Manipulating Data in R

Introduction to R for Public Health Researchers

Reshaping Data

In this module, we will show you how to:

1. Reshaping data from wide (fat) to long (tall)
2. Reshaping data from long (tall) to wide (fat)
3. Merging Data
4. Perform operations by a grouping variable

Setup

We will show you how to do each operation in base R then show you how to use the `dplyr` or `tidyr` package to do the same operation (if applicable).

See the "Data Wrangling Cheat Sheet using `dplyr` and `tidyr`":

- `https://www.rstudio.com/wp-content/uploads/2015/02/data-wrangling-cheatsheet.pdf`

What is wide/long data?

See `http://www.cookbook-r.com/Manipulating_data/Converting_data_between_wide_and_long_format/`

- Wide - multiple columns per observation
  - e.g. visit1, visit2, visit3

```
  id visit1 visit2 visit3
1  1     10      4      3
2  2      5      6     NA
```

- Long - multiple rows per observation

```
  id visit value
1  1     1    10
2  1     2     4
3  1     3     3
4  2     1     5
5  2     2     6
```

What is wide/long data?

More accurately, data is wide or long **with respect** to certain variables.

Data used: Charm City Circulator

http://www.aejaffe.com/winterR_2017/data/Charm_City_Circulator_Ridership.csv

```
circ = read_csv(
  paste0("http://www.aejaffe.com/winterR_2017/",
         "data/Charm_City_Circulator_Ridership.csv")
)
head(circ, 2)
```

```
# A tibble: 2 × 15
      day       date orangeBoardings orangeAlightings orang
    <chr>      <chr>           <int>            <int>
1  Monday 01/11/2010             877             1027
2 Tuesday 01/12/2010             777              815
# ... with 10 more variables: purpleBoardings <int>,
#   purpleAlightings <int>, purpleAverage <dbl>, greenBoar
#   greenAlightings <int>, greenAverage <dbl>, bannerBoardi
#   bannerAlightings <int>, bannerAverage <dbl>, daily <dbl
```

Creating a Date class from a character date

```r
library(lubridate) # great for dates!
library(dplyr) # mutate/summarise functions
```

Creating a Date class from a character date

```r
sum(is.na(circ$date))
```

```
[1] 0
```

```r
sum( circ$date == "")
```

```
[1] 0
```

```r
circ = mutate(circ, date = mdy(date))
sum( is.na(circ$date) ) # all converted correctly
```

```
[1] 0
```

```r
head(circ$date, 3)
```

```
[1] "2010-01-11" "2010-01-12" "2010-01-13"
```

```r
class(circ$date)
```

Reshaping data from wide (fat) to long (tall): base R

The `reshape` command exists. It is a **confusing** function. Don't use it.

tidyr package

`tidyr` allows you to "tidy" your data. We will be talking about:

- `gather` - make multiple columns into variables, (wide to long)
- `spread` - make a variable into multiple columns, (long to wide)
- `separate` - string into multiple columns
- `unite` - multiple columns into one string

Reshaping data from wide (fat) to long (tall): tidyr

`tidyr::gather` - puts column data into rows.

We want the column names into "`var`" variable in the output dataset and the value in "`number`" variable. We then describe which columns we want to "gather:"

```r
library(tidyr)
long = gather(circ, key = "var", value = "number",
              starts_with("orange"), starts_with("purple")
              starts_with("green"), starts_with("banner"))
head(long, 4)
```

```
# A tibble: 4 × 5
        day       date  daily              var number
      <chr>     <date>  <dbl>            <chr>  <dbl>
1    Monday 2010-01-11  952.0 orangeBoardings    877
2   Tuesday 2010-01-12  796.0 orangeBoardings    777
3 Wednesday 2010-01-13 1211.5 orangeBoardings   1203
4  Thursday 2010-01-14 1213.5 orangeBoardings   1194
```

