.co/api/starships/5/
##  2 Death Star                    http://swapi.co/api/starships/9/
##  3 Millennium Falcon             http://swapi.co/api/starships/10/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

Joining

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

```
## # A tibble: 98 x 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
```

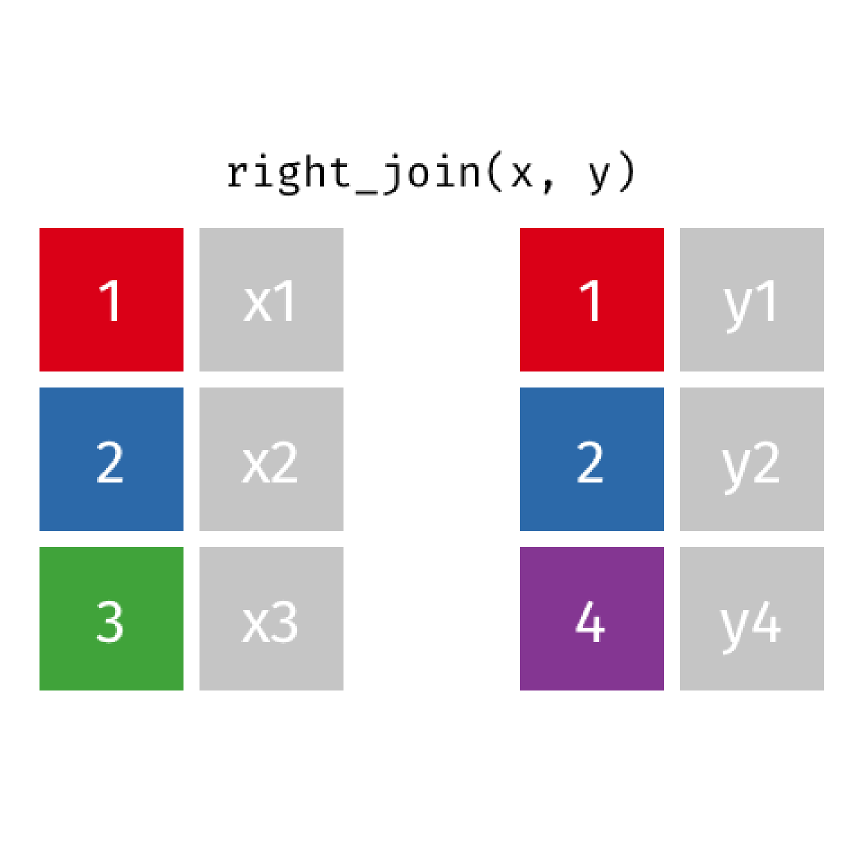
Joins in general



left_join(x, y)

1	x1
2	x2
3	x3

1	y1
2	y2
4	y4
2	y5



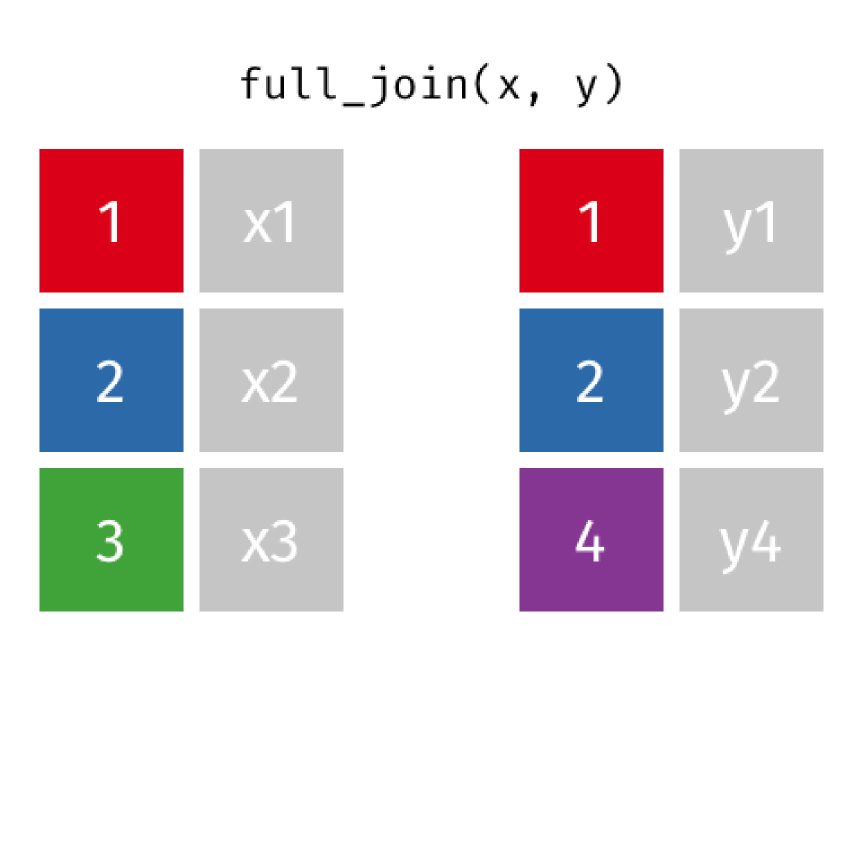
right_join(x, y)

