R Notebook

The goal of this assignment is to get you started with predictive analytics on city bikeshare data. Weu will first prepare and explore the data, and run a basic regression. We will then predict the variable COUNT as a function of the other variables. We will also determine the effect of bad weather on the number of bikes rented. Finally, you will build alternative models, measure and compare their predictive performance, make data-informed and data-driven inferences for a business case.

We will install basic libraries for the analysis in R and analyze the data step by step

```
#setwd("C:/") #Don't forget to set your working directory before you start!

library("tidyverse")
```

```
## ── Attaching packages ─────────────────────────────────────── tidyverse
1.3.0 ──

## ✓ ggplot2 3.2.1     ✓ purrr   0.3.3
## ✓ tibble  2.1.3     ✓ dplyr   0.8.3
## ✓ tidyr   1.0.0     ✓ stringr 1.4.0
## ✓ readr   1.3.1     ✓ forcats 0.4.0

## ── Conflicts ────────────────────────────────────────── tidyverse_conflicts() ──
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library("tidymodels")
```

```
## ── Attaching packages ─────────────────────────────────────── tidymodels
0.0.3 ──

## ✓ broom     0.5.3     ✓ recipes   0.1.9
## ✓ dials     0.0.4     ✓ rsample   0.0.5
## ✓ infer     0.5.1     ✓ yardstick 0.0.4
## ✓ parsnip   0.0.5

## ── Conflicts ──────────────────────────────────────── tidymodels_conflicts() ──
## x scales::discard()   masks purrr::discard()
## x dplyr::filter()     masks stats::filter()
## x recipes::fixed()    masks stringr::fixed()
## x dplyr::lag()        masks stats::lag()
## x dials::margin()     masks ggplot2::margin()
## x yardstick::spec()   masks readr::spec()
## x recipes::step()     masks stats::step()
## x recipes::yj_trans() masks scales::yj_trans()
```

```
library("plotly")
```

```
##
## Attaching package: 'plotly'
```

```
## The following object is masked from 'package:ggplot2':
##
##     last_plot
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following object is masked from 'package:graphics':
##
##     layout
```

```
library("skimr")
library("lubridate")
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:base':
##
##     date
```

a) Data preparation

```
dfbOrg <- read_csv("assignment2BikeShare.csv")
```

```
## Parsed with column specification:
## cols(
##   DATE = col_date(format = ""),
##   HOLIDAY = col_character(),
##   WEEKDAY = col_character(),
##   WEATHERSIT = col_double(),
##   TEMP = col_double(),
##   ATEMP = col_double(),
##   HUMIDITY = col_double(),
##   WINDSPEED = col_double(),
##   CASUAL = col_double(),
##   REGISTERED = col_double()
## )
```

```
skim(dfbOrg)
```

Data summary

Name	dfbOrg
Number of rows	731
Number of columns	10

Column type frequency:

character	2
Date	1
numeric	7

Group variables None

Variable type: character

skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
HOLIDAY	0	1	2	3	0	2	0
WEEKDAY	0	1	2	3	0	2	0

Variable type: Date

skim_variable	n_missing	complete_rate	min	max	median	n_unique
DATE	0	1	2011-01-01	2012-12-31	2012-01-01	731

Variable type: numeric

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
WEATHERSIT	0	1	1.40	0.54	1	1.0	1	2.00	3.00	
TEMP	0	1	15.87	8.83	1	8.0	16	23.15	34.00	
ATEMP	0	1	16.00	9.67	1	6.6	16	23.95	41.00	
HUMIDITY	0	1	63.17	15.47	17	51.0	62	74.00	100.00	
WINDSPEED	0	1	12.82	5.54	0	9.0	12	16.00	40.16	
CASUAL	0	1	848.18	686.62	2	315.5	713	1096.00	3410.00	
REGISTERED	0	1	3656.17	1560.26	20	2497.0	3662	4776.50	6946.00	

1.a.

```
dfbOrg<-
  dfbOrg %>%
```

```
  mutate(Count = CASUAL + REGISTERED, MONTH = months(DATE))
dfbOrg

## # A tibble: 731 x 12
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2011-01-01 NO      NO               2  11    11       81          17
331
##  2 2011-01-02 NO      NO               2   9     6.5     71.5        17
131
##  3 2011-01-03 NO      YES              1   1     4       44          18
120
##  4 2011-01-04 NO      YES              1   2     2.5     64           9
108
##  5 2011-01-05 NO      YES              1   2.5   1       42.5        13
82
##  6 2011-01-06 NO      YES              1   2     2       52           6
88
##  7 2011-01-07 NO      YES              2   1     3       47.5        11
148
##  8 2011-01-08 NO      NO               2   1     5       51          17
68
##  9 2011-01-09 NO      NO               1   2     8.5     46          25
54
## 10 2011-01-10 NO      YES              1   2     6       50          15
41
## # … with 721 more rows, and 3 more variables: REGISTERED <dbl>, Count
<dbl>,
## #   MONTH <chr>
```