Reshaping data from wide (fat) to long (tall): tidyr

```r
table(long$var)
```

```
bannerAlightings     bannerAverage  bannerBoardings   greenAl
            1146              1146             1146
     greenAverage   greenBoardings orangeAlightings      orang
            1146              1146             1146
 orangeBoardings purpleAlightings    purpleAverage   purpleB
            1146              1146             1146
```

Making a separator

We will use `str_replace` from `stringr` to put periods in the names:

```
library(stringr)
long = long %>% mutate(
  var = var %>% str_replace("Board", ".Board") %>%
    str_replace("Alight", ".Alight") %>%
    str_replace("Average", ".Average")
)
table(long$var)
```

```
banner.Alightings    banner.Average  banner.Boardings  gree
             1146              1146              1146
    green.Average   green.Boardings orange.Alightings    or
             1146              1146              1146
 orange.Boardings purple.Alightings    purple.Average  purp
             1146              1146              1146
```

Reshaping data from wide (fat) to long (tall): tidyr

Now each var is boardings, averages, or alightings. We want to separate these so we can have these by line. Remember "." is special character:

```
long = separate(long, var, into = c("line", "type"),
                sep = "[.]")
head(long, 2)
```

```
# A tibble: 2 × 6
      day       date daily   line      type number
    <chr>     <date> <dbl>  <chr>     <chr>  <dbl>
1  Monday 2010-01-11   952 orange Boardings    877
2 Tuesday 2010-01-12   796 orange Boardings    777
```

```
unique(long$line)
```

```
[1] "orange" "purple" "green"  "banner"
```

```
unique(long$type)
```

Re-uniting all the lines

If we had the opposite problem, we could use the `unite` function:

```
reunited = long %>%
  unite(col = var, line, type, sep = ".")
reunited %>% select(day, var) %>% head(3) %>% print
```

```
# A tibble: 3 × 2
        day               var
      <chr>             <chr>
1    Monday orange.Boardings
2   Tuesday orange.Boardings
3 Wednesday orange.Boardings
```

We could also use `paste`/`paste0`.

Making column names a little more separated

Alternative: We could have replaced the column names first **then** reshaped:

```
cn = colnames(circ)
cn = cn %>%
  str_replace("Board", ".Board") %>%
  str_replace("Alight", ".Alight") %>%
  str_replace("Average", ".Average")
colnames(circ) = cn # then reshape using gather!
```

Reshaping data from long (tall) to wide (fat): tidyr

In tidyr, the spread function spreads rows into columns. Now we have a long data set, but we want to separate the Average, Alightings and Boardings into different columns:

```
# have to remove missing days
wide = filter(long, !is.na(date))
wide = spread(wide, type, number)
head(wide)
```

```
# A tibble: 6 × 7
      day       date  daily   line Alightings Average Boardi
    <chr>     <date>  <dbl>  <chr>      <dbl>   <dbl>     <c
1 Friday 2010-01-15 1644.0 banner         NA      NA
2 Friday 2010-01-15 1644.0  green         NA      NA
3 Friday 2010-01-15 1644.0 orange       1643    1644       1
4 Friday 2010-01-15 1644.0 purple         NA      NA
5 Friday 2010-01-22 1394.5 banner         NA      NA
6 Friday 2010-01-22 1394.5  green         NA      NA
```

Reshaping data from long (tall) to wide (fat): tidyr

We can use `rowSums` to see if any values in the row is `NA` and keep if the row, which is a combination of date and line type has any non-missing data.

```
# wide = wide %>%
#     select(Alightings, Average, Boardings) %>%
#     mutate(good = rowSums(is.na(.)) > 0)
not_namat = !is.na(select(wide, Alightings, Average, Boardi
head(not_namat, 2)
```

```
  Alightings Average Boardings
1      FALSE   FALSE     FALSE
2      FALSE   FALSE     FALSE
```

```
wide$good = rowSums(not_namat) > 0
```

