# Assignment 4 - Tidy Data and Table Joins

*Lulu Pei*

*03/10/2019*

In this assignment, we will be exploring methods of data tidying and reshaping, as well as table joining. We will be performing these manipulations using `dplyr` and `tidyr` functions, so we need to first load their parent package, `tidyverse`. For the first two exercises, we will be using the `gapminder` dataset, so we must also load the `gapminder` package to access this data.

```
library(gapminder)
library(tidyverse)
```

With all of our tools loaded, let's get started with the exercises!

## Exercise 1: Univariate Data Reshaping

### *Data Re-shaping*

From our `gapminder` dataset, suppose we want to compare the life expectancy between two countries by year. Let's pick Canada and Cambodia as our two countries. We will need to perform some re-shaping of the `gapminder` dataset to obtain two separate columns for the life expectancy of Canada and the life expectancy of Cambodia.

```
uni_wide <- gapminder %>%
  filter(country == "Canada" | country == "Cambodia") %>%
  select(year, country, lifeExp) %>%
  pivot_wider(id_cols = year,
              names_from = country,
              values_from = lifeExp) %>%
  arrange(year)

uni_wide %>%
  select(year, "Cambodia_lifeExp" = Cambodia, "Canada_lifeExp" = Canada)
```

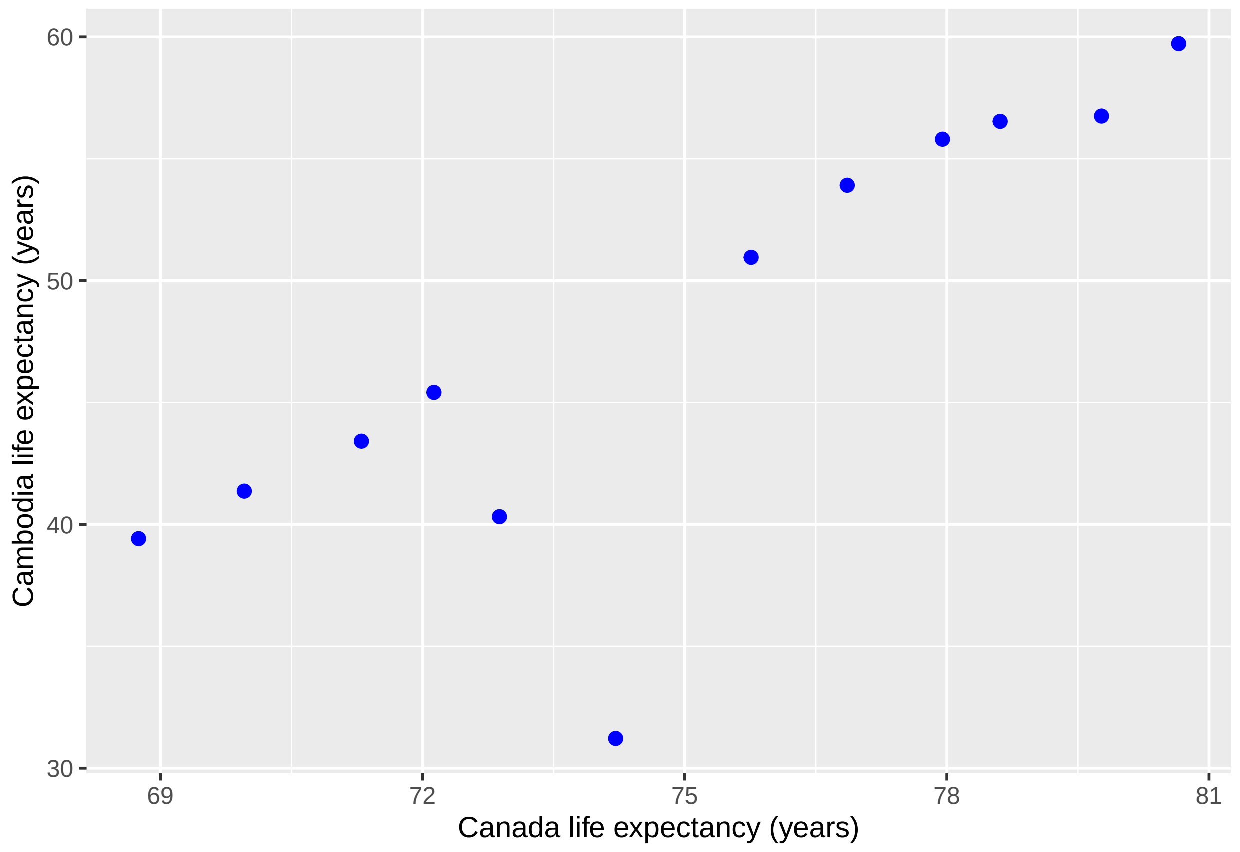
```
# A tibble: 12 x 3
    year Cambodia_lifeExp Canada_lifeExp
   <int>            <dbl>          <dbl>
 1  1952             39.4           68.8
 2  1957             41.4           70.0
 3  1962             43.4           71.3
 4  1967             45.4           72.1
 5  1972             40.3           72.9
 6  1977             31.2           74.2
 7  1982             51.0           75.8
 8  1987             53.9           76.9
 9  1992             55.8           78.0
10  1997             56.5           78.6
11  2002             56.8           79.8
12  2007             59.7           80.7
```