1.b.Scale the data (and save it as dfbStd): Start by standardizing the four variables, TEMP, ATEMP, HUMIDITY, WINDSPEED.

```
dfbStd <- cbind.data.frame(dfbOrg[1:4], scale(dfbOrg[5:8]), dfbOrg[9:12])
dfbStd

##           DATE HOLIDAY WEEKDAY WEATHERSIT        TEMP         ATEMP
HUMIDITY
## 1   2011-01-01      NO      NO          2 -0.55208087 -0.5166362098
1.15262592
## 2   2011-01-02      NO      NO          2 -0.77864711 -0.9820289892
0.53843749
## 3   2011-01-03      NO     YES          1 -1.68491207 -1.2405805333 -
1.23947638
## 4   2011-01-04      NO     YES          1 -1.57162895 -1.3957114597
0.05355189
## 5   2011-01-05      NO     YES          1 -1.51498739 -1.5508423862 -
1.33645350
## 6   2011-01-06      NO     YES          1 -1.57162895 -1.4474217685 -
```

```
0.72226507
## 7   2011-01-07      NO     YES          2 -1.68491207 -1.3440011509 -
1.01319644
## 8   2011-01-08      NO      NO          2 -1.68491207 -1.1371599156 -
0.78691649
## 9   2011-01-09      NO      NO          1 -1.57162895 -0.7751877539 -
1.11017356
## 10  2011-01-10      NO     YES          1 -1.57162895 -1.0337392980 -
0.85156790
## 11  2011-01-11      NO     YES          2 -1.68491207 -1.2922908421 -
0.39900801
## 12  2011-01-12      NO     YES          1 -1.68491207 -1.0854496068 -
0.52831083
## 13  2011-01-13      NO     YES          1 -1.57162895 -0.9303186804 -
0.94854502
## 14  2011-01-14      NO     YES          1 -1.57162895 -1.3440011509 -
0.59296225
## 15  2011-01-15      NO      NO          2 -1.40170427 -1.2922908421 -
0.72226507
## 16  2011-01-16      NO      NO          1 -1.51498739 -1.4474217685 -
0.88389361
## 17  2011-01-17     YES     YES          2 -1.68491207 -1.2405805333 -
0.98087073
## 18  2011-01-18      NO     YES          2 -1.68491207 -1.3440011509
1.54053440
## 19  2011-01-19      NO     YES          2 -1.17513803 -1.3957114597
0.53843749
## 20  2011-01-20      NO     YES          2 -1.34506271 -1.4474217685 -
0.46365942
## 21  2011-01-21      NO     YES          1 -1.57162895 -1.1371599156 -
1.36877921
## 22  2011-01-22      NO      NO          1 -1.06185491 -0.5166362098 -
1.36877921
## 23  2011-01-23      NO      NO          1 -1.34506271 -0.6200568275 -
1.36877921
## 24  2011-01-24      NO     YES          1 -1.51498739 -0.9303186804 -
0.91621932
## 25  2011-01-25      NO     YES          2 -1.57162895 -1.2405805333
0.11820330
## 26  2011-01-26      NO     YES          3 -1.57162895 -1.2405805333
1.92844289
## 27  2011-01-27      NO     YES          1 -1.62827051 -1.4474217685
0.44146037
## 28  2011-01-28      NO     YES          2 -1.68491207 -1.4474217685
1.08797451
## 29  2011-01-29      NO      NO          1 -1.68491207 -1.3957114597
0.05355189
## 30  2011-01-30      NO      NO          1 -1.45834583 -1.4474217685
0.44146037
## 31  2011-01-31      NO     YES          2 -1.68491207 -1.2405805333 -
```

```
0.26970518
## 32  2011-02-01      NO     YES          2 -1.57162895 -1.5508423862
1.50820870
## 33  2011-02-02      NO     YES          2 -1.51498739 -1.3957114597
1.92844289
## 34  2011-02-03      NO     YES          1 -1.68491207 -1.1888702244 -
1.23947638
## 35  2011-02-04      NO     YES          2 -1.45834583 -1.4991320773 -
0.26970518
## 36  2011-02-05      NO      NO          2 -1.57162895 -1.5508423862
2.38100278
## 37  2011-02-06      NO      NO          1 -1.28842115 -1.3440011509 -
0.14040235
## 38  2011-02-07      NO     YES          1 -1.23177959 -1.1371599156
0.76471744
## 39  2011-02-08      NO     YES          1 -1.45834583 -1.2405805333 -
1.49808204
## 40  2011-02-09      NO     YES          2 -1.57162895 -1.0337392980 -
1.23947638
## 41  2011-02-10      NO     YES          1 -1.57162895 -1.0854496068 -
1.40110492
## 42  2011-02-11      NO     YES          1 -1.34506271 -1.2405805333 -
0.26970518
## 43  2011-02-12      NO      NO          1 -1.40170427 -1.4474217685 -
1.27180209
## 44  2011-02-13      NO      NO          1 -0.72200555 -1.0337392980 -
1.75668769
## 45  2011-02-14      NO     YES          1 -0.66536399 -1.0337392980 -
1.46575633
## 46  2011-02-15      NO     YES          1 -1.34506271 -1.2922908421 -
2.01529335
## 47  2011-02-16      NO     YES          1 -0.89193023 -1.0854496068 -
1.23947638
## 48  2011-02-17      NO     YES          1 -0.26887307 -0.2580846658 -
0.56063654
## 49  2011-02-18      NO     YES          1 -0.04230683 -0.0512434305 -
0.78691649
## 50  2011-02-19      NO      NO          1 -0.55208087 -0.5166362098 -
2.98506455
## 51  2011-02-20      NO      NO          1 -1.11849647 -1.2405805333 -
1.33645350
## 52  2011-02-21     YES     YES          2 -1.00521335 -1.1371599156
0.18285472
## 53  2011-02-22      NO     YES          1 -1.57162895 -1.0337392980 -
0.20505377
## 54  2011-02-23      NO     YES          1 -1.45834583 -1.0337392980 -
0.98087073
