Massachusetts Bay Transportation Authority Ridership Data Cleaning

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January 11, 2017

Import packages

```
library("readxl")
library("tidyr")
library("ggplot2")
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    11 obs. of  60 variables:
##  $        : num  1 2 3 4 5 6 7 8 9 10 ...
##  $ mode   : chr  "All Modes by Qtr" "Boat" "Bus" "Commuter Rail" ...
##  $ 2007-01: chr  "NA" "4" "335.819" "142.2" ...
##  $ 2007-02: chr  "NA" "3.6" "338.675" "138.5" ...
##  $ 2007-03: num  1188 40 340 138 459 ...
##  $ 2007-04: chr  "NA" "4.3" "352.162" "139.5" ...
##  $ 2007-05: chr  "NA" "4.9" "354.367" "139" ...
##  $ 2007-06: num  1246 5.8 350.5 143 477 ...
##  $ 2007-07: chr  "NA" "6.521" "357.519" "142.391" ...
##  $ 2007-08: chr  "NA" "6.572" "355.479" "142.364" ...
##  $ 2007-09: num  1256.57 5.47 372.6 143.05 499.57 ...
##  $ 2007-10: chr  "NA" "5.145" "368.847" "146.542" ...
##  $ 2007-11: chr  "NA" "3.763" "330.826" "145.089" ...
##  $ 2007-12: num  1216.89 2.98 312.92 141.59 448.27 ...
##  $ 2008-01: chr  "NA" "3.175" "340.324" "142.145" ...
##  $ 2008-02: chr  "NA" "3.111" "352.905" "142.607" ...
##  $ 2008-03: num  1253.52 3.51 361.15 137.45 494.05 ...
##  $ 2008-04: chr  "NA" "4.164" "368.189" "140.389" ...
##  $ 2008-05: chr  "NA" "4.015" "363.903" "142.585" ...
##  $ 2008-06: num  1314.82 5.19 362.96 142.06 518.35 ...
##  $ 2008-07: chr  "NA" "6.016" "370.921" "145.731" ...
##  $ 2008-08: chr  "NA" "5.8" "361.057" "144.565" ...
##  $ 2008-09: num  1307.04 4.59 389.54 141.91 517.32 ...
##  $ 2008-10: chr  "NA" "4.285" "357.974" "151.957" ...
##  $ 2008-11: chr  "NA" "3.488" "345.423" "152.952" ...
##  $ 2008-12: num  1232.65 3.01 325.77 140.81 446.74 ...
##  $ 2009-01: chr  "NA" "3.014" "338.532" "141.448" ...
##  $ 2009-02: chr  "NA" "3.196" "360.412" "143.529" ...
##  $ 2009-03: num  1209.79 3.33 353.69 142.89 467.22 ...
##  $ 2009-04: chr  "NA" "4.049" "359.38" "142.34" ...
##  $ 2009-05: chr  "NA" "4.119" "354.75" "144.225" ...
##  $ 2009-06: num  1233.1 4.9 347.9 142 473.1 ...
##  $ 2009-07: chr  "NA" "6.444" "339.477" "137.691" ...
##  $ 2009-08: chr  "NA" "5.903" "332.661" "139.158" ...
##  $ 2009-09: num  1230.5 4.7 374.3 139.1 500.4 ...
##  $ 2009-10: chr  "NA" "4.212" "385.868" "137.104" ...
##  $ 2009-11: chr  "NA" "3.576" "366.98" "129.343" ...
##  $ 2009-12: num  1207.85 3.11 332.39 126.07 440.93 ...
##  $ 2010-01: chr  "NA" "3.207" "362.226" "130.91" ...
##  $ 2010-02: chr  "NA" "3.195" "361.138" "131.918" ...
##  $ 2010-03: num  1208.86 3.48 373.44 131.25 483.4 ...
##  $ 2010-04: chr  "NA" "4.452" "378.611" "131.722" ...
##  $ 2010-05: chr  "NA" "4.415" "380.171" "128.8" ...
##  $ 2010-06: num  1244.41 5.41 363.27 129.14 490.26 ...
##  $ 2010-07: chr  "NA" "6.513" "353.04" "122.935" ...
##  $ 2010-08: chr  "NA" "6.269" "343.688" "129.732" ...
##  $ 2010-09: num  1225.5 4.7 381.6 132.9 521.1 ...
##  $ 2010-10: chr  "NA" "4.402" "384.987" "131.033" ...
##  $ 2010-11: chr  "NA" "3.731" "367.955" "130.889" ...
##  $ 2010-12: num  1216.26 3.16 326.34 121.42 450.43 ...
##  $ 2011-01: chr  "NA" "3.14" "334.958" "128.396" ...
##  $ 2011-02: chr  "NA" "3.284" "346.234" "125.463" ...
##  $ 2011-03: num  1223.45 3.67 380.4 134.37 516.73 ...
##  $ 2011-04: chr  "NA" "4.251" "380.446" "134.169" ...
##  $ 2011-05: chr  "NA" "4.431" "385.289" "136.14" ...
##  $ 2011-06: num  1302.41 5.47 376.32 135.58 529.53 ...
##  $ 2011-07: chr  "NA" "6.581" "361.585" "132.41" ...
##  $ 2011-08: chr  "NA" "6.733" "353.793" "130.616" ...
##  $ 2011-09: num  1291 5 388 137 550 ...
##  $ 2011-10: chr  "NA" "4.484" "398.456" "128.72" ...
```

```
