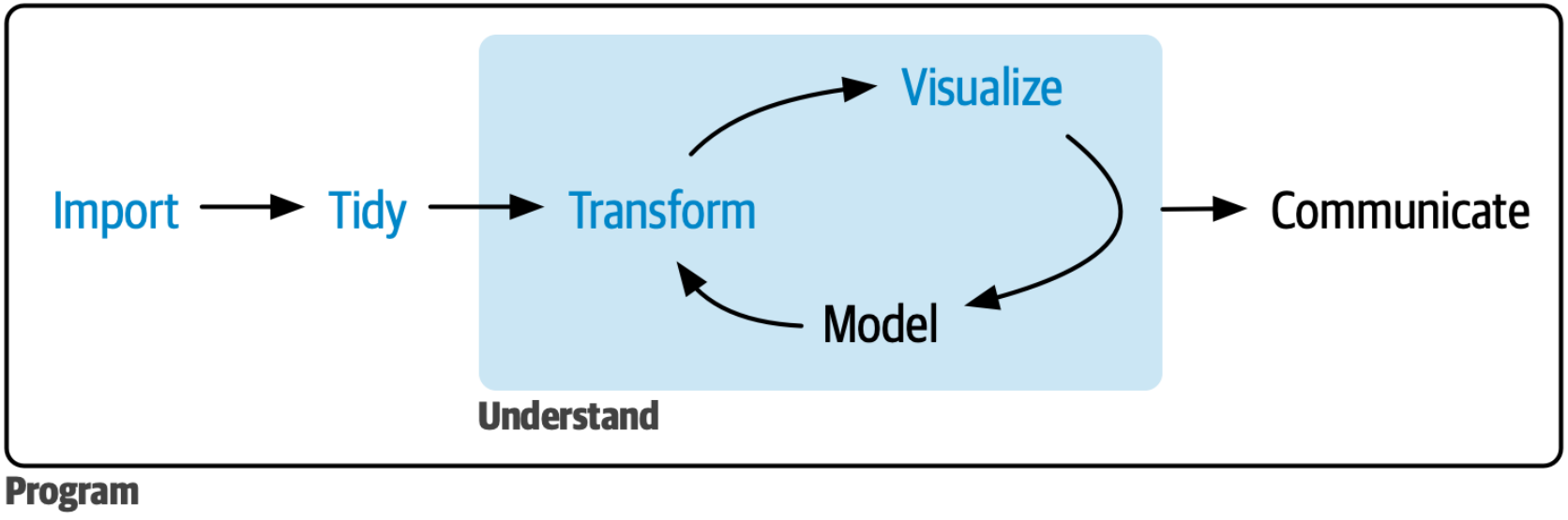
https://r4ds.hadley.nz/ Chapter 3-9

CSCI 297b, Spring 2023

May 5, 2023

The Big Picture



The dplyr package and the nycflights13 dataset

```
library(nycflights13)
library(tidyverse)
```

the nycflights13 dataset

```
> glimpse(flights)
Rows: 336,776
Columns: 19
$ year           <int> 2013, 2013, 2013, 2013,...
$ month          <int> 1, 1, 1, 1, 1, 1, 1, 1,...
$ day            <int> 1, 1, 1, 1, 1, 1, 1, 1,...
$ dep_time       <int> 517, 533, 542, 544, 554...
$ sched_dep_time <int> 515, 529, 540, 545, 600...
$ dep_delay      <dbl> 2, 4, 2, -1, -6, -4, -5...
$ arr_time       <int> 830, 850, 923, 1004, 81...
$ sched_arr_time <int> 819, 830, 850, 1022, 83...
$ arr_delay      <dbl> 11, 20, 33, -18, -25, 1...
$ carrier        <chr> "UA", "UA", "AA", "B6",...
$ flight         <int> 1545, 1714, 1141, 725, ...
$ tailnum        <chr> "N14228", "N24211", "N6...
$ origin         <chr> "EWR", "LGA", "JFK", "J...
$ dest           <chr> "IAH", "IAH", "MIA", "B...
$ air_time       <dbl> 227, 227, 160, 183, 116...
$ distance       <dbl> 1400, 1416, 1089, 1576,...
$ hour           <dbl> 5, 5, 5, 5, 6, 5, 6, 6,...
$ minute         <dbl> 15, 29, 40, 45, 0, 58, ...
$ time_hour      <dttm> 2013-01-01 05:00:00, 2...
```