## 55  2011-02-24      NO     YES          2 -1.00521335 -1.2405805333
0.44146037
## 56  2011-02-25      NO     YES          2 -1.00521335 -1.0337392980 -
```

```
0.20505377
## 57  2011-02-26      NO      NO          1 -1.23177959 -1.3440011509 -
0.46365942
## 58  2011-02-27      NO      NO          1 -0.77864711 -0.8268980627 -
0.07575094
## 59  2011-02-28      NO     YES          2 -0.66536399 -0.8268980627
1.92844289
## 60  2011-03-01      NO     YES          1 -1.40170427 -1.2405805333 -
0.33435659
## 61  2011-03-02      NO     YES          1 -1.06185491 -1.2922908421 -
1.69203628
## 62  2011-03-03      NO     YES          1 -1.62827051 -1.3440011509 -
1.88599052
## 63  2011-03-04      NO     YES          2 -1.17513803 -1.2405805333
0.27983184
## 64  2011-03-05      NO      NO          2 -0.43879775 -0.4132155922
0.89402027
## 65  2011-03-06      NO      NO          2 -0.49543931 -0.4649259010
2.38100278
## 66  2011-03-07      NO     YES          1 -1.34506271 -1.2405805333 -
0.98087073
## 67  2011-03-08      NO     YES          1 -1.11849647 -1.3440011509 -
1.14249926
## 68  2011-03-09      NO     YES          2 -1.00521335 -1.3440011509
0.82936885
## 69  2011-03-10      NO     YES          3 -0.60872243 -0.6717671363
2.38100278
## 70  2011-03-11      NO     YES          2 -1.00521335 -1.2405805333 -
0.39900801
## 71  2011-03-12      NO      NO          1 -0.83528867 -1.0854496068
0.02122618
## 72  2011-03-13      NO      NO          1 -0.72200555 -0.7751877539 -
0.62528795
## 73  2011-03-14      NO     YES          1 -0.94857179 -1.0854496068 -
1.01319644
## 74  2011-03-15      NO     YES          2 -1.00521335 -1.1371599156
0.31215754
## 75  2011-03-16      NO     YES          2 -0.77864711 -0.8268980627
1.21727733
## 76  2011-03-17      NO     YES          1 -0.43879775 -0.4132155922 -
0.01109952
## 77  2011-03-18      NO     YES          1  0.35418409  0.3107287312 -
0.72226507
## 78  2011-03-19      NO      NO          1 -0.21223151 -0.2063743570 -
1.62738487
## 79  2011-03-20      NO      NO          1 -0.89193023 -1.1371599156 -
0.75459078
## 80  2011-03-21      NO     YES          2 -0.38215619 -0.3615052834
0.73239173
## 81  2011-03-22      NO     YES          1 -0.32551463 -0.3097949746 -
```

```
0.43133371
## 82  2011-03-23      NO     YES          2 -0.89193023 -1.1371599156
1.54053440
## 83  2011-03-24      NO     YES          2 -1.17513803 -1.4474217685
0.82936885
## 84  2011-03-25      NO     YES          1 -1.28842115 -1.3440011509 -
1.23947638
## 85  2011-03-26      NO      NO          1 -1.34506271 -1.4474217685 -
1.36877921
## 86  2011-03-27      NO      NO          2 -1.34506271 -1.3440011509 -
1.17482497
## 87  2011-03-28      NO     YES          1 -1.34506271 -1.3440011509 -
2.40320183
## 88  2011-03-29      NO     YES          1 -0.94857179 -1.1888702244 -
2.27389900
## 89  2011-03-30      NO     YES          2 -1.00521335 -1.1371599156 -
0.39900801
## 90  2011-03-31      NO     YES          3 -1.28842115 -1.4991320773
1.92844289
## 91  2011-04-01      NO     YES          2 -1.00521335 -1.2405805333 -
0.14040235
## 92  2011-04-02      NO      NO          2 -1.00521335 -1.1888702244
0.15052901
## 93  2011-04-03      NO      NO          1 -0.55208087 -0.5166362098 -
1.23947638
## 94  2011-04-04      NO     YES          1  0.69403345  0.5692802753 -
1.30412780
## 95  2011-04-05      NO     YES          2 -0.66536399 -1.0337392980 -
0.20505377
## 96  2011-04-06      NO     YES          1 -0.38215619 -0.3615052834 -
1.43343062
## 97  2011-04-07      NO     YES          1 -0.43879775 -0.4132155922 -
0.01109952
## 98  2011-04-08      NO     YES          2 -0.89193023 -1.0337392980
1.54053440
## 99  2011-04-09      NO      NO          2 -0.77864711 -0.8268980627
1.54053440
## 100 2011-04-10      NO      NO          2 -0.49543931 -0.4649259010
1.60518582
## 101 2011-04-11      NO     YES          2  0.52410877  0.4658596576
0.63541461
## 102 2011-04-12      NO     YES          2  0.01433473  0.0004668783
0.89402027
## 103 2011-04-13      NO     YES          2 -0.49543931 -0.4649259010
1.41123158
## 104 2011-04-14      NO     YES          1 -0.21223151 -0.2063743570 -
0.52831083
## 105 2011-04-15     YES     YES          1 -0.32551463 -0.3097949746
0.24750613
## 106 2011-04-16      NO      NO          3 -0.43879775 -0.4132155922
```

```
1.60518582
## 107 2011-04-17      NO      NO          1 -0.26887307 -0.2580846658 -
1.30412780
## 108 2011-04-18      NO     YES          1  0.12761785  0.1038874959 -
0.91621932
## 109 2011-04-19      NO     YES          2  0.01433473  0.0004668783
0.27983184
## 110 2011-04-20      NO     YES          1  0.69403345  0.6209905841 -
0.56063654
## 111 2011-04-21      NO     YES          1 -0.26887307 -0.2580846658 -
1.33645350
## 112 2011-04-22      NO     YES          2 -0.89193023 -1.1371599156
0.18285472
