

Lecture 10: Wrangling Data



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BSDS 100 - Intro to Data Science with R



- Tidying Data
 - The `tidyr` package
 - The `dplyr` package
- Piping and the `magrittr` package

Reference: Chapter 12 in *R for Data Science* book



- In many cases, data doesn't come in the structure we'd like it to for easy analysis and plotting
- It is not uncommon that a majority of the time spent visualizing data is not writing the visualization code, e.g, `ggplot`, but rather *restructuring* data (mainly data frames) so as to be able to visualize the data



- There are functions in base R such as `aggregate()` and `merge()` that can help with this, as well as functions such as `melt()` and `cast()` from the `reshape2` package
- Here, we will examine the use of the `tidyr` and `dplyr` packages



- Data should always be tidy before you begin to work with it!
- All data should be organized such that
 - 1 **each column is a variable**
 - 2 **each row is an observation**
- `tidyr` provides four main functions for tidying messy data
 - 1 `gather()`
 - 2 `spread()`
 - 3 `separate()`
 - 4 `unite()`

The `gather()` function



- `gather()` takes multiple columns and gathers them into key-value pairs
- It makes *wide* data *longer*
- The `melt()` function in the `reshape2` package is equivalent to this function



- In an experiment, you compare the *normal* weekly sales to sales when using *fancy* lighting and signage in a grocery store in three different cities
- The data may be stored as follows

```
> myDataFrame <- data.frame(  
  City = c("Austin", "Georgia", "Vancouver"),  
  Fancy = c(35000, 43000, 106000),  
  Normal = c(30000, 44000, 77000)  
)
```

```
> myDataFrame  
      City  Fancy Normal  
1  Austin 35000 30000  
2 Georgia 43000 44000  
3 Vancouver 106000 77000
```



- **Goal:** Create a nice `ggplot` comparing the `Fancy` sales with `normal` sales from each location.
- In this case, we cannot directly use the data frame as it is formatted
- We can use the `gather()` function to reshape the data frame into two columns so that we can directly compare.



```
> library(tidyr)
> library(dplyr)

> (myTidyDataFrame <- gather(myDataFrame, lightSign, Sales,
  Fancy, Normal))
```

	City	lightSign	Sales
1	Austin	Fancy	35000
2	Georgia	Fancy	43000
3	Vancouver	Fancy	106000
4	Austin	Normal	30000
5	Georgia	Normal	44000
6	Vancouver	Normal	77000

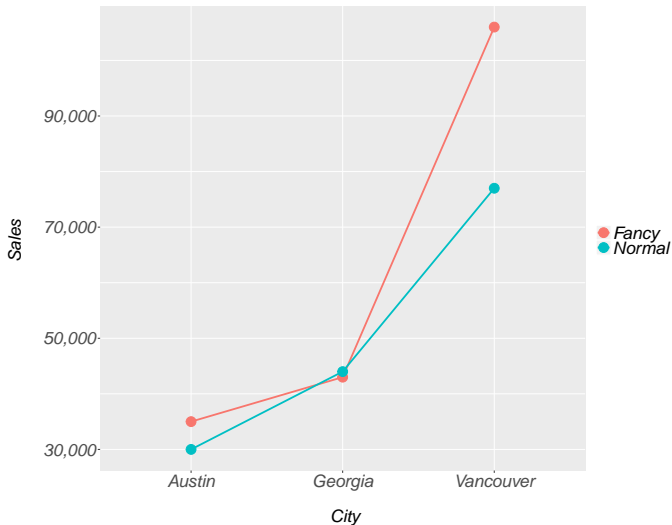
Now plot with ggplot



```
> library(scales)

ggplot(myTidyDataFrame,
       aes(x = City, y = Sales, group = lightSign, colour = lightSign))
+ geom_line()
+ geom_point(size = 3)
+ scale_y_continuous(labels = comma)
+ ylab("Sales \n")
+ xlab("\n City")
+ theme(legend.title = element_blank())
```

The Result



The `separate()` function



- Sometimes variables are clumped together in a single column but we'd like to *separate* them
- The `separate()` function allows you to parse them
- The `extract()` function works similarly but uses regular expressions groups instead of a splitting pattern or position
- The opposite of `separate()` is `unite()`



- There is an experiment which measures how much time (in hrs) a person has spent on their mobile phones at specific times in the day. The experiment controls for the mobile operating system (iOS or Android). Each subject has two readings taken taken at work and at home in the AM and PM.
- **Goal** Generate a plot with the mean time spent on mobile device (y), time of day (x) by location (work/home) and operating system (iOS/Android)