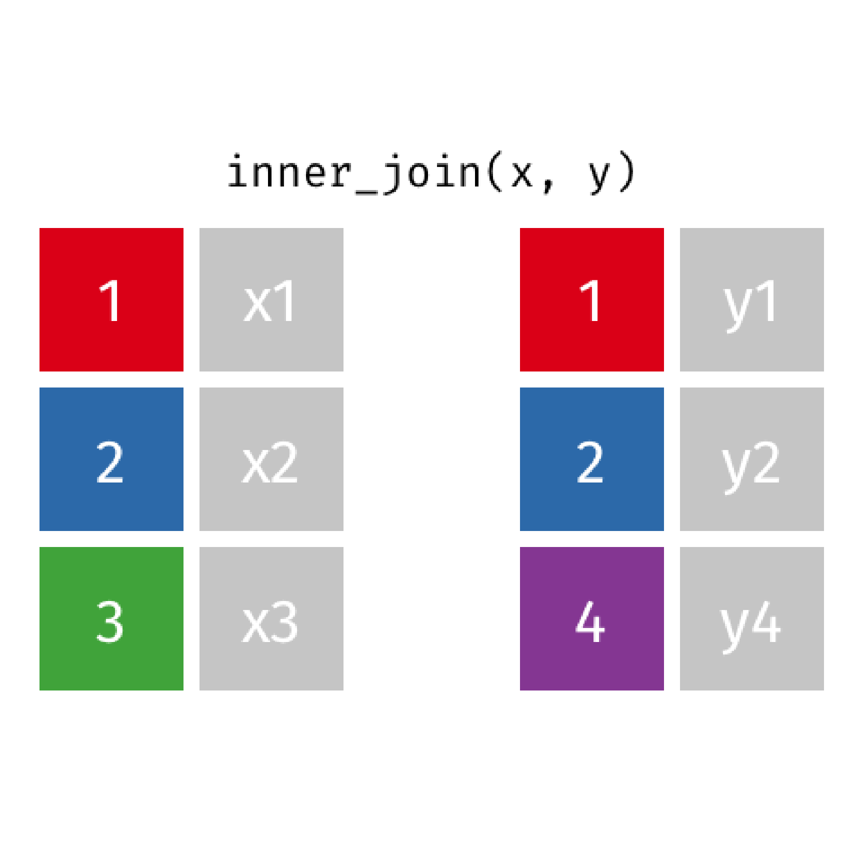
1	x1
2	x2
3	x3

1	y1
2	y2
4	y4

From gadenbuie/tidyexplain

Joins in general (2)





From gadenbuie/tidyexplain

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 x 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]>
## 13 Luke Skywalker    <chr [2]>
## 14 Nien Nunb         <chr [1]>
## 15 Obi-Wan Kenobi    <chr [5]>
```

```
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 x 2
##    name               ships
##    <chr>              <chr>
##  1 Anakin Skywalk… Trade Federation cruiser, Jedi Interceptor, Naboo fighter
##  2 Arvel Crynyd       A-wing
##  3 Biggs Darkligh… 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 Porki… X-wing
## 12 Lando Calrissi… 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 skiff…
## 16 Padmé Amidala      H-type Nubian yacht, Naboo star skiff, Naboo fighter
## 17 Plo Koon           Jedi starfighter
## 18 Poe Dameron        T-70 X-wing fighter
```

hoist

Complex heirarchical data

Often we may encounter complex data structures where our goal is not to rectangle every value (which may not even be possible) but rather to rectangle a small subset of the data.