## 113 2011-04-23      NO      NO          2 -0.21223151 -0.2063743570
1.60518582
## 114 2011-04-24      NO      NO          2  0.35418409  0.3107287312
1.28192875
## 115 2011-04-25      NO     YES          1  0.58075033  0.5175699665
0.70006603
## 116 2011-04-26      NO     YES          1  0.75067501  0.6727008929
0.70006603
## 117 2011-04-27      NO     YES          2  0.69403345  0.6209905841
1.28192875
## 118 2011-04-28      NO     YES          2  0.69403345  0.6209905841
0.95867168
## 119 2011-04-29      NO     YES          1  0.12761785  0.1038874959 -
1.17482497
## 120 2011-04-30      NO      NO          1 -0.32551463 -0.3097949746 -
0.59296225
## 121 2011-05-01      NO      NO          2 -0.21223151 -0.2063743570
0.89402027
## 122 2011-05-02      NO     YES          2  0.41082565  0.3624390400
0.63541461
## 123 2011-05-03      NO     YES          2  0.69403345  0.6209905841
0.21518042
## 124 2011-05-04      NO     YES          2 -0.55208087 -0.5166362098
0.73239173
## 125 2011-05-05      NO     YES          1 -0.04230683 -0.0512434305 -
1.56273345
## 126 2011-05-06      NO     YES          1 -0.21223151 -0.2063743570 -
0.07575094
## 127 2011-05-07      NO      NO          1  0.24090097  0.2073081136 -
0.91621932
## 128 2011-05-08      NO      NO          1  0.12761785  0.1038874959 -
0.01109952
## 129 2011-05-09      NO     YES          1  0.18425941  0.1555978047 -
0.46365942
## 130 2011-05-10      NO     YES          1  0.18425941  0.1555978047 -
0.72226507
## 131 2011-05-11      NO     YES          1  0.18425941  0.1555978047 -
```

```
0.10807664
## 132 2011-05-12      NO     YES          1  0.24090097  0.2073081136
0.95867168
## 133 2011-05-13      NO     YES          2  0.12761785  0.1038874959
1.60518582
## 134 2011-05-14      NO      NO          2  0.12761785  0.1038874959
1.99309430
## 135 2011-05-15      NO      NO          2  0.29754253  0.2590184224
1.44355728
## 136 2011-05-16      NO     YES          1  0.41082565  0.3624390400
1.28192875
## 137 2011-05-17      NO     YES          2  0.35418409  0.3107287312
1.60518582
## 138 2011-05-18      NO     YES          2  0.24090097  0.2073081136
1.60518582
## 139 2011-05-19      NO     YES          2  0.18425941  0.1555978047
1.60518582
## 140 2011-05-20      NO     YES          1  0.29754253  0.2590184224
0.18285472
## 141 2011-05-21      NO      NO          1  0.63739189  0.5692802753 -
0.04342523
## 142 2011-05-22      NO      NO          1  0.69403345  0.6209905841
0.50611178
## 143 2011-05-23      NO     YES          2  0.69403345  0.7244112017
1.60518582
## 144 2011-05-24      NO     YES          2  0.86395813  0.7761215105
0.70006603
## 145 2011-05-25      NO     YES          1  0.97724125  0.8795421282
0.24750613
## 146 2011-05-26      NO     YES          1  1.20380749  1.1898039810
0.15052901
## 147 2011-05-27      NO     YES          1  1.03388281  0.9312524370
0.11820330
## 148 2011-05-28      NO      NO          1  0.92059969  0.8278318193
0.70006603
## 149 2011-05-29      NO      NO          1  0.92059969  0.9312524370
1.28192875
## 150 2011-05-30     YES     YES          1  1.26044905  1.3449349075
0.44146037
## 151 2011-05-31      NO     YES          1  1.60029841  1.7586173780 -
0.17272806
## 152 2011-06-01      NO     YES          2  1.37373217  1.5517761428
0.70006603
## 153 2011-06-02      NO     YES          1  1.26044905  1.0346730546 -
2.17692188
## 154 2011-06-03      NO     YES          1  0.69403345  0.5175699665 -
1.85366481
## 155 2011-06-04      NO      NO          1  0.80731657  0.7244112017 -
1.07784785
## 156 2011-06-05      NO      NO          2  0.80731657  0.7244112017
```

```
0.11820330
## 157 2011-06-06      NO     YES          1  0.97724125  0.8795421282 -
0.23737947
## 158 2011-06-07      NO     YES          1  1.26044905  1.2932245987 -
0.23737947
## 159 2011-06-08      NO     YES          1  1.71358153  1.8620379956 -
0.07575094
## 160 2011-06-09      NO     YES          2  1.60029841  1.7069070692 -
0.85156790
## 161 2011-06-10      NO     YES          1  1.48701529  1.5000658339 -
0.17272806
## 162 2011-06-11      NO      NO          1  1.20380749  1.2415142899 -
0.07575094
## 163 2011-06-12      NO      NO          1  0.97724125  0.9829627458
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## 164 2011-06-13      NO     YES          1  0.80731657  0.6727008929 -
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## 165 2011-06-14      NO     YES          1  0.58075033  0.5175699665 -
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## 166 2011-06-15      NO     YES          1  0.75067501  0.6727008929 -
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## 167 2011-06-16      NO     YES          2  0.69403345  0.6209905841