The dplyr package

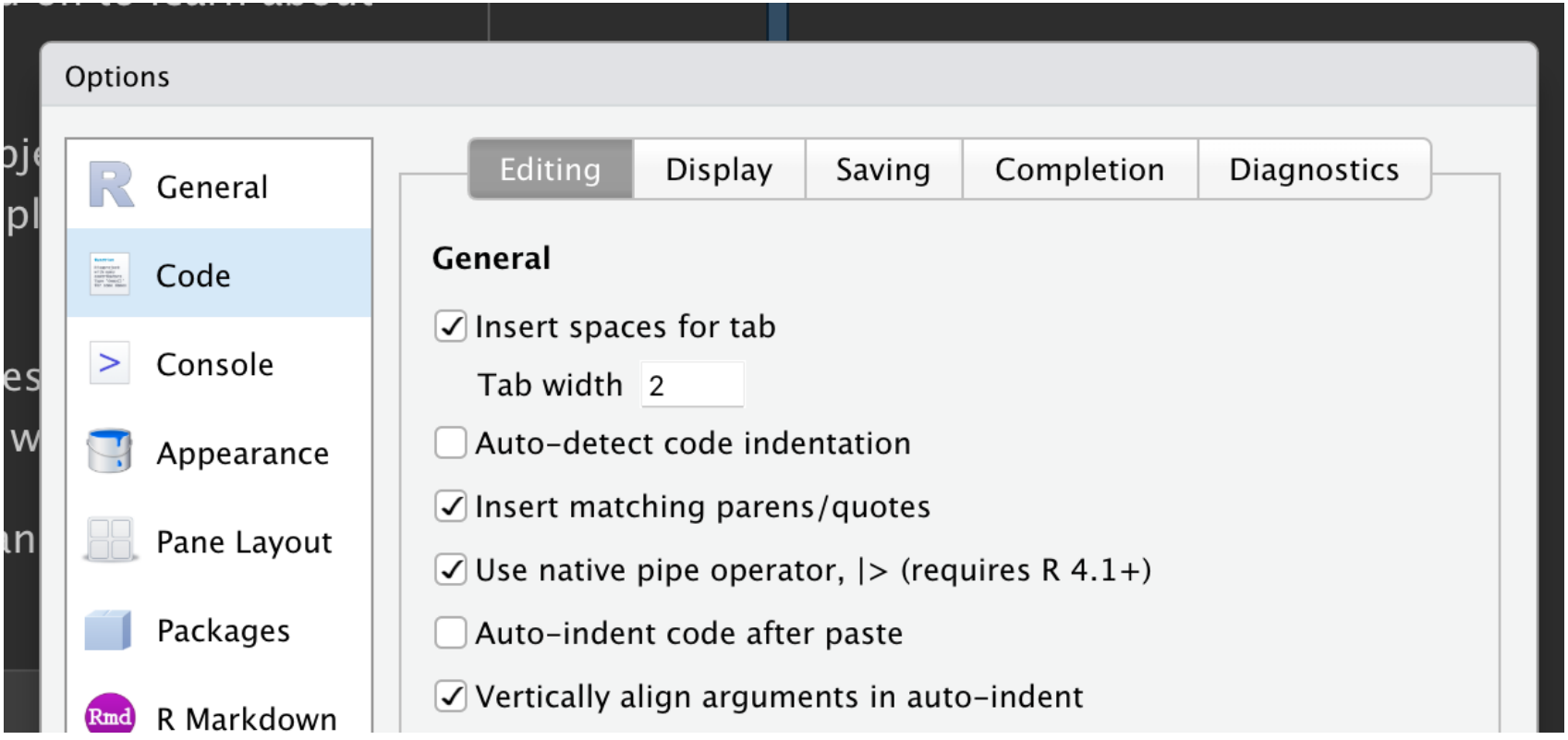
- The first argument is always a data frame.
- The subsequent arguments typically describe which columns to operate on, using the variable names (without quotes).
- The output is always a new data frame.
- Each verb operates on either
  - rows,
  - columns,
  - groups, or
  - tables

The pipe

```
x |> f(y)       ⇔  f(x, y)
x |> f(y) |> g(z)  ⇔  g(f(x, y), z)
```

```
flights |>
  filter(dest == "IAH") |>
  group_by(year, month, day) |>
  summarize(
    arr_delay = mean(arr_delay, na.rm = TRUE)
  )
```

Global options



- Enable "Use native pipe operator."
- This will enable you to produce the pipe with `ctrl-shift-M`

filter

```
flights |>
  filter(dep_delay > 120)
#> # A tibble: 9,723 × 19
#>    year month   day dep_time sched_dep_time dep_delay arr
#>   <int> <int> <int>    <int>          <int>     <dbl>
#> 1  2013     1     1      848           1835       853
#> 2  2013     1     1      957            733       144
#> 3  2013     1     1     1114            900       134
#> 4  2013     1     1     1540           1338       122
#> 5  2013     1     1     1815           1325       290
#> 6  2013     1     1     1842           1422       260
#> # i 9,717 more rows
#> # i 11 more variables: arr_delay <dbl>, carrier <chr>, fl
```

arrange

```
flights |>
  arrange(year, month, day, dep_time)
#> # A tibble: 336,776 × 19
#>    year month   day dep_time sched_dep_time dep_delay ar
#>   <int> <int> <int>    <int>          <int>     <dbl>
#> 1  2013     1     1      517            515         2
#> 2  2013     1     1      533            529         4
#> 3  2013     1     1      542            540         2
#> 4  2013     1     1      544            545        -1
#> 5  2013     1     1      554            600        -6
#> 6  2013     1     1      554            558        -4
#> # i 9,717 more rows
#> # i 11 more variables: arr_delay <dbl>, carrier <chr>, fl
```

