Lecture 14: Reshaping data

So far

- `select`: choose certain columns
- `filter`: choose certain rows
- `summarize`: calculate summary statistics
- `group_by`: group rows together
- `mutate`: create new columns
- `count`: count the number of rows
- `arrange`: re-order the rows

Do dogs help exam stress?

- Data collected on 284 students at a mid-size Canadian university
- Students randomly assigned to one of three treatment groups: handler-only contact, indirect contact, and direct contact
- Well-being and ill-being measures recorded before and after treatment for each student
- Approach: compare pre/post measures of well-being and ill-being

Recording well-being and ill-being measures

- Likert items for each well-being / ill-being measure
- Average the likert items to get a score for each measure
- E.g.:
  - Positive affect score is the average of 5 Likert items
  - Social connectedness is the average of 20 Likert items

Example Likert item for social connectedness

“I am able to relate to my peers.”

- Strongly disagree (1)
- Disagree
- Somewhat disagree
- Somewhat agree
- Agree
- Strongly agree (6)

The data

want: lm(Score ~ GroupAssignment + Stage)
↑ pre or post

```
1  sc_data <- cleaned_data |>
2    select(RID, GroupAssignment, sc_pre, sc_post)
3
4  sc_data
```

	RID	GroupAssignment	sc_pre	sc_post
1	1	Control	3.900000	3.800000
2	2	Direct	5.150000	5.263158
3	3	Indirect	4.100000	4.150000
4	4	Control	4.650000	5.100000
5	5	Direct	3.650000	3.600000
6	6	Indirect	4.350000	4.650000
7	7	Control	4.750000	4.400000
8	8	Direct	4.600000	4.650000
9	9	Indirect	4.200000	4.150000
10	10	Control	5.800000	5.750000
11	11	Direct	4.400000	4.800000
12	12	Indirect	4.100000	4.250000
13	13	Control	5.400000	5.600000

lm(sc_pre ~ GroupAssignment)
↑ only looking at pre-test scores

lm(sc_post ~ GroupAssignment)
↑ only looking at post-test scores

Question: What if we want to fit a model with this data?

$$\text{Social Connectedness}_i = \beta_0 + \beta_1 \text{Direct}_i + \beta_2 \text{Indirect}_i + \beta_3 \text{Post}_i + \varepsilon_i$$

↑ =1 if direct, =0 otherwise

↑ =1 post-test, =0 pre-test score

Fitting a model

Want code that looks like this:

```
1  lm(score ~ GroupAssignment + stage, data = sc_data)
```

Problem: We don't have a column for stage! Or a column for score!

want:

ID	GroupAssignment	Stage	Sc score
1	Control	Pre	3.9
1	Control	Post	3.8
⋮			

pivot_longer

```
1 sc_data |>
2   pivot_longer(cols = c(sc_pre, sc_post),
3                names_to = "stage",
4                values_to = "score")
```

columns that we want to pivot

names

make a new column to store the old column names

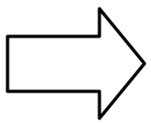
takes the values (i.e., the SC values) from the old columns and stores them in a new column (called "score")

```
# A tibble: 568 × 4
     RID GroupAssignment stage   score
   <int> <chr>           <chr>   <dbl>
 1     1 Control         sc_pre   3.9
 2     1 Control         sc_post  3.8
 3     2 Direct          sc_pre   5.15
 4     2 Direct          sc_post  5.26
 5     3 Indirect        sc_pre   4.1
 6     3 Indirect        sc_post  4.15
 7     4 Control         sc_pre   4.65
 8     4 Control         sc_post  5.1
 9     5 Direct          sc_pre   3.65
10     5 Direct          sc_post  3.6
# ℹ 558 more rows
```