```r
str(repurrrsive::discog, max.level = 3)
```

```
## List of 155
##  $ :List of 5
##   ..$ instance_id      : int 354823933
##   ..$ date_added       : chr "2019-02-16T17:48:59-08:00"
##   ..$ basic_information:List of 11
##   .. ..$ labels      :List of 1
##   .. ..$ year        : int 2015
##   .. ..$ master_url  : NULL
##   .. ..$ artists     :List of 1
##   .. ..$ id          : int 7496378
##   .. ..$ thumb       : chr "https://img.discogs.com/vEVegHrMNTsP6xG_K6OuFXz4h_U=/fit-in/150x150/filters:s
##   .. ..$ title       : chr "Demo"
##   .. ..$ formats     :List of 1
##   .. ..$ cover_image : chr "https://img.discogs.com/EmbMh7vsElksjRgoXLFSuY1sjRQ=/fit-in/500x499/filters:s
##   .. ..$ resource_url: chr "https://api.discogs.com/releases/7496378"
##   .. ..$ master_id   : int 0
##   ..$ id               : int 7496378
##   ..$ rating           : int 0
##  $ :List of 5
##   ..$ instance_id      : int 354092601
##   ..$ date_added       : chr "2019-02-13T14:13:11-08:00"
```

```r
tibble(disc = repurrrsive::discog) %>%
  hoist(
    disc,
    info = "basic_information"
  )
```

```
## # A tibble: 155 x 2
##    info                 disc
##    <list>               <list>
##  1 <named list [11]> <named list [4]>
##  2 <named list [11]> <named list [4]>
##  3 <named list [11]> <named list [4]>
##  4 <named list [11]> <named list [4]>
##  5 <named list [11]> <named list [4]>
##  6 <named list [11]> <named list [4]>
##  7 <named list [11]> <named list [4]>
##  8 <named list [11]> <named list [4]>
##  9 <named list [11]> <named list [4]>
## 10 <named list [11]> <named list [4]>
## # … with 145 more rows
```

```r
tibble(disc = repurrrsive::discog) %>%
  hoist(
    disc,
    id = "id",
    info = "basic_information"
  ) %>%
  hoist(
    info,
    year = c("year"), title = c("title"),
    artist = list("artists", 1, "name"),
    label = list("labels", 1, "name")
  )
```

```
## # A tibble: 155 x 7
##          id  year title          artist       label             info     disc
##       <int> <int> <chr>          <chr>        <chr>             <list>   <list>
##  1  7.50e6  2015 Demo           Mollot       Tobi Records (2)  <named … <named …
##  2  4.49e6  2013 Observant Com… Una Bèstia … La Vida Es Un Mus <named … <named …
##  3  9.83e6  2017 I              S.H.I.T. (3) La Vida Es Un Mus <named … <named …
##  4  9.77e6  2017 Oído Absoluto  Rata Negra   La Vida Es Un Mus <named … <named …
##  5  7.24e6  2015 A Cat's Cause… Ivy (18)     Katorga Works     <named … <named …
##  6  1.31e7  2019 Tashme         Tashme       High Fashion Ind… <named … <named …
##  7  7.11e6  2014 Demo           Desgraciados Mind Control Rec… <named … <named …
##  8  1.05e7  2015 Let The Mirac… Phantom Head Not On Label (Ph… <named … <named …
##  9  1.13e7  2017 Sub Space      Sub Space (… Not On Label (Su… <named … <named …
## 10  1.17e7  2017 Demo           Small Man (… Prescience Tapes  <named … <named …
## # … with 145 more rows
```