distinct

```
# Find all unique origin and destination pairs
flights |>
  distinct(origin, dest)
#> # A tibble: 224 × 2
#>   origin dest
#>   <chr>  <chr>
#> 1 EWR    IAH
#> 2 LGA    IAH
#> 3 JFK    MIA
#> 4 JFK    BQN
#> 5 LGA    ATL
#> 6 EWR    ORD
#> # i 218 more rows
```

count

```
flights |>
  count(origin, dest, sort = TRUE)
#> # A tibble: 224 × 3
#>   origin dest      n
#>   <chr>  <chr> <int>
#> 1 JFK    LAX   11262
#> 2 LGA    ATL   10263
#> 3 LGA    ORD    8857
#> 4 JFK    SFO    8204
#> 5 LGA    CLT    6168
#> 6 EWR    ORD    6100
#> # i 218 more rows
```

Do exercise 6

mutate

```
flights |>
  mutate(
    gain = dep_delay - arr_delay,
    speed = distance / air_time * 60,
    .before = 1
  )
#> # A tibble: 336,776 × 21
#>    gain speed  year month   day dep_time sched_dep_time dep_delay arr_time
#>   <dbl> <dbl> <int> <int> <int>    <int>          <int>     <dbl>    <int>
#> 1    -9  370.  2013     1     1      517            515         2      830
#> 2   -16  374.  2013     1     1      533            529         4      850
#> 3   -31  408.  2013     1     1      542            540         2      923
#> 4    17  517.  2013     1     1      544            545        -1     1004
#> 5    19  394.  2013     1     1      554            600        -6      812
#> 6   -16  288.  2013     1     1      554            558        -4      740
#> # i 336,770 more rows
#> # i 12 more variables: sched_arr_time <int>, arr_delay <dbl>, ...
```

select

```
flights |>
  select(year, month, day)

flights |>
  select(year:day)

flights |>
  select(!year:day)

flights |>
  select(where(is.character))
```

- `starts_with("abc")`: matches names that begin with "abc".
- `ends_with("xyz")`: matches names that end with "xyz".
- `contains("ijk")`: matches names that contain "ijk".
- `num_range("x", 1:3)`: matches x1, x2 and x3.

rename

```
flights |>
  rename(tail_num = tailnum)
#> # A tibble: 336,776 × 19
#>    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_tim
#>   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int
#> 1  2013     1     1      517            515         2      830            81
#> 2  2013     1     1      533            529         4      850            83
#> 3  2013     1     1      542            540         2      923            85
#> 4  2013     1     1      544            545        -1     1004           102
#> 5  2013     1     1      554            600        -6      812            83
#> 6  2013     1     1      554            558        -4      740            72
```

relocate

```
flights |>
  relocate(time_hour, air_time)
#> # A tibble: 336,776 × 19
#>   time_hour           air_time  year month   day dep_time sched_dep_time
#>   <dttm>                 <dbl> <int> <int> <int>    <int>          <int>
#> 1 2013-01-01 05:00:00      227  2013     1     1      517            515
#> 2 2013-01-01 05:00:00      227  2013     1     1      533            529
#> 3 2013-01-01 05:00:00      160  2013     1     1      542            540
#> 4 2013-01-01 05:00:00      183  2013     1     1      544            545
#> 5 2013-01-01 06:00:00      116  2013     1     1      554            600
#> 6 2013-01-01 05:00:00      150  2013     1     1      554            558
```

Do exercise 7

The Pipe

```
flights |>
  filter(dest == "IAH") |>
  mutate(speed = distance / air_time * 60) |>
  select(year:day, dep_time, carrier, flight, speed) |>
  arrange(desc(speed))
#> # A tibble: 7,198 × 7
#>    year month   day dep_time carrier flight speed
#>   <int> <int> <int>    <int> <chr>    <int> <dbl>
#> 1  2013     7     9      707 UA         226  522.
#> 2  2013     8    27     1850 UA        1128  521.
#> 3  2013     8    28      902 UA        1711  519.
#> 4  2013     8    28     2122 UA        1022  519.
#> 5  2013     6    11     1628 UA        1178  515.
#> 6  2013     8    27     1017 UA         333  515.
```

The Pipe vs. function nesting

```
arrange(
  select(
    mutate(
      filter(
        flights,
        dest == "IAH"
      ),
      speed = distance / air_time * 60
    ),
    year:day, dep_time, carrier, flight, speed
  ),
  desc(speed)
)
```

The Pipe vs. assignment to temporaries

```
flights1 <- filter(flights, dest == "IAH")
flights2 <- mutate(flights1, speed = distance / air_time * 60)
flights3 <- select(flights2, year:day, dep_time, carrier, flight, speed)
arrange(flights3, desc(speed))
```

group_by

```
flights |>
  group_by(month)
#> # A tibble: 336,776 × 19
#> # Groups:   month [12]
#>    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_tim
#>   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int
#> 1  2013     1     1      517            515         2      830            81
#> 2  2013     1     1      533            529         4      850            83
#> 3  2013     1     1      542            540         2      923            85
#> 4  2013     1     1      544            545        -1     1004           102
#> 5  2013     1     1      554            600        -6      812            83
#> 6  2013     1     1      554            558        -4      740            72
```