pivot_longer

df

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



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

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

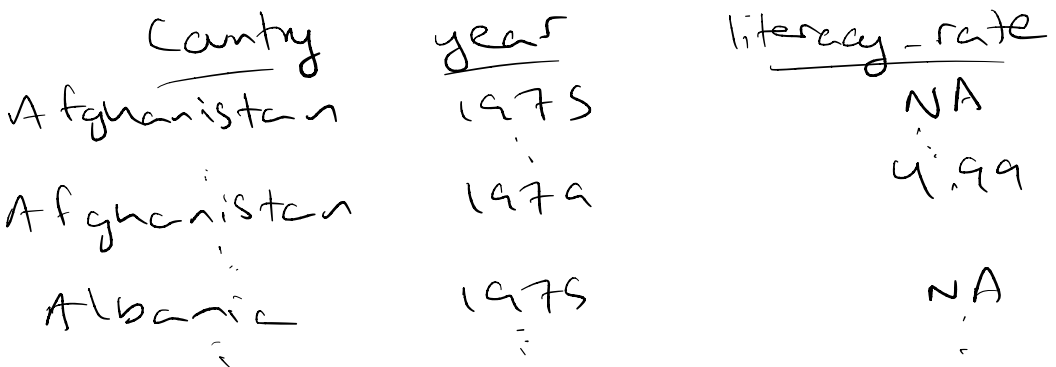
(Image from *R for Data Science*)

pivot_longer

Another example:

```
# A tibble: 260 × 38
   Adult (15+) literacy rate …¹ `1975` `1976` `1977` `1978` `1979` `1980` `1981`
   <chr>                          <dbl>  <dbl>  <dbl>  <dbl>  <dbl> <dbl>  <dbl>
 1 Afghanistan                       NA     NA     NA     NA   4.99    NA     NA
 2 Albania                           NA     NA     NA     NA   NA      NA     NA
 3 Algeria                           NA     NA     NA     NA   NA      NA     NA
 4 Andorra                           NA     NA     NA     NA   NA      NA     NA
 5 Angola                            NA     NA     NA     NA   NA      NA     NA
```

How might we want to restructure this data?



pivot_longer

```
# A tibble: 260 × 38
   Adult (15+) literacy rate …¹ `1975` `1976` `1977` `1978` `1979`
`1980` `1981`
   <chr>                          <dbl>  <dbl>  <dbl>  <dbl>  <dbl>
<dbl>  <dbl>
 1 Afghanistan                       NA     NA     NA     NA   4.99    NA
NA
 2 Albania                           NA     NA     NA     NA   NA      NA
NA
 3 Algeria                           NA     NA     NA     NA   NA      NA
NA
 4 Andorra                           NA     NA     NA     NA   NA      NA
NA
 5 Angola                            NA     NA     NA     NA   NA      NA
```

year

```
litF |>
  rename(country = starts_with("Adult")) |>
  pivot_longer(
    cols = -country,
    names_to = ...,
    values_to = ...
  )
```

← pivot all columns except country

← "year"

← "literacy_rate"

pivot_longer

```
litF |>
  rename(country = starts_with("Adult")) |>
  pivot_longer(
    cols = -country,
    names_to = "year",
    values_to = "literacy_rate"
  ) |>
  drop_na(literacy_rate)
```

```
# A tibble: 571 × 3
   country     year  literacy_rate
   <chr>       <chr>         <dbl>
 1 Afghanistan 1979           4.99
 2 Afghanistan 2011          13
 3 Albania     2001          98.3
 4 Albania     2008          94.7
 5 Albania     2011          95.7
 6 Algeria     1987          35.8
 7 Algeria     2002          60.1
 8 Algeria     2006          63.9
 9 Angola      2001          54.2
10 Angola      2011          58.6
# ℹ 561 more rows
```

pivot_longer

```
litF |>
  rename(country = starts_with("Adult")) |>
  pivot_longer(
    cols = -country,
    names_to = "year",
    values_to = "literacy_rate",
    values_drop_na = T
  )
```

```
# A tibble: 571 × 3
   country     year  literacy_rate
   <chr>       <chr>         <dbl>
 1 Afghanistan 1979           4.99
 2 Afghanistan 2011          13
 3 Albania     2001          98.3
 4 Albania     2008          94.7
 5 Albania     2011          95.7
 6 Algeria     1987          35.8
 7 Algeria     2002          60.1
 8 Algeria     2006          63.9
 9 Angola      2001          54.2
10 Angola      2011          58.6
# ℹ 561 more rows
```