## # A tibble: 6 × 60
##      ``             mode `2007-01` `2007-02` `2007-03` `2007-04` `2007-05`
##   <dbl>            <chr>     <chr>     <chr>     <dbl>     <chr>     <chr>
## 1     1 All Modes by Qtr        NA        NA  1187.653        NA        NA
## 2     2             Boat         4       3.6    40.000       4.3       4.9
## 3     3              Bus   335.819   338.675   339.867   352.162   354.367
## 4     4    Commuter Rail     142.2     138.5   137.700     139.5       139
## 5     5       Heavy Rail   435.294   448.271   458.583   472.201   474.579
## 6     6       Light Rail   227.231   240.262   241.444   255.557   248.262
## # ... with 53 more variables: `2007-06` <dbl>, `2007-07` <chr>,
## #   `2007-08` <chr>, `2007-09` <dbl>, `2007-10` <chr>, `2007-11` <chr>,
## #   `2007-12` <dbl>, `2008-01` <chr>, `2008-02` <chr>, `2008-03` <dbl>,
## #   `2008-04` <chr>, `2008-05` <chr>, `2008-06` <dbl>, `2008-07` <chr>,
## #   `2008-08` <chr>, `2008-09` <dbl>, `2008-10` <chr>, `2008-11` <chr>,
## #   `2008-12` <dbl>, `2009-01` <chr>, `2009-02` <chr>, `2009-03` <dbl>,
## #   `2009-04` <chr>, `2009-05` <chr>, `2009-06` <dbl>, `2009-07` <chr>,
## #   `2009-08` <chr>, `2009-09` <dbl>, `2009-10` <chr>, `2009-11` <chr>,
## #   `2009-12` <dbl>, `2010-01` <chr>, `2010-02` <chr>, `2010-03` <dbl>,
## #   `2010-04` <chr>, `2010-05` <chr>, `2010-06` <dbl>, `2010-07` <chr>,
## #   `2010-08` <chr>, `2010-09` <dbl>, `2010-10` <chr>, `2010-11` <chr>,
## #   `2010-12` <dbl>, `2011-01` <chr>, `2011-02` <chr>, `2011-03` <dbl>,
## #   `2011-04` <chr>, `2011-05` <chr>, `2011-06` <dbl>, `2011-07` <chr>,
## #   `2011-08` <chr>, `2011-09` <dbl>, `2011-10` <chr>
```

```
##                      mode             2007-01            2007-02
##  Min.   : 1.0   Length:11          Length:11          Length:11
##  1st Qu.: 3.5   Class :character   Class :character   Class :character
##  Median : 6.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   : 6.0
##  3rd Qu.: 8.5
##  Max.   :11.0
##     2007-03            2007-04            2007-05
##  Min.   :   0.114   Length:11          Length:11
##  1st Qu.:   9.278   Class :character   Class :character
##  Median : 137.700   Mode  :character   Mode  :character
##  Mean   : 330.293
##  3rd Qu.: 399.225
##  Max.   :1204.725
##     2007-06            2007-07            2007-08
##  Min.   :   0.096   Length:11          Length:11
##  1st Qu.:   5.700   Class :character   Class :character
##  Median : 143.000   Mode  :character   Mode  :character
##  Mean   : 339.846
##  3rd Qu.: 413.788
##  Max.   :1246.129
##     2007-09            2007-10            2007-11
##  Min.   :  -0.007   Length:11          Length:11
##  1st Qu.:   5.539   Class :character   Class :character
##  Median : 143.051   Mode  :character   Mode  :character
##  Mean   : 352.554
##  3rd Qu.: 436.082
##  Max.   :1310.764
##     2007-12            2008-01            2008-02
##  Min.   :  -0.060   Length:11          Length:11
##  1st Qu.:   4.385   Class :character   Class :character
##  Median : 141.585   Mode  :character   Mode  :character
##  Mean   : 321.588
##  3rd Qu.: 380.594
##  Max.   :1216.890
##     2008-03            2008-04            2008-05
##  Min.   :   0.058   Length:11          Length:11
##  1st Qu.:   5.170   Class :character   Class :character
##  Median : 137.453   Mode  :character   Mode  :character
##  Mean   : 345.604
##  3rd Qu.: 427.601
##  Max.   :1274.031
##     2008-06            2008-07            2008-08
##  Min.   :   0.060   Length:11          Length:11
##  1st Qu.:   5.742   Class :character   Class :character
##  Median : 142.057   Mode  :character   Mode  :character
##  Mean   : 359.667
##  3rd Qu.: 440.656
##  Max.   :1320.728
##     2008-09            2008-10            2008-11
##  Min.   :   0.021   Length:11          Length:11
##  1st Qu.:   5.691   Class :character   Class :character
##  Median : 141.907   Mode  :character   Mode  :character
##  Mean   : 362.099
##  3rd Qu.: 453.430
##  Max.   :1338.015
##     2008-12            2009-01            2009-02
##  Min.   :  -0.015   Length:11          Length:11
##  1st Qu.:   4.689   Class :character   Class :character
##  Median : 140.810   Mode  :character   Mode  :character
##  Mean   : 319.882
##  3rd Qu.: 386.255
##  Max.   :1232.655
##     2009-03            2009-04             2009-05
##  Min.   :  -0.050   Length:11          Length:11
##  1st Qu.:   5.003   Class :character   Class :character
##  Median : 142.893   Mode  :character   Mode  :character
##  Mean   : 330.142
##  3rd Qu.: 410.455
##  Max.   :1210.912
##     2009-06            2009-07             2009-08
##  Min.   :  -0.079   Length:11          Length:11
##  1st Qu.:   5.845   Class :character   Class :character
##  Median : 142.006   Mode  :character   Mode  :character
##  Mean   : 333.194
##  3rd Qu.: 410.482
##  Max.   :1233.085
##     2009-09            2009-10             2009-11
##  Min.   :  -0.035   Length:11          Length:11
##  1st Qu.:   5.693   Class :character   Class :character
##  Median : 139.087   Mode  :character   Mode  :character
##  Mean   : 346.687
##  3rd Qu.: 437.332
##  Max.   :1291.564
##     2009-12            2010-01             2010-02
##  Min.   :  -0.022   Length:11          Length:11
##  1st Qu.:   4.784   Class :character   Class :character
##  Median : 126.066   Mode  :character   Mode  :character
##  Mean   : 312.962
##  3rd Qu.: 386.659
##  Max.   :1207.845
##     2010-03            2010-04             2010-05
##  Min.   :   0.012   Length:11          Length:11
##  1st Qu.:   5.274   Class :character   Class :character
##  Median : 131.252   Mode  :character   Mode  :character
##  Mean   : 332.726
##  3rd Qu.: 428.420
##  Max.   :1225.556
##     2010-06            2010-07             2010-08
##  Min.   :   0.008   Length:11          Length:11
##  1st Qu.:   6.436   Class :character   Class :character
##  Median : 129.144   Mode  :character   Mode  :character
##  Mean   : 335.964
##  3rd Qu.: 426.769
##  Max.   :1244.409
##     2010-09            2010-10             2010-11
##  Min.   :   0.001   Length:11          Length:11
##  1st Qu.:   5.567   Class :character   Class :character
##  Median : 132.892   Mode  :character   Mode  :character
##  Mean   : 346.524
##  3rd Qu.: 451.361
##  Max.   :1293.117
##     2010-12            2011-01             2011-02
##  Min.   :  -0.004   Length:11          Length:11
##  1st Qu.:   4.466   Class :character   Class :character
##  Median : 121.422   Mode  :character   Mode  :character
##  Mean   : 312.917
##  3rd Qu.: 388.385
##  Max.   :1216.262
##     2011-03          2011-04            2011-05
##  Min.   :   0.05   Length:11          Length:11
##  1st Qu.:   6.03   Class :character   Class :character
##  Median : 134.37   Mode  :character   Mode  :character
##  Mean   : 345.17
##  3rd Qu.: 448.56
##  Max.   :1286.66
##     2011-06           2011-07            2011-08
##  Min.   :   0.054   Length:11          Length:11
##  1st Qu.:   6.926   Class :character   Class :character
##  Median : 135.581   Mode  :character   Mode  :character
##  Mean   : 353.331
##  3rd Qu.: 452.923
##  Max.   :1302.414
##     2011-09           2011-10
##  Min.   :   0.043   Length:11
##  1st Qu.:   6.660   Class :character
##  Median : 136.901   Mode  :character
##  Mean   : 362.555
##  3rd Qu.: 469.204
##  Max.   :1348.754
```