- All subsequent operations will now work "by month"

summarize

```
flights |>
  group_by(month) |>
  summarize(
    avg_delay = mean(dep_delay)
  )
#> # A tibble: 12 × 2
#>   month avg_delay
#>   <int>     <dbl>
#> 1     1        NA
#> 2     2        NA
#> 3     3        NA
#> 4     4        NA
#> 5     5        NA
#> 6     6        NA
```

- We forgot `na.rm`

summarize

```
flights |>
  group_by(month) |>
  summarize(
    delay = mean(dep_delay, na.rm = TRUE)
  )
#> # A tibble: 12 × 2
#>   month delay
#>   <int> <dbl>
#> 1     1  10.0
#> 2     2  10.8
#> 3     3  13.2
#> 4     4  13.9
#> 5     5  13.0
#> 6     6  20.8
```

summarize with n

```
flights |>
  group_by(month) |>
  summarize(
    delay = mean(dep_delay, na.rm = TRUE),
    n = n()
  )
#> # A tibble: 12 × 3
#>   month delay     n
#>   <int> <dbl> <int>
#> 1     1  10.0 27004
#> 2     2  10.8 24951
#> 3     3  13.2 28834
#> 4     4  13.9 28330
#> 5     5  13.0 28796
#> 6     6  20.8 28243
```

slice

- `df |> slice_head(n = 1)`
  takes the first row from each group.
- `df |> slice_tail(n = 1)`
  takes the last row in each group.
- `df |> slice_min(x, n = 1)`
  takes the row with the smallest value of column x.
- `df |> slice_max(x, n = 1)`
  takes the row with the largest value of column x.
- `df |> slice_sample(n = 1)`
  takes one random row.

slice

```
flights |>
  group_by(dest) |>
  slice_max(arr_delay, n = 1) |>
  relocate(dest)
#> # A tibble: 108 × 19
#> # Groups:   dest [105]
#>   dest   year month   day dep_time sched_dep_time dep_delay arr_time
#>   <chr> <int> <int> <int>    <int>          <int>     <dbl>    <int>
#> 1 ABQ    2013     7    22     2145           2007        98      132
#> 2 ACK    2013     7    23     1139            800       219     1250
#> 3 ALB    2013     1    25      123           2000       323      229
#> 4 ANC    2013     8    17     1740           1625        75     2042
#> 5 ATL    2013     7    22     2257            759       898      121
#> 6 AUS    2013     7    10     2056           1505       351     2347
```

Groiuping by more than one variable

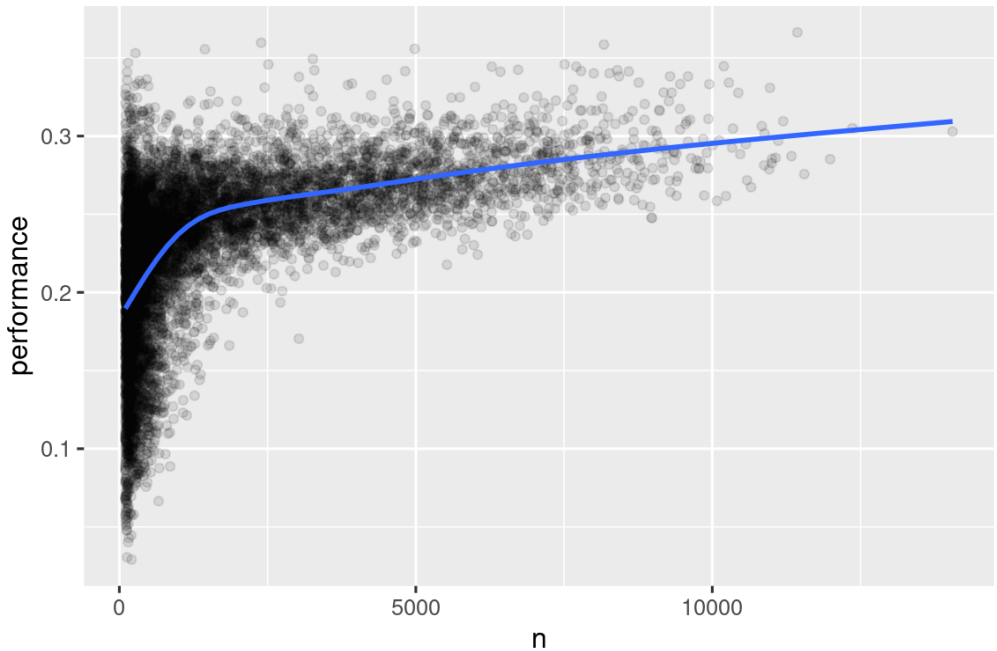
```
daily <- flights |>
  group_by(year, month, day)
daily
#> # A tibble: 336,776 × 19
#> # Groups:   year, month, day [365]
#>    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_tim
#>   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int
#> 1  2013     1     1      517            515         2      830            81
#> 2  2013     1     1      533            529         4      850            83
#> 3  2013     1     1      542            540         2      923            85
#> 4  2013     1     1      544            545        -1     1004           102
#> 5  2013     1     1      554            600        -6      812            83
#> 6  2013     1     1      554            558        -4      740            72
```