Reshaping data from long (tall) to wide (fat): tidyr

Now we can filter only the good rows and delete the good column.

```
wide = filter(wide, good) %>% select(-good)
head(wide)
```

```
# A tibble: 6 × 7
     day       date  daily   line Alightings Average Boardi
   <chr>     <date>  <dbl>  <chr>      <dbl>   <dbl>     <c
1 Friday 2010-01-15 1644.0 orange       1643  1644.0       1
2 Friday 2010-01-22 1394.5 orange       1388  1394.5       1
3 Friday 2010-01-29 1332.0 orange       1322  1332.0       1
4 Friday 2010-02-05 1217.5 orange       1204  1217.5       1
5 Friday 2010-02-12  671.0 orange        678   671.0
6 Friday 2010-02-19 1642.0 orange       1647  1642.0       1
```

Finding the First (or Last) record

```r
long = long %>% filter(!is.na(number) & number > 0)
first_and_last = long %>% arrange(date) %>% # arrange by da
  filter(type %in% "Boardings") %>% # keep boardings only
  group_by(line) %>% # group by line
  slice( c(1, n())) # select ("slice") first and last (n()
first_and_last %>%  head(4)
```

```
Source: local data frame [4 x 6]
Groups: line [2]

      day       date   daily   line       type number
    <chr>     <date>   <dbl>  <chr>      <chr>  <dbl>
1  Monday 2012-06-04 13342.5 banner Boardings    520
2  Friday 2013-03-01      NA banner Boardings    817
3 Tuesday 2011-11-01  8873.0  green Boardings    887
4  Friday 2013-03-01      NA  green Boardings   2592
```

Data Merging/Append in Base R

- Merging - joining data sets together - usually on key variables, usually “id”
- `merge()` is the most common way to do this with data sets
- `rbind`/`cbind` - row/column bind, respectively
  - `rbind` is the equivalent of “appending” in Stata or “setting” in SAS
  - `cbind` allows you to add columns in addition to the previous ways
- `t()` is a function that will transpose the data

Merging

```
base <- data.frame(id = 1:10, Age= seq(55,60, length=10))
base[1:2,]
```

```
  id      Age
1  1 55.00000
2  2 55.55556
```

```
visits <- data.frame(id = rep(1:8, 3), visit= rep(1:3, 8),
                    Outcome = seq(10,50, length=24))
visits[1:2,]
```

```
  id visit  Outcome
1  1     1 10.00000
2  2     2 11.73913
```

Merging

```r
merged.data <- merge(base, visits, by="id")
merged.data[1:5,]
```

```
  id      Age visit  Outcome
1  1 55.00000     1 10.00000
2  1 55.00000     3 23.91304
3  1 55.00000     2 37.82609
4  2 55.55556     2 11.73913
5  2 55.55556     1 25.65217
```

```r
dim(merged.data)
```

```
[1] 24  4
```

Merging

```r
all.data <- merge(base, visits, by="id", all=TRUE)
tail(all.data)
```

```
   id      Age visit  Outcome
21  7 58.33333     2 48.26087
22  8 58.88889     2 22.17391
23  8 58.88889     1 36.08696
24  8 58.88889     3 50.00000
25  9 59.44444    NA       NA
26 10 60.00000    NA       NA
```

```r
dim(all.data)
```

```
[1] 26  4
```

Joining in dplyr

- ?join - see different types of joining for dplyr
- Let's look at https://www.rstudio.com/wp-content/uploads/2015/02/data-wrangling-cheatsheet.pdf

Left Join

```
lj = left_join(base, visits)
```

```
Joining, by = "id"
```

```
dim(lj)
```

```
[1] 26  4
```

```
tail(lj)
```

```
   id      Age visit  Outcome
21  7 58.33333     2 48.26087
22  8 58.88889     2 22.17391
23  8 58.88889     1 36.08696
24  8 58.88889     3 50.00000
25  9 59.44444    NA       NA
26 10 60.00000    NA       NA
```