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## 168 2011-06-17      NO     YES          1  0.75067501  0.7244112017
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## 169 2011-06-18      NO      NO          1  1.26044905  1.2415142899 -
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## 170 2011-06-19      NO      NO          2  1.14716593  1.1380936722
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## 171 2011-06-20      NO     YES          2  0.80731657  0.7244112017
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## 172 2011-06-21      NO     YES          2  1.03388281  1.0346730546
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## 173 2011-06-22      NO     YES          1  1.31709061  1.5000658339
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## 174 2011-06-23      NO     YES          2  1.26044905  1.3449349075
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## 175 2011-06-24      NO     YES          1  1.20380749  1.1380936722 -
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## 176 2011-06-25      NO      NO          1  1.14716593  1.0346730546 -
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## 177 2011-06-26      NO      NO          1  1.14716593  1.0346730546 -
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## 178 2011-06-27      NO     YES          2  1.14716593  1.1380936722
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## 179 2011-06-28      NO     YES          1  1.37373217  1.3966452163
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## 180 2011-06-29      NO     YES          1  1.26044905  1.1380936722 -
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## 181 2011-06-30      NO     YES          1  1.14716593  1.0346730546 -
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## 182 2011-07-01      NO     YES          1  1.14716593  1.0346730546 -
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## 183 2011-07-02      NO      NO          1  1.37373217  1.2932245987 -
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## 184 2011-07-03      NO      NO          2  1.09052437  1.0863833634
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## 185 2011-07-04     YES     YES          2  1.37373217  1.4483555251 -
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## 186 2011-07-05      NO     YES          1  1.48701529  1.4483555251 -
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## 189 2011-07-08      NO     YES          2  1.14716593  1.1380936722
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## 190 2011-07-09      NO      NO          1  1.37373217  1.3449349075 -
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## 191 2011-07-10      NO      NO          1  1.37373217  1.4483555251 -
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## 192 2011-07-11      NO     YES          1  1.31709061  1.3966452163 -
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## 196 2011-07-15      NO     YES          1  0.92059969  0.8278318193 -
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## 197 2011-07-16      NO      NO          1  1.14716593  1.1380936722 -
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## 198 2011-07-17      NO      NO          1  1.31709061  1.3449349075 -
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## 199 2011-07-18      NO     YES          1  1.43037373  1.5000658339
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## 200 2011-07-19      NO     YES          1  1.48701529  1.7586173780
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## 201 2011-07-20      NO     YES          1  1.48701529  1.8620379956
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## 202 2011-07-21      NO     YES          2  1.82686465  2.5859823191
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## 203 2011-07-22      NO     YES          1  1.94014777  2.2757204662 -
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## 205 2011-07-24      NO      NO          1  1.82686465  2.0688792309 -
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## 206 2011-07-25      NO     YES          1  1.37373217  1.5517761428
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## 207 2011-07-26      NO     YES          1  1.54365685  1.5000658339 -
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## 214 2011-08-02      NO     YES          1  1.71358153  1.6551967604 -
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## 216 2011-08-04      NO     YES          2  1.14716593  1.1380936722
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## 217 2011-08-05      NO     YES          1  1.14716593  1.1380936722
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## 223 2011-08-11      NO     YES          1  1.20380749  1.0863833634 -
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## 225 2011-08-13      NO      NO          2  1.03388281  1.0346730546