Case study

```
batters <- Lahman::Batting |>
  group_by(playerID) |>
  summarize(
    performance = sum(H, na.rm = TRUE) / sum(AB, na.rm = TRUE),
    n = sum(AB, na.rm = TRUE)
  )
batters
#> # A tibble: 20,166 × 3
#>   playerID  performance     n
#>   <chr>           <dbl> <int>
#> 1 aardsda01       0         4
#> 2 aaronha01       0.305 12364
#> 3 aaronto01       0.229   944
#> 4 aasedo01        0         5
#> 5 abadan01        0.0952   21
#> 6 abadfe01        0.111     9
#> # i 20,160 more rows
```

Case study

```
batters |>
  filter(n > 100) |>
  ggplot(aes(x = n, y = performance)) +
  geom_point(alpha = 1 / 10) +
  geom_smooth(se = FALSE)
```



- The variation in performance is larger among players with fewer at-bats.
- There's a positive correlation between skill (performance) and opportunities to hit the ball (n) because teams want to give their best batters the most opportunities to hit the ball.

Finding the best batters

```
batters |>
  arrange(desc(performance))
#> # A tibble: 20,166 × 3
#>   playerID  performance     n
#>   <chr>           <dbl> <int>
#> 1 abramge01           1     1
#> 2 alberan01           1     1
#> 3 banisje01           1     1
#> 4 bartocl01           1     1
#> 5 bassdo01            1     1
#> 6 birasst01           1     2
```

- http://varianceexplained.org/r/empirical_bayes_baseball/
- https://www.evanmiller.org/how-not-to-sort-by-average-rating.html

pivot_longer()

```
billboard
#> # A tibble: 317 × 79
#>   artist       track                   date.entered   wk1   wk2   wk3   wk4   wk
#>   <chr>        <chr>                   <date>       <dbl> <dbl> <dbl> <dbl> <dbl
#> 1 2 Pac        Baby Don't Cry (Ke... 2000-02-26      87    82    72    77
#> 2 2Ge+her      The Hardest Part O... 2000-09-02      91    87    92    NA
#> 3 3 Doors Down Kryptonite            2000-04-08      81    70    68    67    6
#> 4 3 Doors Down Loser                 2000-10-21      76    76    72    69    6
#> 5 504 Boyz     Wobble Wobble         2000-04-15      57    34    25    17    1
#> 6 98^0         Give Me Just One N... 2000-08-19      51    39    34    26
#> # i 311 more rows
#> # i 71 more variables: wk6 <dbl>, wk7 <dbl>, wk8 <dbl>, wk9 <dbl>, ...
```

pivot_longer()

```
billboard |>
  pivot_longer(
    cols = starts_with("wk"),
    names_to = "week",
    values_to = "rank"
  )
#> # A tibble: 24,092 × 5
#>    artist track                   date.entered week   rank
#>    <chr>  <chr>                   <date>       <chr> <dbl>
#>  1 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk1      87
#>  2 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk2      82
#>  3 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk3      72
#>  4 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk4      77
#>  5 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk5      87
#>  6 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk6      94
#>  7 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk7      99
#>  8 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk8      NA
#>  9 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk9      NA
#> 10 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk10     NA
#> # i 24,082 more rows
```

pivot_longer()