Example: Generating the Data



```
> set.seed(1979)

(myDataFrame <- data.frame(
  uniqueId = 1:4,
  treatment = sample(rep(c('iOS', 'Android'), each = 2)),
  work_am = runif(4, 0, 1),
  home_am = runif(4, 0, 1),
  work_pm = runif(4, 1, 2),
  home_pm = runif(4, 1, 2)
))
```

	uniqueId	treatment	work_am	home_am	work_pm	home_pm
1	1	Android	0.1655928	0.47930296	1.912491	1.068928
2	2	iOS	0.2641590	0.36626685	1.276391	1.317642
3	3	iOS	0.6108628	0.34724530	1.011851	1.572617
4	4	Android	0.3877454	0.06951258	1.222138	1.759057



- The raw data from the previous slide is *not* tidy, i.e., each column should be a variable and each row should be an observation

STEP 1: Make the data tidy using `gather()`

```
> myTidyDataFrame <- gather(myDataFrame,  
  sample, time, -uniqueId, -treatment)
```

```
> head(myTidyDataFrame)
```

	uniqueId	treatment	sample	time
1	1	Android	work_am	0.1655928
2	2	iOS	work_am	0.2641590
3	3	iOS	work_am	0.6108628
4	4	Android	work_am	0.3877454
5	1	Android	home_am	0.4793030
6	2	iOS	home_am	0.3662669

Now separating the data



STEP 2: Split `sample` into location (work, home) and time of day (AM, PM) using `separate()`

```
> myTidierDataFrame <- separate(myTidyDataFrame, sample,  
  into = c("location", "timeOfDay"), sep = "\\_")
```

```
> head(myTidierDataFrame)
```

	uniqueId	treatment	location	timeOfDay	time
1	1	Android	work	am	0.1655928
2	2	iOS	work	am	0.2641590
3	3	iOS	work	am	0.6108628
4	4	Android	work	am	0.3877454
5	1	Android	home	am	0.4793030
6	2	iOS	home	am	0.3662669

Separating the data, continued...



```
> myTidierDataFrame$timeOfDay <- toupper(myTidierDataFrame$timeOfDay)
```

```
> head(myTidierDataFrame, 3)
```

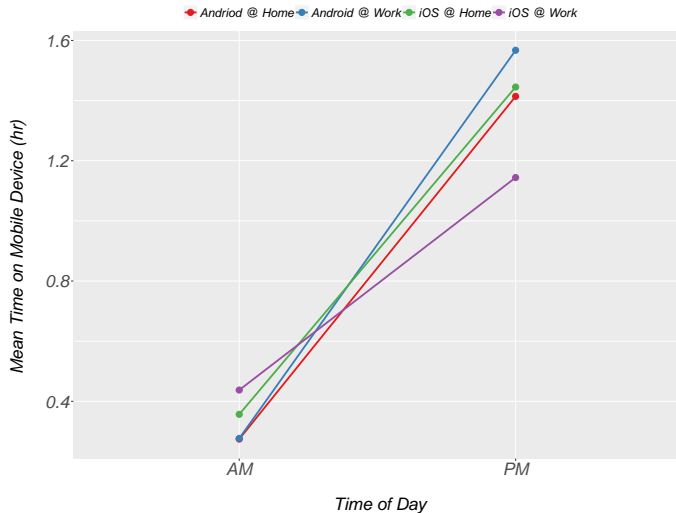
	uniqueId	treatment	location	timeOfDay	time
1	1	Android	work	AM	0.1655928
2	2	iOS	work	AM	0.2641590
3	3	iOS	work	AM	0.6108628

Plotting the data



```
ggplot(myTidierDataFrame, aes(x = timeOfDay, y = time)) +  
  aes(group = interaction(location, treatment),  
    colour = interaction(location, treatment)) +  
  stat_summary(fun.y = mean, geom = "line", size = 1) +  
  stat_summary(fun.y = mean, geom = "point", size = 3) +  
  labs(x = "\n Time of Day", y = "Time on Mobile Device \n") +  
  theme(legend.title = element_blank(),  
    axis.title = element_text(size = 20, face = "italic"),  
    axis.text = element_text(size = 20, face = "italic"),  
    legend.text = element_text(size = 14, face = "italic"),  
    legend.position = "top") +  
  scale_colour_brewer(palette = "Set1",  
    labels=c("Andriod @ Home", "Android @ Work", "iOS @ Home",  
      "iOS @ Work"))
```