Now time for some data cleaning

In this data, most typical problem of messy data can be seen, that is, "variables are stored in rows instead of columns", so firstly to correct that-

```
## # A tibble: 6 × 3
##           mode   month thousand_riders
##          <chr>   <chr>           <chr>
## 1         Boat 2007-01               4
## 2          Bus 2007-01         335.819
## 3 Commuter Rail 2007-01           142.2
## 4    Heavy Rail 2007-01         435.294
## 5    Light Rail 2007-01         227.231
## 6   Private Bus 2007-01           4.772
```

The column "thousand_riders" showing the average weekday number of riders, is a character vector so first step will be to coerce it into numeric values to make further calculations easy

```
## # A tibble: 6 × 3
##           mode   month thousand_riders
##          <chr>   <chr>           <dbl>
## 1         Boat 2007-01           4.000
## 2          Bus 2007-01         335.819
## 3 Commuter Rail 2007-01         142.200
## 4    Heavy Rail 2007-01         435.294
## 5    Light Rail 2007-01         227.231
## 6   Private Bus 2007-01           4.772
```

Second basic symptomof messy data is, variables stored as rows, so to make this right we have to spread the variables into columns

```
## # A tibble: 6 × 9
##     month  Boat     Bus `Commuter Rail` `Heavy Rail` `Light Rail`
##     <chr> <dbl>   <dbl>           <dbl>        <dbl>        <dbl>
## 1 2007-01   4.0 335.819           142.2      435.294      227.231
## 2 2007-02   3.6 338.675           138.5      448.271      240.262
## 3 2007-03  40.0 339.867           137.7      458.583      241.444
## 4 2007-04   4.3 352.162           139.5      472.201      255.557
## 5 2007-05   4.9 354.367           139.0      474.579      248.262
## 6 2007-06   5.8 350.543           143.0      477.032      246.108
## # ... with 3 more variables: `Private Bus` <dbl>, RIDE <dbl>, `Trackless
## #   Trolley` <dbl>
```