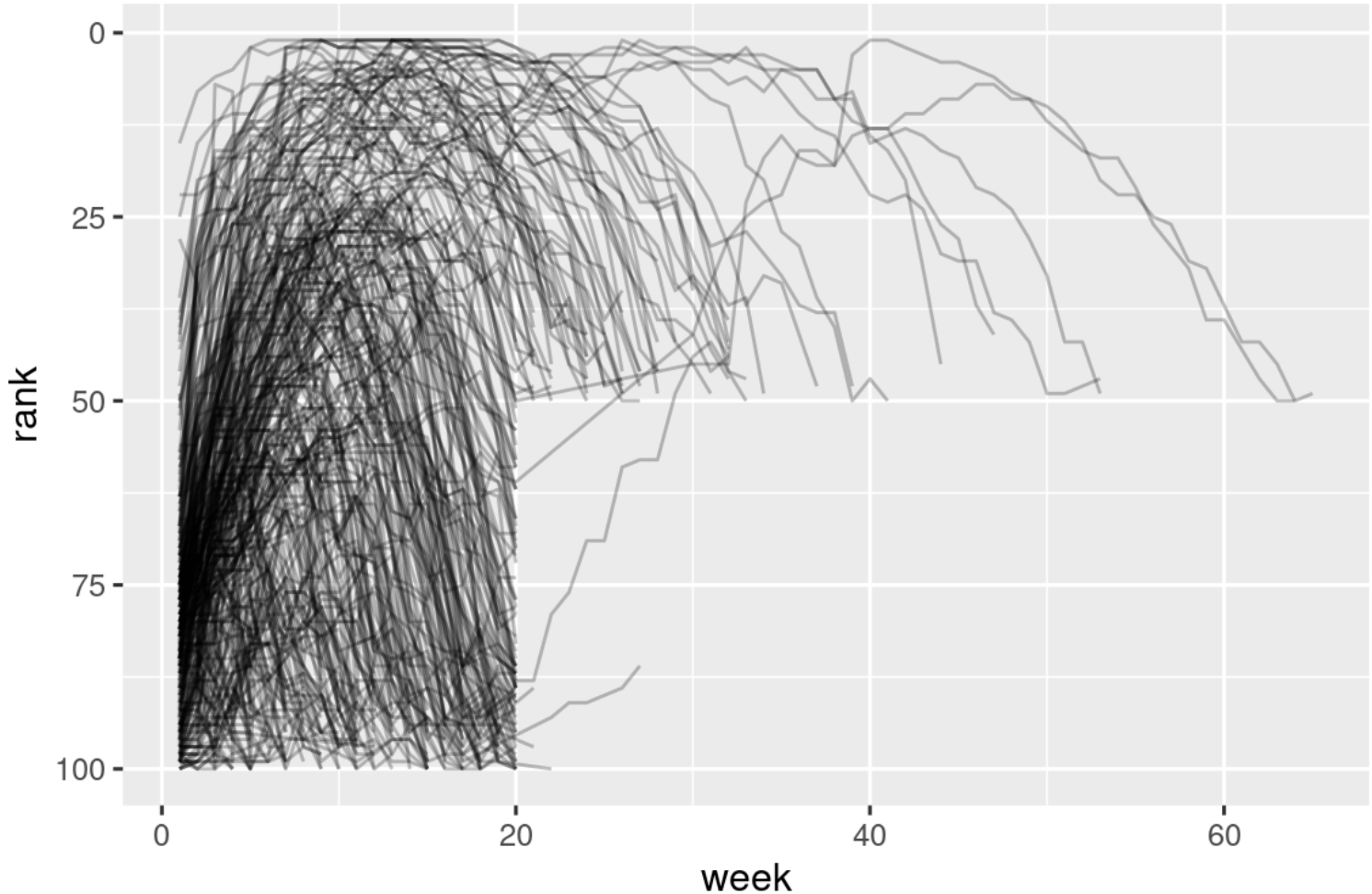
```
billboard |>
  pivot_longer(
    cols = starts_with("wk"),
    names_to = "week",
    values_to = "rank",
    values_drop_na = TRUE
  )
#> # A tibble: 5,307 × 5
#>   artist track                   date.entered week   rank
#>   <chr>  <chr>                   <date>       <chr> <dbl>
#> 1 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk1      87
#> 2 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk2      82
#> 3 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk3      72
#> 4 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk4      77
#> 5 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk5      87
#> 6 2 Pac  Baby Don't Cry (Keep... 2000-02-26   wk6      94
#> # i 5,301 more rows
```

pivot_longer()

```
billboard_longer <- billboard |>
  pivot_longer(
    cols = starts_with("wk"),
    names_to = "week",
    values_to = "rank",
    values_drop_na = TRUE
  ) |>
  mutate(
    week = parse_number(week)
  )
billboard_longer
#> # A tibble: 5,307 × 5
#>   artist track                   date.entered  week  rank
#>   <chr>  <chr>                   <date>       <dbl> <dbl>
#> 1 2 Pac  Baby Don't Cry (Keep... 2000-02-26       1    87
#> 2 2 Pac  Baby Don't Cry (Keep... 2000-02-26       2    82
#> 3 2 Pac  Baby Don't Cry (Keep... 2000-02-26       3    72
#> 4 2 Pac  Baby Don't Cry (Keep... 2000-02-26       4    77
#> 5 2 Pac  Baby Don't Cry (Keep... 2000-02-26       5    87
#> 6 2 Pac  Baby Don't Cry (Keep... 2000-02-26       6    94
#> # i 5,301 more rows
```

pivot_longer()

```
billboard_longer |>
  ggplot(aes(x = week, y = rank, group = track)) +
  geom_line(alpha = 0.25) +
  scale_y_reverse()
```



