

# Data manipulation in R

APAM E4990

Modeling Social Data

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February 3, 2017

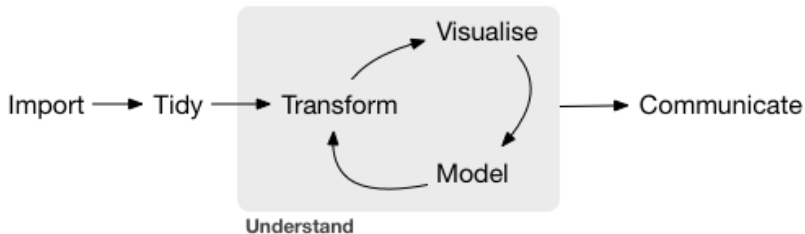
# The good, the bad, & the ugly

- R isn't the best programming language out there
- But it happens to be great for data analysis
- The result is a steep learning curve with a high payoff

## For instance ...

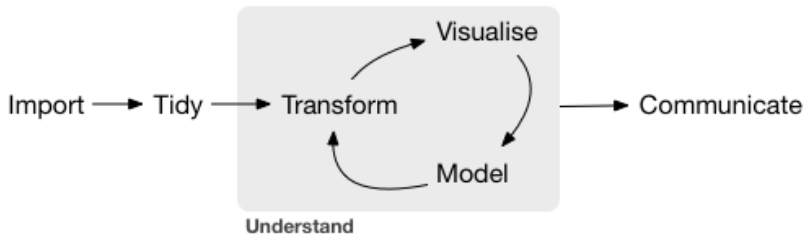
- You'll see a mix of `camelCase`, `this.that`, and `snake_case` conventions
- Dots (.) (mostly) don't mean anything special
- Likewise, \$ gets used in funny ways
- R is loosely typed, which can lead to unexpected coercions and silent fails
- It also tries to be clever about variable scope, which can backfire if you're not careful

But it will help you ...



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- Easily generate high-quality data visualizations
- Fit and evaluate pretty much any statistical model you can think of

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This will change the way you do data analysis, because you'll ask questions you wouldn't have bothered to otherwise

# Basic types

- `int`, `double`: for numbers
- `character`: for strings
- `factor`: for categorical variables ( $\sim$  `struct` or `ENUM`)

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Factors are handy, but take some getting used to

# Containers

- `vector`: for multiple values of the same type ( $\sim$  array)
- `list`: for multiple values of different types ( $\sim$  dictionary)
- `data.frame`: for tables of rectangular data of mixed types ( $\sim$  matrix)



# Containers

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We'll mostly work with data frames, which themselves are lists of vectors

# The tidyverse

The tidyverse is a collection of packages that work together to make data analysis easier:

- dplyr for split / apply / combine type counting
- ggplot2 for making plots
- tidyr for reshaping and “tidying” data
- readr for reading and writing files
- ...

# Tidy data

The core philosophy is that your data should be in a “tidy” table with:

- One observation per row
- One variable per column
- One measured value per cell

# Tidy data

	tripduration	starttime	stoptime	start_station_id	start_station_name	start_station_latitude	start_station_longitude
1	382	2014-02-01 00:00:00	2014-02-01 00:06:22	294	Washington Square E	40.73049	-73.99572
2	372	2014-02-01 00:00:03	2014-02-01 00:06:15	285	Broadway & E 14 St	40.73455	-73.99074
3	591	2014-02-01 00:00:09	2014-02-01 00:10:00	247	Perry St & Bleecker St	40.73535	-74.00483
4	583	2014-02-01 00:00:32	2014-02-01 00:10:15	357	E 11 St & Broadway	40.73262	-73.99158
5	223	2014-02-01 00:00:41	2014-02-01 00:04:24	401	Allen St & Rivington St	40.72020	-73.98998
6	541	2014-02-01 00:00:46	2014-02-01 00:09:47	152	Warren St & Church St	40.71474	-74.00911

- Most of the work goes into getting your data into shape
- After which descriptives statistics, modeling, and visualization are easy