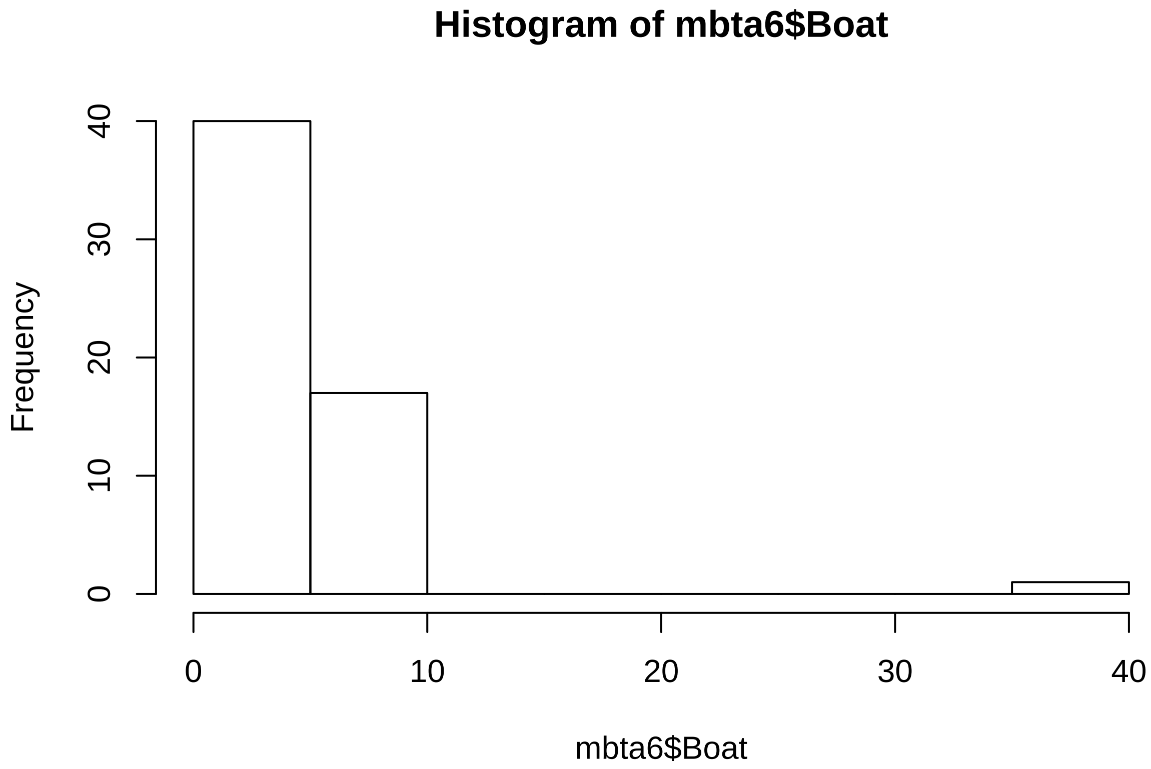
Divide the month column containing month-year data together into “Month and”Year" column separately

```
## # A tibble: 6 × 10
##    Year Month  Boat     Bus `Commuter Rail` `Heavy Rail` `Light Rail`
##   <chr> <chr> <dbl>   <dbl>           <dbl>        <dbl>        <dbl>
## 1  2007    01   4.0 335.819           142.2      435.294      227.231
## 2  2007    02   3.6 338.675           138.5      448.271      240.262
## 3  2007    03  40.0 339.867           137.7      458.583      241.444
## 4  2007    04   4.3 352.162           139.5      472.201      255.557
## 5  2007    05   4.9 354.367           139.0      474.579      248.262
## 6  2007    06   5.8 350.543           143.0      477.032      246.108
## # ... with 3 more variables: `Private Bus` <dbl>, RIDE <dbl>, `Trackless
## #   Trolley` <dbl>
```

Before the data as “clean”, let’s look for any obvious mistakes or outliers in the data

```
## # A tibble: 6 × 10
##    Year Month  Boat     Bus `Commuter Rail` `Heavy Rail` `Light Rail`
##   <chr> <chr> <dbl>   <dbl>           <dbl>        <dbl>        <dbl>
## 1  2007    01   4.0 335.819           142.2      435.294      227.231
## 2  2007    02   3.6 338.675           138.5      448.271      240.262
## 3  2007    03  40.0 339.867           137.7      458.583      241.444
## 4  2007    04   4.3 352.162           139.5      472.201      255.557
## 5  2007    05   4.9 354.367           139.0      474.579      248.262
## 6  2007    06   5.8 350.543           143.0      477.032      246.108
## # ... with 3 more variables: `Private Bus` <dbl>, RIDE <dbl>, `Trackless
## #   Trolley` <dbl>
```