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## 226 2011-08-14      NO      NO          2  0.92059969  0.9312524370
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## 227 2011-08-15      NO     YES          1  0.92059969  0.8278318193
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## 228 2011-08-16      NO     YES          1  1.14716593  1.1380936722 -
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## 230 2011-08-18      NO     YES          1  1.03388281  0.9829627458
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## 231 2011-08-19      NO     YES          2  0.86395813  0.8795421282
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## 235 2011-08-23      NO     YES          1  0.75067501  0.6727008929 -
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## 236 2011-08-24      NO     YES          1  1.14716593  1.1380936722 -
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## 237 2011-08-25      NO     YES          2  1.03388281  0.9312524370
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## 241 2011-08-29      NO     YES          1  0.75067501  0.6727008929 -
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## 242 2011-08-30      NO     YES          1  0.86395813  0.7761215105 -
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## 243 2011-08-31      NO     YES          1  0.92059969  0.8278318193 -
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## 244 2011-09-01      NO     YES          1  0.92059969  0.8278318193 -
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## 248 2011-09-05     YES     YES          2  0.97724125  0.9312524370
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## 251 2011-09-08      NO     YES          3  0.69403345  0.7244112017
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## 257 2011-09-14      NO     YES          1  0.92059969  0.8278318193
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## 266 2011-09-23      NO     YES          2  0.69403345  0.7244112017
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## 268 2011-09-25      NO      NO          2  0.75067501  0.7244112017
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## 273 2011-09-30      NO     YES          1  0.24090097  0.2073081136 -
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## 274 2011-10-01      NO      NO          2 -0.55208087 -0.5166362098
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## 275 2011-10-02      NO      NO          2 -0.77864711 -1.0337392980
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## 276 2011-10-03      NO     YES          2 -0.55208087 -0.5166362098
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## 277 2011-10-04      NO     YES          1 -0.04230683 -0.0512434305
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## 291 2011-10-18      NO     YES          2  0.18425941  0.1555978047
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## 292 2011-10-19      NO     YES          3  0.18425941  0.1555978047
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## 295 2011-10-22      NO      NO          1 -0.49543931 -0.4649259010 -
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## 304 2011-10-31      NO     YES          1 -0.89193023 -1.0337392980
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## 305 2011-11-01      NO     YES          1 -0.66536399 -0.6200568275
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## 316 2011-11-12      NO      NO          1 -0.55208087 -0.5166362098 -
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## 384 2012-01-19      NO     YES          1 -1.45834583 -1.4474217685 -
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## 385 2012-01-20      NO     YES          2 -1.57162895 -1.4474217685 -
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## 386 2012-01-21      NO      NO          2 -1.68491207 -1.1371599156
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## 387 2012-01-22      NO      NO          2 -1.68491207 -1.1371599156
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## 388 2012-01-23      NO     YES          2 -1.57162895 -1.5508423862
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## 389 2012-01-24      NO     YES          1 -1.00521335 -1.0337392980
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## 390 2012-01-25      NO     YES          1 -1.17513803 -1.1371599156
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## 391 2012-01-26      NO     YES          2 -0.66536399 -0.6717671363
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## 392 2012-01-27      NO     YES          2 -0.43879775 -0.4132155922 -
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## 393 2012-01-28      NO      NO          1 -1.11849647 -1.2405805333 -
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## 394 2012-01-29      NO      NO          1 -1.11849647 -1.3440011509 -