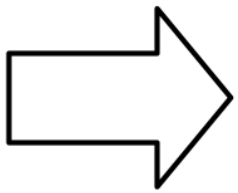
pivot_longer()

```
df <- tribble(
  ~id,  ~bp1, ~bp2,
   "A",  100,  120,
   "B",  140,  115,
   "C",  120,  125
)
df |>
  pivot_longer(
    cols = bp1:bp2,
    names_to = "measurement",
    values_to = "value"
  )
#> # A tibble: 6 × 3
#>   id    measurement value
#>   <chr> <chr>       <dbl>
#> 1 A     bp1           100
#> 2 A     bp2           120
#> 3 B     bp1           140
#> 4 B     bp2           115
#> 5 C     bp1           120
#> 6 C     bp2           125
```

pivot_longer()

```
df |>
  pivot_longer(
    cols = bp1:bp2,
    names_to = "measurement",
    values_to = "value"
  )
```

id	bp1	bp2
A	100	120
B	140	115
C	120	125

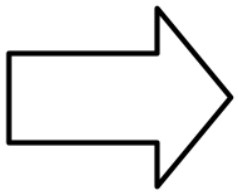


id	name	value
A	bp1	100
A	bp2	120
B	bp1	140
B	bp2	115
C	bp1	120
C	bp2	125

pivot_longer()

```
df |>
  pivot_longer(
    cols = bp1:bp2,
    names_to = "measurement",
    values_to = "value"
  )
```

id	bp1	bp2
A	100	120
B	140	115
C	120	125

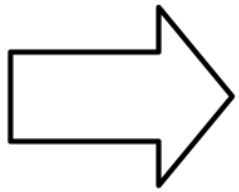


id	name	value
A	bp1	100
A	bp2	120
B	bp1	140
B	bp2	115
C	bp1	120
C	bp2	125

pivot_longer()

```
df |>
  pivot_longer(
    cols = bp1:bp2,
    names_to = "measurement",
    values_to = "value"
  )
```

id	bp1	bp2
A	100	120
B	140	115
C	120	125



id	name	value
A	bp1	100
A	bp2	120
B	bp1	140
B	bp2	115
C	bp1	120
C	bp2	125

Many variables in column names

```
who2
#> # A tibble: 7,240 × 58
#>   country      year sp_m_014 sp_m_1524 sp_m_2534 sp_m_3544 sp_m_4554
#>   <chr>       <dbl>    <dbl>     <dbl>     <dbl>     <dbl>     <dbl>
#> 1 Afghanistan  1980       NA        NA        NA        NA        NA
#> 2 Afghanistan  1981       NA        NA        NA        NA        NA
#> 3 Afghanistan  1982       NA        NA        NA        NA        NA
#> 4 Afghanistan  1983       NA        NA        NA        NA        NA
#> 5 Afghanistan  1984       NA        NA        NA        NA        NA
#> 6 Afghanistan  1985       NA        NA        NA        NA        NA
#> # i 7,234 more rows
#> # i 51 more variables: sp_m_5564 <dbl>, sp_m_65 <dbl>, sp_f_014 <dbl>, ...
```

Tuberculosis diagnoses

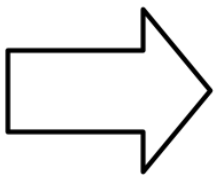
- `sp/rel/ep` describes the method used for the diagnosis
- `m/f` is the gender (coded as a binary variable in this dataset)
- `014/1524/2534/3544/4554/5564/65` is the age range (014 represents 0-14, for example)

names_to names_sep values_to

```
who2 |>
  pivot_longer(
    cols = !(country:year),
    names_to = c("diagnosis", "gender", "age"),
    names_sep = "_",
    values_to = "count"
  )
#> # A tibble: 405,440 × 6
#>   country      year diagnosis gender age   count
#>   <chr>       <dbl> <chr>     <chr>  <chr> <dbl>
#> 1 Afghanistan  1980 sp        m      014      NA
#> 2 Afghanistan  1980 sp        m      1524     NA
#> 3 Afghanistan  1980 sp        m      2534     NA
#> 4 Afghanistan  1980 sp        m      3544     NA
#> 5 Afghanistan  1980 sp        m      4554     NA
#> 6 Afghanistan  1980 sp        m      5564     NA
#> # i 405,434 more rows
```

Data in column names

id	x_1	y_2
A	1	2
B	3	4
C	5	6



id	name	number	value
A	x	1	1
A	y	2	2
B	x	1	3
B	y	2	4
C	x	1	5
C	y	2	6

Data and variable names in column header

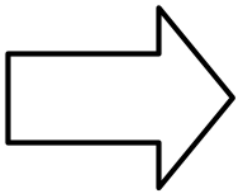
```
household
#> # A tibble: 5 × 5
#>   family dob_child1 dob_child2 name_child1 name_child2
#>    <int> <date>     <date>     <chr>       <chr>
#> 1      1 1998-11-26 2000-01-29 Susan       Jose
#> 2      2 1996-06-22 NA         Mark        <NA>
#> 3      3 2002-07-11 2004-04-05 Sam         Seth
#> 4      4 2004-10-10 2009-08-27 Craig       Khai
#> 5      5 2000-12-05 2005-02-28 Parker      Gracie
```