The Resulting Plot





- The opposite of the `gather()` function is the `spread()` function, which takes *long* data and makes it *wide*
- Recall the example from a few slides ago, where *wide* data was made *long*

```
> head(myTidyDataFrame <- gather(myDataFrame, lightSign, Sales,
  Fancy, Normal), 4)
```

	City	lightSign	Sales
1	Austin	Fancy	35000
2	Georgia	Fancy	43000
3	Vancouver	Fancy	106000
4	Austin	Normal	30000



- Undo what was done to the data and return it to its original form using `spread()`

```
> (spread(myTidyDataFrame, lightSign, Sales))
```

	City	Fancy	Normal
1	Austin	35000	30000
2	Georgia	43000	44000
3	Vancouver	106000	77000



- `magrittr` is package which allows for the use of the piping operator `%>%`
- There are various piping operators, but for the purposes of this brief introduction, the focus will be solely on `%>%`; you are encouraged to read the `magrittr` documentation to learn more about the different piping operators
- Piping allows for a significant reduction in typing, as well as making code intuitive to external code reviewers



- Piping is very useful when using data manipulation packages such `tidyr` and `dplyr`
- Flow: data is piped into a function and the data argument in the function can be dropped
 - Without the piping operator: `mean(x)`
 - With the piping operator: `x %>% mean()`
- Piping operator keystroke: `SHIFT + COMMAND + M`



- Imagine taking the sum of the square root of a vector of numbers X . We could simply write

```
> sum(sqrt(X))
```

- But, we have to read this from the inside out, which can seem a little unintuitive.

- Piping allows us to write this more naturally:

```
> X %>% sqrt() %>% sum()
```

- Obviously things can get much more complicated, but this can be really useful for complicated flow

A more robust example



```
# Without magrittr
myTidyDataFrame <- gather(myDataFrame, lightSign, Sales, Fancy, Normal)

ggplot(myTidyDataFrame,
       aes(x = City, y = Sales, group = lightSign, colour = lightSign))
  + geom_line(size = 1)

#-----
# With magrittr
library(magrittr)

myDataFrame %>%
  gather(lightSign, Sales, Fancy, Normal) %>%
  ggplot(aes(x = City, y = Sales, group = lightSign, colour = lightSign))
    geom_line(size = 1)
```



- `dplyr` is a package which provides a set of tools for efficiently manipulating datasets in R
- `dplyr` is designed to have a set of functions defined by verbs
 - 1 `filter()`: keep rows with matching criteria
 - 2 `select()`: select columns by name
 - 3 `arrange()`: reorder rows
 - 4 `mutate()`: add new variables
 - 5 `summarise()`: reduce variables to values
- How it works
 - 1 First argument is a data frame
 - 2 Subsequent arguments say what to do with data frame
 - 3 Always returns a data frame

Using the `filter()` function



- Load `flights.csv`
- Find all flights
 - 1 in May
 - 2 that were not delayed
 - 3 that departed between 4pm and 5pm
 - 4 to SFO



- ❶ `flights %>% filter(date < "2011-06-01" & date >= "2011-05-01")`
- ❷ `flights %>% filter(arr_delay <= 0 & dep_delay <= 0)`
- ❸ `flights %>% filter(dep >= 1600 & dep <= 1700)`
- ❹ `flights %>% filter(dest == "SFO")`

Example of the `select()` function



```
myDF <- data.frame(myNum = c(1,2,3,4,5),
  myColor = c("blue", "yellow", "yellow", "blue", "blue"))

# select a column from a data frame
my DF %>% select()

### using flights.csv data

flights %>% select(arr_delay:dep_delay)

flights %>% select(ends_with("delay"))

flights %>% select(contains("dep_delay"))
```

Example of the `arrange()` function



```
myDF <- data.frame(myNum = c(1,2,3,4,5),
  myColor = c("blue", "yellow", "yellow", "blue", "blue"))

# select a column from a data frame
my DF %>% select()

### using flights.csv data

flights %>% select(arr_delay:dep_delay)

flights %>% select(ends_with("delay"))

flights %>% select(contains("dep_delay"))
```

Example of the `mutate()` function



```
myDF <- data.frame(myNum = c(1,2,3,4,5),  
  myColor = c("blue", "yellow", "yellow", "blue", "blue"))  
  
# select a column from a data frame  
my DF %>% select()  
  
### using flights.csv data  
  
flights %>% select(arr_delay:dep_delay)  
  
flights %>% select(ends_with("delay"))  
  
flights %>% select(contains("dep_delay"))
```