Back to the dog data

```
sc_data |>
  pivot_longer(cols = c(sc_pre, sc_post),
               names_to = "stage",
               values_to = "score")
```

```
# A tibble: 568 × 4
     RID GroupAssignment stage   score
   <int> <chr>           <chr>   <dbl>
 1     1 Control         sc_pre   3.9
 2     1 Control         sc_post  3.8
 3     2 Direct          sc_pre   5.15
 4     2 Direct          sc_post  5.26
 5     3 Indirect        sc_pre   4.1
 6     3 Indirect        sc_post  4.15
 7     4 Control         sc_pre   4.65
 8     4 Control         sc_post  5.1
 9     5 Direct          sc_pre   3.65
10     5 Direct          sc_post  3.6
# ℹ 558 more rows
```

Does the `stage` column only contain information about stage?

Back to the dog data

```
1  sc_data |>
2    pivot_longer(cols = c(sc_pre, sc_post),
3                 names_to = c("measurement", "stage"),
4                 names_sep = "_",
5                 values_to = "score")
```

sc pre sc post

← Separate names of original columns (by _)

```
# A tibble: 568 × 5
     RID GroupAssignment measurement stage score
   <int> <chr>           <chr>       <chr> <dbl>
 1     1 Control         sc          pre    3.9
 2     1 Control         sc          post   3.8
 3     2 Direct          sc          pre    5.15
 4     2 Direct          sc          post   5.26
 5     3 Indirect        sc          pre    4.1
 6     3 Indirect        sc          post   4.15
 7     4 Control         sc          pre    4.65
 8     4 Control         sc          post   5.1
 9     5 Direct          sc          pre    3.65
10     5 Direct          sc          post   3.6
# ℹ 558 more rows
```

Working with all the measurements

```r
cleaned_data |>
  pivot_longer(cols = -c(RID, GroupAssignment),
               names_to = c("measurement", "stage"),
               names_sep = "_",
               values_to = "score")
```

```
# A tibble: 4,544 × 5
     RID GroupAssignment measurement stage score
   <int> <chr>           <chr>       <chr> <dbl>
 1     1 Control         pa          pre    3.2
 2     1 Control         pa          post   3.8
 3     1 Control         happiness   pre    2.33
 4     1 Control         happiness   post   3.33
 5     1 Control         sc          pre    3.9
 6     1 Control         sc          post   3.8
 7     1 Control         fs          pre    6.12
 8     1 Control         fs          post   6
 9     1 Control         stress      pre    2
10     1 Control         stress      post   2
# ℹ 4,534 more rows
```

Fitting a model

```r
long_data <- cleaned_data |>
  pivot_longer(cols = -c(RID, GroupAssignment),
               names_to = c("measurement", "stage"),
               names_sep = "_",
               values_to = "score")

lm(score ~ GroupAssignment + stage, data = long_data)
```

```
Call:
lm(formula = score ~ GroupAssignment + stage, data = long_data)

Coefficients:
            (Intercept)    GroupAssignmentDirect
GroupAssignmentIndirect
                3.16307                 -0.10118
-0.04836
              stagepre
                0.13805
```

Lengthing data in Python

```python
import pandas as pd

df1 = pd.DataFrame({
  'id' : ['A', 'B', 'C'],
  'bp1' : [100, 140, 120],
  'bp2' : [120, 115, 125]
})

df1
```

```
  id  bp1  bp2
0  A  100  120
1  B  140  115
2  C  120  125
```

variables that we don't want to change

name of column in the new dataset that has old column names (equiv. to names_to in R)

```python
df1.melt(id_vars = 'id', var_name = 'measurement',
         value_name = 'value')
```

(equiv. to values_to in R)

```
  id measurement  value
0  A         bp1    100
1  B         bp1    140
2  C         bp1    120
3  A         bp2    120
4  B         bp2    115
5  C         bp2    125
```

Reshaping data in R

```r
litF |>
  rename(country = starts_with("Adult")) |>
  pivot_longer(
    cols = -country,
    names_to = "year",
    values_to = "literacy_rate"
  ) |>
  drop_na(literacy_rate)
```

```
# A tibble: 571 × 3
   country     year  literacy_rate
   <chr>       <chr>         <dbl>
 1 Afghanistan 1979           4.99
 2 Afghanistan 2011          13
 3 Albania     2001          98.3
 4 Albania     2008          94.7
 5 Albania     2011          95.7
 6 Algeria     1987          35.8
 7 Algeria     2002          60.1
 8 Algeria     2006          63.9
 9 Angola      2001          54.2
10 Angola      2011          58.6
# ℹ 561 more rows
```

```
.melt(id_vars = "country",
      var_name = "year",
      value_name = "literacy_rate")
```

What would the corresponding Python code look like?