# dplyr: a grammar of data manipulation

dplyr implements the split / apply / combine framework discussed in the last lecture

- Its “grammar” has five main verbs used in the “apply” phase:
  - `filter`: restrict rows based on a condition ( $N \rightarrow N'$ )
  - `arrange`: reorder rows by a variable ( $N \rightarrow N'$ )
  - `select`: pick out specific columns ( $K \rightarrow K'$ )
  - `mutate`: create new or change existing columns ( $K \rightarrow K'$ )
  - `summarize`: collapse a column into one value ( $N \rightarrow 1$ )
- The `group_by` function creates indices to take care of the split and combine phases

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The cost is that you have to think “functionally”, in terms of “vectorized” operations

# filter

```
filter(trips, start_station_name == "Broadway & E 14 St")
```

	tripduration <sup>↕</sup>	starttime <sup>↕</sup>	stoptime <sup>↕</sup>	start_station_id	start_station_name <sup>↕</sup>	start_station_latitude <sup>↕</sup>	start_station_longitude <sup>↕</sup>
1	372	2014-02-01 00:00:03	2014-02-01 00:06:15	285	Broadway & E 14 St	40.73455	-73.99074
2	439	2014-02-01 00:02:14	2014-02-01 00:09:33	285	Broadway & E 14 St	40.73455	-73.99074
3	636	2014-02-01 00:08:25	2014-02-01 00:19:01	285	Broadway & E 14 St	40.73455	-73.99074
4	914	2014-02-01 00:43:21	2014-02-01 00:58:35	285	Broadway & E 14 St	40.73455	-73.99074
5	906	2014-02-01 00:43:36	2014-02-01 00:58:42	285	Broadway & E 14 St	40.73455	-73.99074
6	468	2014-02-01 00:57:12	2014-02-01 01:05:00	285	Broadway & E 14 St	40.73455	-73.99074

# arrange

```
arrange(trips, starttime)
```

	tripduration <sup>+</sup>	starttime <sup>↕</sup>	stoptime <sup>↕</sup>	start_station_id	start_station_name <sup>↕</sup>	start_station_latitude	start_station_longitude <sup>↕</sup>
1	382	2014-02-01 00:00:00	2014-02-01 00:06:22	294	Washington Square E	40.73049	-73.99572
2	372	2014-02-01 00:00:03	2014-02-01 00:06:15	285	Broadway & E 14 St	40.73455	-73.99074
3	591	2014-02-01 00:00:09	2014-02-01 00:10:00	247	Perry St & Bleecker St	40.73535	-74.00483
4	583	2014-02-01 00:00:32	2014-02-01 00:10:15	357	E 11 St & Broadway	40.73262	-73.99158
5	223	2014-02-01 00:00:41	2014-02-01 00:04:24	401	Allen St & Rivington St	40.72020	-73.98998
6	541	2014-02-01 00:00:46	2014-02-01 00:09:47	152	Warren St & Church St	40.71474	-74.00911



select

```
select(trips, starttime, stoptime,  
       start_station_name, end_station_name)
```

	starttime	stoptime	start_station_name	end_station_name
1	2014-02-01 00:00:00	2014-02-01 00:06:22	Washington Square E	Stanton St & Chrystie St
2	2014-02-01 00:00:03	2014-02-01 00:06:15	Broadway & E 14 St	E 4 St & 2 Ave
3	2014-02-01 00:00:09	2014-02-01 00:10:00	Perry St & Bleecker St	Mott St & Prince St
4	2014-02-01 00:00:32	2014-02-01 00:10:15	E 11 St & Broadway	Greenwich Ave & 8 Ave
5	2014-02-01 00:00:41	2014-02-01 00:04:24	Allen St & Rivington St	E 4 St & 2 Ave
6	2014-02-01 00:00:46	2014-02-01 00:09:47	Warren St & Church St	Pike St & Monroe St