The output tibble above provides the life expectancy of Cambodia and the life expectancy of Canada in individual rows representing each time point between 1952 and 2007 in the `gapminder` dataset.

### *Plotting*

To better visualize the relationship between life expectancy of Cambodia and life expectancy of Canada, let's create a scatterplot.

```
uni_wide %>%
  ggplot(aes(x = Canada, y = Cambodia)) +
  geom_point(colour = "blue", size = 2) +
  ylab("Cambodia life expectancy (years)") +
  xlab("Canada life expectancy (years)")
```



In the plot above, each point represents an observation from a time point between 1952 and 2007, ordered chronologically from left to right. We observe an overall positive relationship between life expectancy in Cambodia and life expectancy in Canada, suggesting that between 1952 and 2007, both Cambodia and Canada have experienced increases in life expectancy. However, we cannot ignore the significant drop in life expectancy experienced by Cambodia between 1967 and 1977. Between these two years, Canada continued to experience a consistent increase in life expectancy, whereas Cambodia experienced a drop in life expectancy of almost 15 years. This extreme decline can be attributed to the Khmer Rouge genocide that occurred in Cambodia during that time, which resulted in the deaths of nearly a quarter of Cambodia's population.

### *Data Re-lengthening*

Now that we've performed our desired analysis on the widened subset of the `gapminder` dataset, let's re-lengthen it back to its original form.

```r
uni_wide %>%
  pivot_longer(cols = (-year),
               names_to = "country",
               values_to = "lifeExp") %>%
  arrange(country)
```

```
# A tibble: 24 x 3
    year country  lifeExp
   <int> <chr>      <dbl>
 1  1952 Cambodia    39.4
 2  1957 Cambodia    41.4
 3  1962 Cambodia    43.4
 4  1967 Cambodia    45.4
 5  1972 Cambodia    40.3
 6  1977 Cambodia    31.2
 7  1982 Cambodia    51.0
 8  1987 Cambodia    53.9
 9  1992 Cambodia    55.8
10  1997 Cambodia    56.5
# ... with 14 more rows
```

The outputted tibble is in a longer format, with Cambodia and Canada columns collapsed back into a single `country` column, with values going to the `lifeExp` column.

## Exercise 2: Multivariate Data Reshaping

### *Data Re-shaping*

Let's take a look at a multivariate case for data re-shaping. Suppose that we are interested in investigating the life expectancy and GDP per capita for two countries: Australia and Sweden. We must widen the original `gapminder` dataset to contain separate columns for life expectancy and GDP per capita values for Australia and Sweden, for each time point between 1952 and 2007.

```r
multi_wide <- gapminder %>%
  filter(country == "Australia" | country == "Sweden") %>%
  select(country, year, lifeExp, gdpPercap) %>%
  pivot_wider(id_cols = year,
              names_from = country,
              values_from = c(lifeExp, gdpPercap)) %>%
  arrange(year)

multi_wide %>%
  select(year, "Australia_lifeExp" = lifeExp_Australia, "Sweden_lifeExp" = lifeExp_Sweden,
         "Australia_gdp" = gdpPercap_Australia, "Sweden_gdp" = gdpPercap_Sweden)
```

```
# A tibble: 12 x 5
    year Australia_lifeExp Sweden_lifeExp Australia_gdp Sweden_gdp
   <int>             <dbl>          <dbl>         <dbl>      <dbl>
 1  1952              69.1           71.9        10040.      8528.
 2  1957              70.3           72.5        10950.      9912.
 3  1962              70.9           73.4        12217.     12329.
 4  1967              71.1           74.2        14526.     15258.
 5  1972              71.9           74.7        16789.     17832.
 6  1977                 73.5           75.4        18334.     18856.
 7  1982                 74.7           76.4        19477.     20667.
 8  1987                 76.3           77.2        21889.     23587.
 9  1992                 77.6           78.2        23425.     23880.
10  1997                 78.8           79.4        26998.     25267.
11  2002                 80.4           80.0        30688.     29342.
12  2007                 81.2           80.9        34435.     33860.
```

The tibble above displays a summary of a subset of the `gapminder` dataset, combining two observations from the original dataset into a single row (characterized by year). We can easily identify the life expectancy and GDP per capita for Australia and Sweden at any given time point between 1952 and 2007.