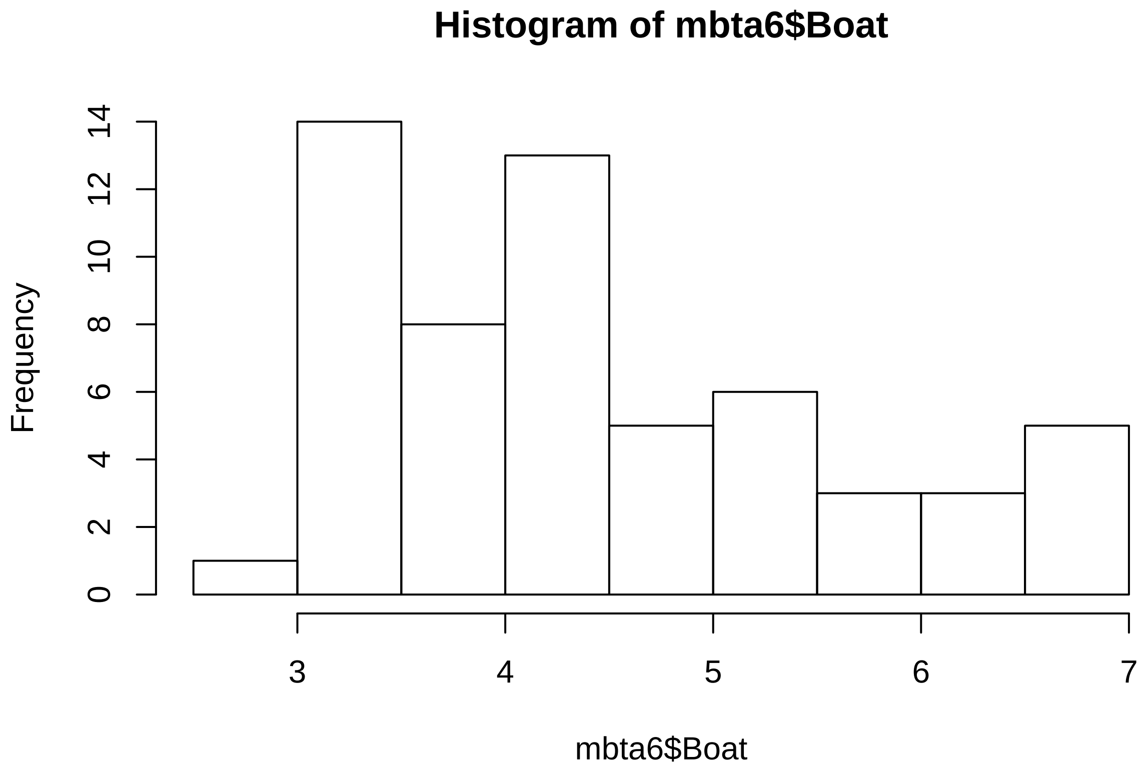
By looking at the data entries in the column "Boat", we can see that there seems to be an obvious data entry error here - Easily seen with a histogram



Now to deal with this entry error-

First find out the row in which this erroneus entry is present and replace the "40" with a "4"