## mutate

```
mutate(trips, time_in_min = tripduration / 60)
```

	tripduration <sup>^</sup>	starttime <sup>^</sup>	stoptime <sup>^</sup>	time_in_min <sup>^</sup>
1	382	2014-02-01 00:00:00	2014-02-01 00:06:22	6.366667
2	372	2014-02-01 00:00:03	2014-02-01 00:06:15	6.200000
3	591	2014-02-01 00:00:09	2014-02-01 00:10:00	9.850000
4	583	2014-02-01 00:00:32	2014-02-01 00:10:15	9.716667
5	223	2014-02-01 00:00:41	2014-02-01 00:04:24	3.716667
6	541	2014-02-01 00:00:46	2014-02-01 00:09:47	9.016667

## mutate

```
summarize(trips, mean_duration = mean(tripduration) / 60,  
           sd_duration = sd(tripduration) / 60)
```

mean_duration	sd_duration
14.57533	91.43487

## group\_by

```
trips_by_gender <- group_by(trips, gender)
```

Source: local data frame [224,736 x 4]

Groups: gender [3]

	tripduration <int>		starttime <dtm>		stoptime <dtm>	gender <int>
1	382	2014-02-01 00:00:00	2014-02-01 00:06:22			1
2	372	2014-02-01 00:00:03	2014-02-01 00:06:15			2
3	591	2014-02-01 00:00:09	2014-02-01 00:10:00			2
4	583	2014-02-01 00:00:32	2014-02-01 00:10:15			1
5	223	2014-02-01 00:00:41	2014-02-01 00:04:24			1
6	541	2014-02-01 00:00:46	2014-02-01 00:09:47			1
7	354	2014-02-01 00:01:01	2014-02-01 00:06:55			1
8	916	2014-02-01 00:01:11	2014-02-01 00:16:27			1
9	277	2014-02-01 00:01:33	2014-02-01 00:06:10			1
10	439	2014-02-01 00:02:14	2014-02-01 00:09:33			2
# ... with 224,726 more rows						

## group\_by

```
trips_by_gender <- group_by(trips, gender)
```

```
Classes 'grouped_df', 'tbl_df', 'tbl' and 'data.frame' 224736 obs. of  4 variables:
 $ tripduration: int  382 372 591 583 223 541 354 916 277 439 ...
 $ starttime   : POSIXct, format: "2014-02-01 00:00:00" "2014-02-01 00:00:03" ...
 $ stoptime    : POSIXct, format: "2014-02-01 00:06:22" "2014-02-01 00:06:15" ...
 $ gender      : int  1 2 2 1 1 1 1 1 1 2 ...
- attr(*, "vars")=List of 1
..$ : symbol gender
- attr(*, "drop")= logi TRUE
- attr(*, "indices")=List of 3
..$ : int  31 55 222 266 293 302 306 329 393 413 ...
..$ : int  0 3 4 5 6 7 8 10 11 12 ...
..$ : int  1 2 9 18 19 22 24 26 34 49 ...
- attr(*, "group_sizes")= int  6731 176526 41479
- attr(*, "biggest_group_size")= int 176526
- attr(*, "labels")='data.frame':  3 obs. of  1 variable:
..$ gender: int  0 1 2
..- attr(*, "vars")=List of 1
.. ..$ : symbol gender
..- attr(*, "drop")= logi TRUE
```

## group\_by + summarize

```
summarize(trips_by_gender,  
          count = n(),  
          mean_duration = mean(tripduration) / 60,  
          sd_duration = sd(tripduration) / 60)
```

# A tibble: 3 × 4

	gender	count	mean_duration	sd_duration
	<int>	<int>	<dbl>	<dbl>
1	0	6731	29.01385	92.76851
2	1	176526	13.56721	83.67627
3	2	41479	16.52268	118.57922

## %>%: the pipe operator

```
trips %>%  
  group_by(gender) %>%  
  summarize(count = n(),  
            mean_duration = mean(tripduration) / 60,  
            sd_duration = sd(tripduration) / 60)
```

# A tibble: 3 × 4

	gender	count	mean_duration	sd_duration
	<int>	<int>	<dbl>	<dbl>
1	0	6731	29.01385	92.76851
2	1	176526	13.56721	83.67627
3	2	41479	16.52268	118.57922