.value

```
household |>
  pivot_longer(
    cols = !family,
    names_to = c(".value", "child"),
    names_sep = "_",
    values_drop_na = TRUE
  )
#> # A tibble: 9 × 4
#>   family child  dob        name
#>    <int> <chr>  <date>     <chr>
#> 1      1 child1 1998-11-26 Susan
#> 2      1 child2 2000-01-29 Jose
#> 3      2 child1 1996-06-22 Mark
#> 4      3 child1 2002-07-11 Sam
#> 5      3 child2 2004-04-05 Seth
#> 6      4 child1 2004-10-10 Craig
#> # i 3 more rows
```

Data and variable names in header

id	x_1	x_2	y_1	y_2
A	1	2	3	4
B	5	6	7	8



id	x	y	num
A	1	3	1
A	2	4	2
B	5	7	1
B	6	8	2

Widening data

```
cms_patient_experience
#> # A tibble: 500 × 5
#>   org_pac_id org_nm                      measure_cd   measure_title   prf_rat
#>   <chr>      <chr>                       <chr>        <chr>              <dbl
#> 1 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_1  CAHPS for MIPS...
#> 2 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_2  CAHPS for MIPS...
#> 3 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_3  CAHPS for MIPS...
#> 4 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_5  CAHPS for MIPS...
#> 5 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_8  CAHPS for MIPS...
#> 6 0446157747 USC CARE MEDICAL GROUP INC CAHPS_GRP_12 CAHPS for MIPS...
#> # i 494 more rows
```

- Each organization is spread over six rows.

Widening data

```
cms_patient_experience |>
  distinct(measure_cd, measure_title)
#> # A tibble: 6 × 2
#>   measure_cd   measure_title
#>   <chr>        <chr>
#> 1 CAHPS_GRP_1  CAHPS for MIPS SSM: Getting Timely Care, Appointments, and In
#> 2 CAHPS_GRP_2  CAHPS for MIPS SSM: How Well Providers Communicate
#> 3 CAHPS_GRP_3  CAHPS for MIPS SSM: Patient's Rating of Provider
#> 4 CAHPS_GRP_5  CAHPS for MIPS SSM: Health Promotion and Education
#> 5 CAHPS_GRP_8  CAHPS for MIPS SSM: Courteous and Helpful Office Staff
#> 6 CAHPS_GRP_12 CAHPS for MIPS SSM: Stewardship of Patient Resources
```

- There are only six unique cd/title combinations

Widening data

```
cms_patient_experience |>
  pivot_wider(
    names_from = measure_cd,
    values_from = prf_rate
  )
#> # A tibble: 500 × 9
#>   org_pac_id org_nm                    measure_title   CAHPS_GRP_1 CAHPS_GRP_
#>   <chr>      <chr>                     <chr>                 <dbl>       <dbl
#> 1 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          63
#> 2 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          NA
#> 3 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          NA
#> 4 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          NA
#> 5 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          NA
#> 6 0446157747 USC CARE MEDICAL GROUP ... CAHPS for MIPS...          NA
#> # i 494 more rows
#> # i 4 more variables: CAHPS_GRP_3 <dbl>, CAHPS_GRP_5 <dbl>, ...
```

- We still have multiple rows for each organization.
- We need to say which columns have values that uniquely identify each row.

Widening data

```
cms_patient_experience |>
  pivot_wider(
    id_cols = starts_with("org"),
    names_from = measure_cd,
    values_from = prf_rate
  )
#> # A tibble: 95 × 8
#>   org_pac_id org_nm           CAHPS_GRP_1 CAHPS_GRP_2 CAHPS_GRP_3 CAHPS_GRP_
#>   <chr>      <chr>                  <dbl>       <dbl>       <dbl>       <dbl
#> 1 0446157747 USC CARE MEDICA...        63          87          86
#> 2 0446162697 ASSOCIATION OF ...        59          85          83
#> 3 0547164295 BEAVER MEDICAL ...        49          NA          75
#> 4 0749333730 CAPE PHYSICIANS...        67          84          85
#> 5 0840104360 ALLIANCE PHYSIC...        66          87          87
#> 6 0840109864 REX HOSPITAL INC          73          87          84          6
#> # i 89 more rows
#> # i 2 more variables: CAHPS_GRP_8 <dbl>, CAHPS_GRP_12 <dbl>
```

pivot_wider

```
df <- tribble(
  ~id, ~measurement, ~value,
  "A",         "bp1",    100,
  "B",         "bp1",    140,
  "B",         "bp2",    115,
  "A",         "bp2",    120,
  "A",         "bp3",    105
)

df |>
  pivot_wider(
    names_from = measurement,
    values_from = value
  )
#> # A tibble: 2 × 4
#>   id      bp1   bp2   bp3
#>   <chr> <dbl> <dbl> <dbl>
#> 1 A       100   120   105
#> 2 B       140   115    NA
```

pivot_wider with duplicate rows

```
df <- tribble(
  ~id, ~measurement, ~value,
  "A",        "bp1",    100,
  "A",        "bp1",    102,
  "A",        "bp2",    120,
  "B",        "bp1",    140,
  "B",        "bp2",    115
)

df |>
  pivot_wider(
    names_from = measurement,
    values_from = value
  )
#> Warning: Values from ‘value‘ are not uniquely identified; output will contai
#> list-cols.
....
```