Now generate a histogram of Boat column



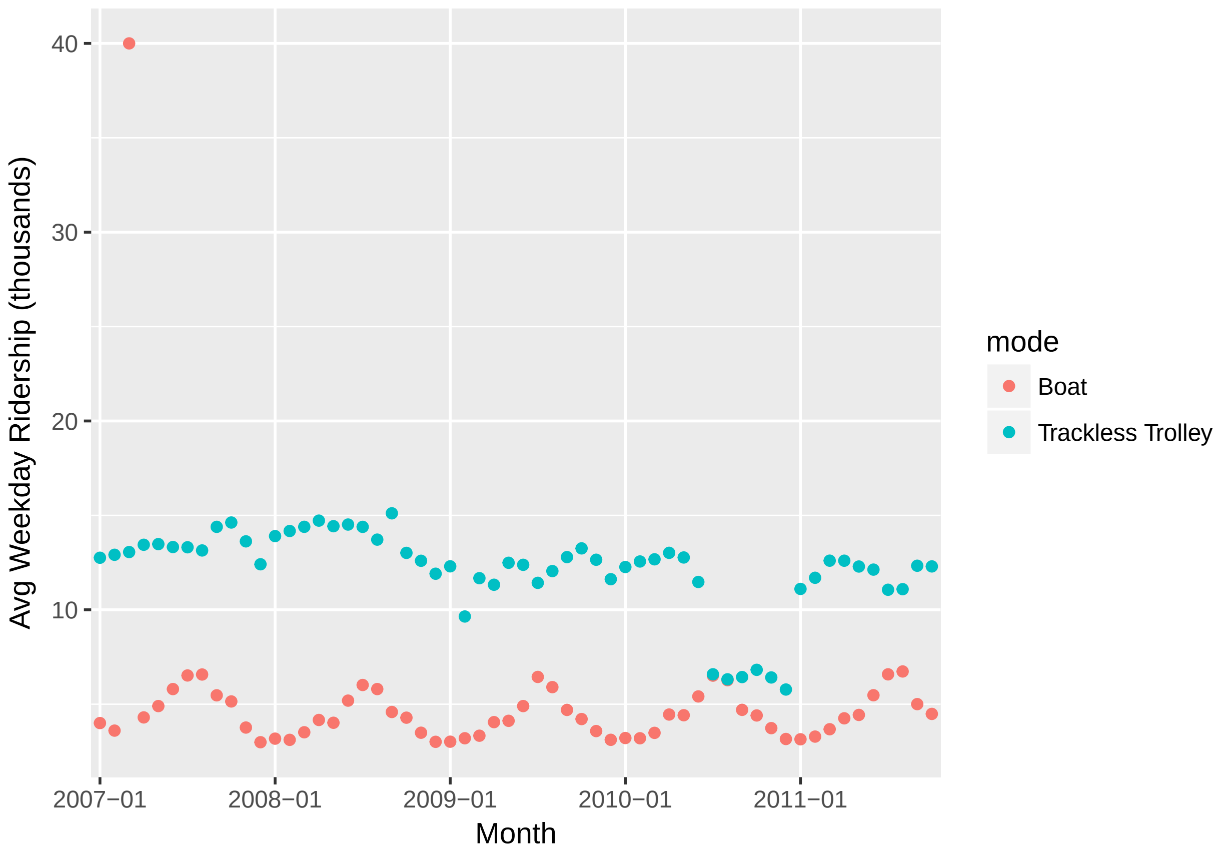
Now that our data is clean lets compare the messy data we got and the clean data, there is quite a lot of visible difference

```
## # A tibble: 6 × 60
##      ``             mode `2007-01` `2007-02` `2007-03` `2007-04` `2007-05`
##   <dbl>            <chr>     <chr>     <chr>     <dbl>     <chr>     <chr>
## 1     1 All Modes by Qtr        NA        NA  1187.653        NA        NA
## 2     2             Boat         4       3.6    40.000       4.3       4.9
## 3     3              Bus   335.819   338.675   339.867   352.162   354.367
## 4     4    Commuter Rail     142.2     138.5   137.700     139.5       139
## 5     5       Heavy Rail   435.294   448.271   458.583   472.201   474.579
## 6     6       Light Rail   227.231   240.262   241.444   255.557   248.262
## # ... with 53 more variables: `2007-06` <dbl>, `2007-07` <chr>,
## #   `2007-08` <chr>, `2007-09` <dbl>, `2007-10` <chr>, `2007-11` <chr>,
## #   `2007-12` <dbl>, `2008-01` <chr>, `2008-02` <chr>, `2008-03` <dbl>,
## #   `2008-04` <chr>, `2008-05` <chr>, `2008-06` <dbl>, `2008-07` <chr>,
## #   `2008-08` <chr>, `2008-09` <dbl>, `2008-10` <chr>, `2008-11` <chr>,
## #   `2008-12` <dbl>, `2009-01` <chr>, `2009-02` <chr>, `2009-03` <dbl>,
## #   `2009-04` <chr>, `2009-05` <chr>, `2009-06` <dbl>, `2009-07` <chr>,
## #   `2009-08` <chr>, `2009-09` <dbl>, `2009-10` <chr>, `2009-11` <chr>,
## #   `2009-12` <dbl>, `2010-01` <chr>, `2010-02` <chr>, `2010-03` <dbl>,
## #   `2010-04` <chr>, `2010-05` <chr>, `2010-06` <dbl>, `2010-07` <chr>,
## #   `2010-08` <chr>, `2010-09` <dbl>, `2010-10` <chr>, `2010-11` <chr>,
## #   `2010-12` <dbl>, `2011-01` <chr>, `2011-02` <chr>, `2011-03` <dbl>,
## #   `2011-04` <chr>, `2011-05` <chr>, `2011-06` <dbl>, `2011-07` <chr>,
## #   `2011-08` <chr>, `2011-09` <dbl>, `2011-10` <chr>
```