Right Join

```r
rj = right_join(base, visits)
```

```
Joining, by = "id"
```

```r
dim(rj)
```

```
[1] 24  4
```

```r
tail(rj)
```

```
   id      Age visit  Outcome
19  3 56.11111     1 41.30435
20  4 56.66667     2 43.04348
21  5 57.22222     3 44.78261
22  6 57.77778     1 46.52174
23  7 58.33333     2 48.26087
24  8 58.88889     3 50.00000
```

Full Join

```
fj = full_join(base, visits)
```

```
Joining, by = "id"
```

```
dim(fj)
```

```
[1] 26  4
```

```
tail(fj)
```

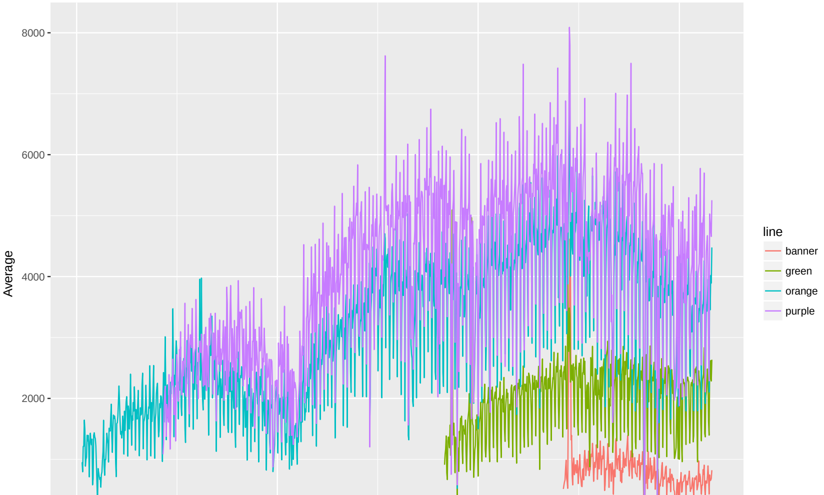
```
   id      Age visit  Outcome
21  7 58.33333     2 48.26087
22  8 58.88889     2 22.17391
23  8 58.88889     1 36.08696
24  8 58.88889     3 50.00000
25  9 59.44444    NA       NA
26 10 60.00000    NA       NA
```

Bonus slides - explore after visualization!

Perform Operations By Multiple Groups: dplyr

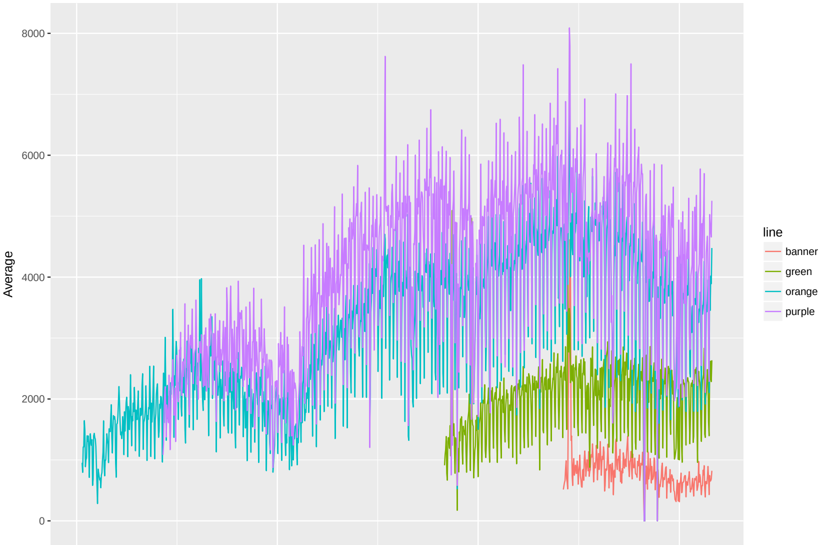
We can then easily plot each day over time:

```
library(ggplot2)
ggplot(aes(x = date, y = Average, colour = line), data = wi
```



ggplot2 with piping

```
wide %>%
  ggplot(aes(x = date, y = Average, colour = line)) + geom_
```