### *Data Re-lengthening*

Now, suppose we want to re-lengthen our widened data back to its original form.

```
multi_wide %>%
  pivot_longer(cols = (-year),
               names_to = c(".value", "country"),
               names_sep = "_") %>%
  arrange(country)
```

```
# A tibble: 24 x 4
    year country   lifeExp gdpPercap
   <int> <chr>       <dbl>     <dbl>
 1  1952 Australia    69.1    10040.
 2  1957 Australia    70.3    10950.
 3  1962 Australia    70.9    12217.
 4  1967 Australia    71.1    14526.
 5  1972 Australia    71.9    16789.
 6  1977 Australia    73.5    18334.
 7  1982 Australia    74.7    19477.
 8  1987 Australia    76.3    21889.
 9  1992 Australia    77.6    23425.
10  1997 Australia    78.8    26998.
# ... with 14 more rows
```

We see that re-lengthening our data collapses country names back into the `country` factor column, and a single observation per year becomes two separate observations for each country.

## Exercise 3: Table Joins

In this exercise, we will be using guestlist and email address tibbles found on Github. Let's first load these tibbles into our working environment - we will name the guestlist tibble `guest` and the email address tibble `email`.

```
(guest <-
   read_csv("https://raw.githubusercontent.com/STAT545-UBC/Classroom/master/data/wedding/attend.csv"))
```

```
# A tibble: 30 x 7
   party name  meal_wedding meal_brunch attendance_wedd~ attendance_brun~
   <dbl> <chr> <chr>        <chr>       <chr>            <chr>
 1     1 Somm~ PENDING      PENDING     PENDING          PENDING
 2     1 Phil~ vegetarian   Menu C      CONFIRMED        CONFIRMED
 3     1 Blan~ chicken      Menu A      CONFIRMED        CONFIRMED
 4     1 Emaa~ PENDING      PENDING     PENDING          PENDING
 5     2 Blai~ chicken      Menu C      CONFIRMED        CONFIRMED
 6     2 Nige~ <NA>         <NA>        CANCELLED        CANCELLED
 7     3 Sine~ PENDING      PENDING     PENDING          PENDING
 8     4 Ayra~ vegetarian   Menu B      PENDING          PENDING
 9     5 Atla~ PENDING      PENDING     PENDING          PENDING
10     5 Denz~ fish         Menu B      CONFIRMED        CONFIRMED
# ... with 20 more rows, and 1 more variable: attendance_golf <chr>
```

```
(email <-
    read_csv("https://raw.githubusercontent.com/STAT545-UBC/Classroom/master/data/wedding/emails.csv"))
```

```
# A tibble: 14 x 2
   guest                                                 email
   <chr>                                                 <chr>
 1 Sommer Medrano, Phillip Medrano, Blanka Medrano,~ sommm@gmail.com
 2 Blair Park, Nigel Webb                            bpark@gmail.com
 3 Sinead English                                    singlish@hotmail.ca
 4 Ayra Marks                                        marksa42@gmail.com
 5 Jolene Welsh, Hayley Booker                       jw1987@hotmail.com
 6 Amayah Sanford, Erika Foley                       erikaaaaaa@gmail.com
 7 Ciaron Acosta                                     shining_ciaron@gmail.~
 8 Diana Stuart                                      doodledianastu@gmail.~
 9 Daisy-May Caldwell, Martin Caldwell, Violet Cald~ caldwellfamily5212@gm~
10 Rosanna Bird, Kurtis Frost                        rosy1987b@gmail.com
11 Huma Stokes, Samuel Rutledge                      humastokes@gmail.com
12 Eddison Collier, Stewart Nicholls                 eddison.collier@gmail~
13 Turner Jones                                      tjjones12@hotmail.ca
14 Albert Marshall, Vivian Marshall                  themarshallfamily1234~
```

Note that in this exercise, we will be converting resulting tibbles into a nicer data frame format for ease of visualization and navigation of columns and observations. We will be using `knitr::kable` and `DT::datatable` for these manipulations.