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## 395 2012-01-30      NO     YES          1 -1.28842115 -1.3440011509 -
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## 396 2012-01-31      NO     YES          1 -0.43879775 -0.4132155922 -
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## 397 2012-02-01      NO     YES          1 -0.21223151 -0.2063743570 -
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## 398 2012-02-02      NO     YES          2 -0.55208087 -0.5166362098
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## 399 2012-02-03      NO     YES          1 -1.06185491 -1.2922908421 -
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## 400 2012-02-04      NO      NO          2 -1.45834583 -1.4474217685
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## 401 2012-02-05      NO      NO          2 -1.34506271 -1.5508423862
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## 402 2012-02-06      NO     YES          1 -1.11849647 -1.2405805333
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## 403 2012-02-07      NO     YES          1 -0.94857179 -0.9820289892 -
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## 404 2012-02-08      NO     YES          2 -1.45834583 -1.5508423862
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## 405 2012-02-09      NO     YES          1 -1.23177959 -1.2405805333 -
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## 406 2012-02-10      NO     YES          2 -1.11849647 -1.2405805333 -
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## 407 2012-02-11      NO      NO          3 -1.57162895 -1.5508423862
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## 408 2012-02-12      NO      NO          1 -1.57162895 -0.8268980627 -
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## 409 2012-02-13      NO     YES          1 -1.34506271 -1.0854496068 -
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## 410 2012-02-14      NO     YES          2 -0.94857179 -0.9820289892 -
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## 411 2012-02-15      NO     YES          1 -0.89193023 -1.0337392980 -
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## 412 2012-02-16      NO     YES          2 -1.00521335 -1.0337392980
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## 413 2012-02-17      NO     YES          1 -0.77864711 -0.9820289892 -
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## 414 2012-02-18      NO      NO          1 -0.83528867 -1.0854496068 -
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## 415 2012-02-19      NO      NO          2 -1.28842115 -1.4474217685 -
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## 416 2012-02-20     YES     YES          1 -1.34506271 -1.2405805333 -
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## 417 2012-02-21      NO     YES          1 -1.00521335 -1.2922908421
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## 418 2012-02-22      NO     YES          1 -0.38215619 -0.3615052834 -
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## 419 2012-02-23      NO     YES          1 -0.32551463 -0.3097949746 -
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## 420 2012-02-24      NO     YES          2 -0.55208087 -0.5166362098
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## 421 2012-02-25      NO      NO          1 -1.11849647 -1.4474217685 -
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## 422 2012-02-26      NO      NO          1 -1.28842115 -1.3440011509 -
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## 423 2012-02-27      NO     YES          1 -0.55208087 -0.5166362098 -
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## 424 2012-02-28      NO     YES          1 -0.83528867 -0.9303186804 -
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## 425 2012-02-29      NO     YES          2 -0.77864711 -1.0337392980
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## 426 2012-03-01      NO     YES          1 -0.21223151 -0.2063743570 -
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## 427 2012-03-02      NO     YES          2 -0.77864711 -0.9303186804
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## 428 2012-03-03      NO      NO          2 -0.55208087 -0.5166362098 -
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## 429 2012-03-04      NO      NO          1 -1.00521335 -1.3957114597 -
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## 430 2012-03-05      NO     YES          1 -1.45834583 -1.4991320773 -
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## 431 2012-03-06      NO     YES          1 -1.23177959 -1.2405805333 -
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## 432 2012-03-07      NO     YES          1 -0.32551463 -0.3097949746 -