Perform Operations By Multiple Groups: dplyr

Let's create the middle of the month (the 15th for example), and name it mon.

```
mon = wide %>%
  mutate(month = month(date), year = year(date)) %>%
  dplyr::group_by(line, month, year) %>%
  dplyr::summarise(mean_avg = mean(Average))
mon = mutate(mon, mid_month = dmy(paste0("15-", month, "-"
head(mon)
```

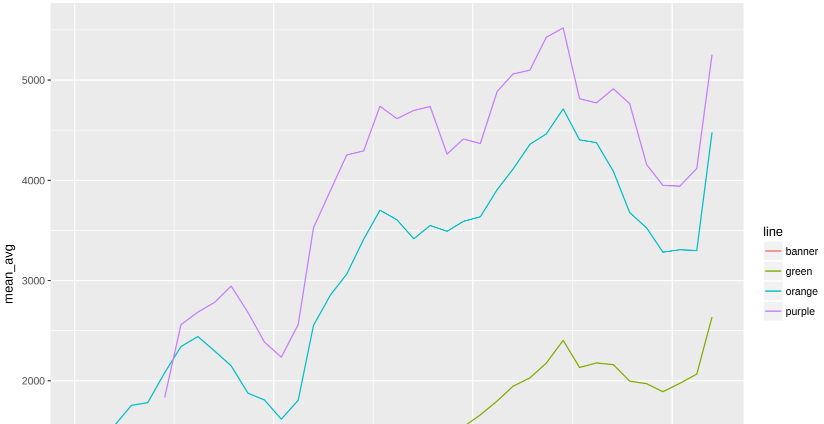
```
Source: local data frame [6 x 5]
Groups: line, month [6]

    line month  year  mean_avg  mid_month
   <chr> <dbl> <dbl>     <dbl>     <date>
1 banner     1  2013  610.3226 2013-01-15
2 banner     2  2013  656.4643 2013-02-15
3 banner     3  2013  822.0000 2013-03-15
4 banner     6  2013 1288.1296 2013-06-15
```

Perform Operations By Multiple Groups: dplyr

We can then easily plot the mean of each month to see a smoother output:

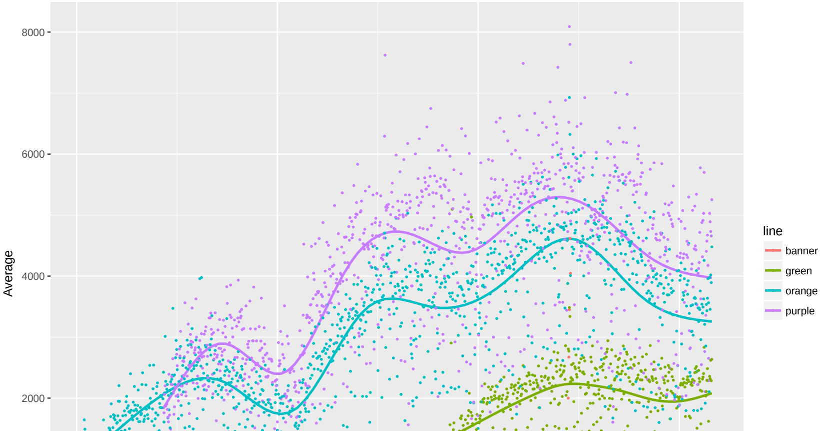
```
ggplot(aes(x = mid_month,
                y = mean_avg,
                colour = line), data = mon) + geom_line()
```



Bonus! Points with a smoother!

```
ggplot(aes(x = date, y = Average, colour = line),
            data = wide) + geom_smooth(se = FALSE) +
  geom_point(size = .5)
```

```
`geom_smooth()` using method = 'gam'
```


Average
line
banner
green
orange
purple