Reshaping data in Python

```
litF = r.litF

# first, need to rename the first column
litF.rename(columns={litF.columns[0]: 'Country'})
```

```
                          Country  1975  1976  ...  2009  2010       2011
0                     Afghanistan   NaN   NaN  ...   NaN   NaN  13.00000
1                         Albania   NaN   NaN  ...   NaN   NaN  95.69148
2                         Algeria   NaN   NaN  ...   NaN   NaN       NaN
3                         Andorra   NaN   NaN  ...   NaN   NaN       NaN
4                          Angola   NaN   NaN  ...   NaN   NaN  58.60846
..                            ...   ...   ...  ...   ...   ...       ...
255          Virgin Islands (U.S.)   NaN   NaN  ...   NaN   NaN       NaN
256  Yemen Arab Republic (Former)   NaN   NaN  ...   NaN   NaN       NaN
257     Yemen Democratic (Former)   NaN   NaN  ...   NaN   NaN       NaN
258                     Yugoslavia   NaN   NaN  ...   NaN   NaN       NaN
259                          Åland   NaN   NaN  ...   NaN   NaN       NaN

[260 rows x 38 columns]
```

Reshaping data in Python

```
litF = r.litF

# rename the first column
# then melt to make the data longer
(litF.rename(columns={litF.columns[0]: 'Country'})
     .melt(id_vars = 'Country',
           var_name = 'year',
           value_name = 'literacy_rate'))
```

```
                          Country  year  literacy_rate
0                     Afghanistan  1975            NaN
1                         Albania  1975            NaN
2                         Algeria  1975            NaN
3                         Andorra  1975            NaN
4                          Angola  1975            NaN
...                           ...   ...            ...
9615         Virgin Islands (U.S.)  2011            NaN
9616  Yemen Arab Republic (Former)  2011            NaN
9617     Yemen Democratic (Former)  2011            NaN
9618                     Yugoslavia  2011            NaN
9619                          Åland  2011            NaN

[9620 rows x 3 columns]
```

Reshaping data in Python

```
litF = r.litF

# rename the first column
# then melt to make the data longer
(litF.rename(columns={litF.columns[0]: 'Country'})
     .melt(id_vars = 'Country',
           var_name = 'year',
           value_name = 'literacy_rate')
     .dropna())
```

```
                  Country  year  literacy_rate
30             Burkina Faso  1975       3.182766
37    Central African Rep.  1975       8.399576
99                  Kuwait  1975      48.015214
191                 Turkey  1975      45.098921
197   United Arab Emirates  1975      38.124870
...                    ...   ...            ...
9562                Vanuatu  2011      81.553540
9564    West Bank and Gaza  2011      92.616180
9565                Vietnam  2011      91.383460
9566           Yemen, Rep.  2011      48.539050
9568              Zimbabwe  2011      80.065659

[571 rows x 3 columns]
```

Reshaping data in Python

```
litF = r.litF

# rename the first column
# then melt to make the data longer
(litF.rename(columns={litF.columns[0]: 'Country'})
     .melt(id_vars = 'Country',
           var_name = 'year',
           value_name = 'literacy_rate')
     .dropna()
     .sort_values(by = ['Country', 'year']))
```

```
          Country  year  literacy_rate
1040  Afghanistan  1979       4.987460
9360  Afghanistan  2011      13.000000
6761      Albania  2001      98.252274
8581      Albania  2008      94.681814
9361      Albania  2011      95.691480
...           ...   ...            ...
7227       Zambia  2002      61.839278
8527       Zambia  2007      51.786967
2028     Zimbabwe  1982      71.853928
4628     Zimbabwe  1992      78.517018
9568     Zimbabwe  2011      80.065659

[571 rows x 3 columns]
```

Class activity

https://sta279-s24.github.io/class_activities/ca_lecture_14.html