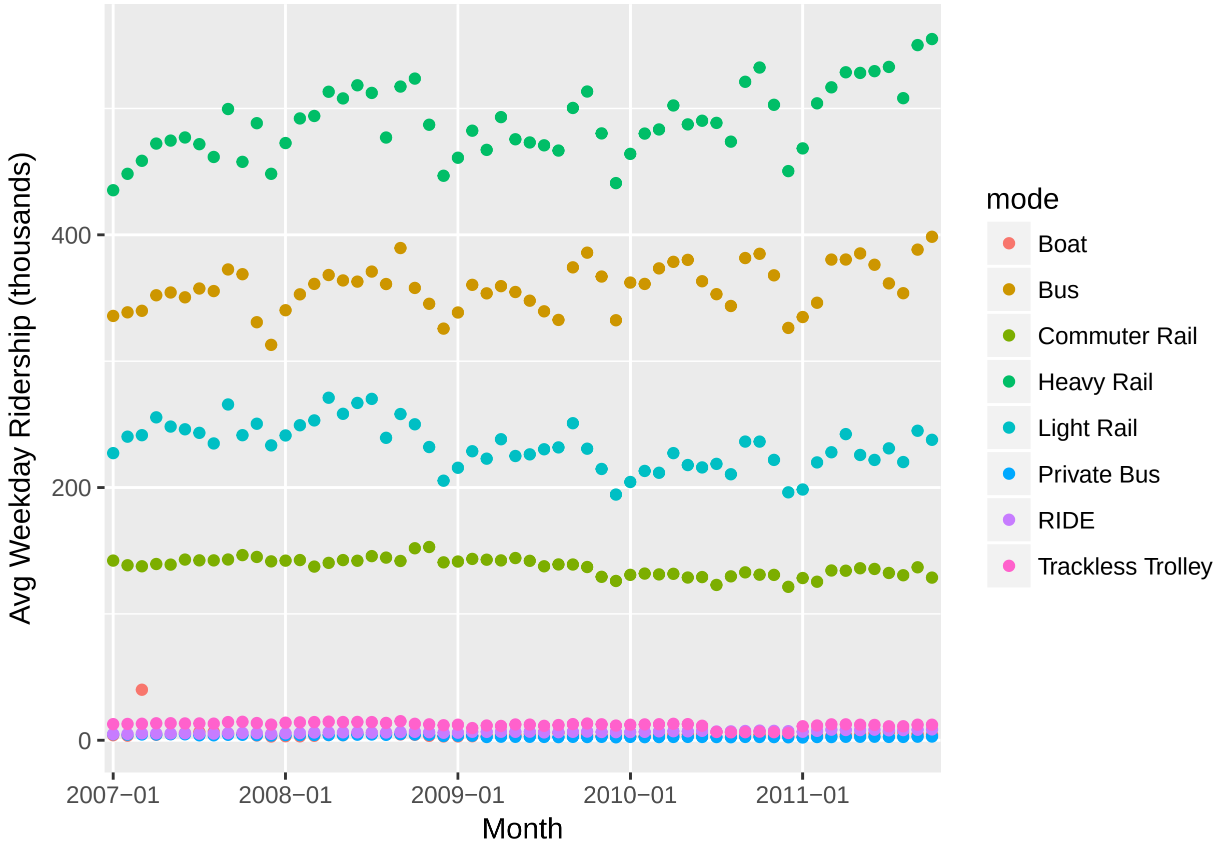
```
## # A tibble: 6 × 10
##    Year Month  Boat     Bus `Commuter Rail` `Heavy Rail` `Light Rail`
##   <chr> <chr> <dbl>   <dbl>           <dbl>        <dbl>        <dbl>
## 1  2007    01   4.0 335.819           142.2      435.294      227.231
## 2  2007    02   3.6 338.675           138.5      448.271      240.262
## 3  2007    03   4.0 339.867           137.7      458.583      241.444
## 4  2007    04   4.3 352.162           139.5      472.201      255.557
## 5  2007    05   4.9 354.367           139.0      474.579      248.262
## 6  2007    06   5.8 350.543           143.0      477.032      246.108
## # ... with 3 more variables: `Private Bus` <dbl>, RIDE <dbl>, `Trackless
## #   Trolley` <dbl>
```

Now lets do some visualizations to finally present the clean data

Look at Boat and Trackless Trolley ridership over time



Look at all T ridership over time


Avg Weekday Ridership (thousands)
Month
mode
Boat
Bus
Commuter Rail
Heavy Rail
Light Rail
Private Bus
RIDE
Trackless Trolley