## *3.1 - `left_join`*

Taking a look at the guestlist, we notice that it does not contain the contact email addresses for each guest. Let's fix this by adding an additional email address column. Prior to joining these two tibbles, we must slightly reshape the email address tibble. We can observe that a single contact email address corresponds to many guests, listed as a single observation with names separated by commas. We will need to separate these comma-separated lists into individual rows for each guest.

```
(email <- email %>%
  separate_rows(guest, sep = ", ") %>%
  rename("name" = guest))
```

```
# A tibble: 28 x 2
   name            email
   <chr>           <chr>
 1 Sommer Medrano  sommm@gmail.com
 2 Phillip Medrano sommm@gmail.com
 3 Blanka Medrano  sommm@gmail.com
 4 Emaan Medrano   sommm@gmail.com
 5 Blair Park      bpark@gmail.com
 6 Nigel Webb      bpark@gmail.com
 7 Sinead English  singlish@hotmail.ca
 8 Ayra Marks      marksa42@gmail.com
 9 Jolene Welsh    jw1987@hotmail.com
10 Hayley Booker   jw1987@hotmail.com
# ... with 18 more rows
```

Now that the email tibble is in a more tidy form, with each row corresponding to only one guest, let's add an email address column to the guestlist.

```r
guest %>%
  left_join(email, by = "name")
```

```
# A tibble: 30 x 8
   party name  meal_wedding meal_brunch attendance_wedd~ attendance_brun~
   <dbl> <chr> <chr>        <chr>       <chr>            <chr>
 1     1 Somm~ PENDING      PENDING     PENDING          PENDING
 2     1 Phil~ vegetarian   Menu C      CONFIRMED        CONFIRMED
 3     1 Blan~ chicken      Menu A      CONFIRMED        CONFIRMED
 4     1 Emaa~ PENDING      PENDING     PENDING          PENDING
 5     2 Blai~ chicken      Menu C      CONFIRMED        CONFIRMED
 6     2 Nige~ <NA>         <NA>        CANCELLED        CANCELLED
 7     3 Sine~ PENDING      PENDING     PENDING          PENDING
 8     4 Ayra~ vegetarian   Menu B      PENDING          PENDING
 9     5 Atla~ PENDING      PENDING     PENDING          PENDING
10     5 Denz~ fish         Menu B      CONFIRMED        CONFIRMED
# ... with 20 more rows, and 2 more variables: attendance_golf <chr>,
#   email <chr>
```

The output data frame is the original guestlist with the addition of an `email` column containing the contact email address for each guest.

## *3.2 - anti_join*

We notice that there is some discrepancy between the number of guests on the guestlist and the number of guests for which we have emails for in the email address tibble. Suppose we want to know who we have emails for but are not on the guestlist.

```r
email %>%
  anti_join(guest, by = "name")
```

```
# A tibble: 3 x 2
  name            email
  <chr>           <chr>
1 Turner Jones    tjjones12@hotmail.ca
2 Albert Marshall themarshallfamily1234@gmail.com
3 Vivian Marshall themarshallfamily1234@gmail.com
```

From this output, we see that three guests (Turner Jones, Albert Marshall, and Vivian Marshall) in the email list are not on the guestlist.

### *3.3 -full_join*

Now that we are aware of this discrepancy between the two tibbles, let's make a master list containing all guests who we have emails for, in addition to those on the guestlist.

```
guest %>%
  full_join(email, by = "name")
```

```
# A tibble: 33 x 8
   party name  meal_wedding meal_brunch attendance_wedd~ attendance_brun~
   <dbl> <chr> <chr>        <chr>       <chr>            <chr>
 1     1 Somm~ PENDING      PENDING     PENDING          PENDING
 2     1 Phil~ vegetarian   Menu C      CONFIRMED        CONFIRMED
 3     1 Blan~ chicken      Menu A      CONFIRMED        CONFIRMED
 4     1 Emaa~ PENDING      PENDING     PENDING          PENDING
 5     2 Blai~ chicken      Menu C      CONFIRMED        CONFIRMED
 6     2 Nige~ <NA>         <NA>        CANCELLED        CANCELLED
 7     3 Sine~ PENDING      PENDING     PENDING          PENDING
 8     4 Ayra~ vegetarian   Menu B      PENDING          PENDING
 9     5 Atla~ PENDING      PENDING     PENDING          PENDING
10     5 Denz~ fish         Menu B      CONFIRMED        CONFIRMED
# ... with 23 more rows, and 2 more variables: attendance_golf <chr>,
#   email <chr>
```

This data table is the concatenated form of the guestlist and email list, including the three guests who were not originally on the guestlist.