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## 434 2012-03-09      NO     YES          2 -0.66536399 -0.9303186804 -
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## 435 2012-03-10      NO      NO          1 -1.34506271 -1.3440011509 -
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## 436 2012-03-11      NO      NO          1 -0.60872243 -0.6200568275 -
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## 437 2012-03-12      NO     YES          1  0.07097629  0.0521771871 -
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## 438 2012-03-13      NO     YES          1  0.29754253  0.2590184224 -
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## 439 2012-03-14      NO     YES          1  0.35418409  0.3107287312 -
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## 440 2012-03-15      NO     YES          1  0.12761785  0.1038874959 -
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## 441 2012-03-16      NO     YES          2 -0.32551463 -0.3097949746
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## 442 2012-03-17      NO      NO          2  0.12761785  0.1038874959
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## 443 2012-03-18      NO      NO          2 -0.21223151 -0.2063743570
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## 444 2012-03-19      NO     YES          1  0.35418409  0.3107287312
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## 445 2012-03-20      NO     YES          1  0.24090097  0.2073081136
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## 446 2012-03-21      NO     YES          2  0.12761785  0.1038874959
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## 447 2012-03-22      NO     YES          1  0.41082565  0.3624390400
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## 448 2012-03-23      NO     YES          2  0.58075033  0.5175699665
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## 449 2012-03-24      NO      NO          2  0.01433473  0.0004668783
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## 450 2012-03-25      NO      NO          2 -0.43879775 -0.4132155922
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## 451 2012-03-26      NO     YES          1 -0.26887307 -0.2580846658 -
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## 452 2012-03-27      NO     YES          1 -1.00521335 -1.1371599156 -
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## 453 2012-03-28      NO     YES          1  0.24090097  0.2073081136 -
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## 454 2012-03-29      NO     YES          1 -0.04230683 -0.0512434305 -
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## 455 2012-03-30      NO     YES          2 -0.72200555 -0.7751877539 -
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## 456 2012-03-31      NO      NO          2 -0.55208087 -0.5166362098
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## 457 2012-04-01      NO      NO          2 -0.38215619 -0.3615052834
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## 458 2012-04-02      NO     YES          1 -0.32551463 -0.3097949746 -
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## 459 2012-04-03      NO     YES          1 -0.04230683 -0.0512434305 -
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## 460 2012-04-04      NO     YES          1  0.35418409  0.3107287312 -
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## 461 2012-04-05      NO     YES          1 -0.43879775 -0.4132155922 -
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## 462 2012-04-06      NO     YES          1 -0.49543931 -0.4649259010 -
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## 463 2012-04-07      NO      NO          1 -0.26887307 -0.2580846658 -
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## 464 2012-04-08      NO      NO          1  0.01433473  0.0004668783 -
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## 465 2012-04-09      NO     YES          1 -0.15558995 -0.1546640481 -
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## 466 2012-04-10      NO     YES          1 -0.38215619 -0.3615052834 -
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## 467 2012-04-11      NO     YES          1 -0.89193023 -1.1371599156 -
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## 468 2012-04-12      NO     YES          1 -0.43879775 -0.4132155922 -
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## 469 2012-04-13      NO     YES          1 -0.32551463 -0.3097949746 -
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## 470 2012-04-14      NO      NO          1  0.24090097  0.2073081136 -
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## 471 2012-04-15      NO      NO          1  0.75067501  0.6727008929 -
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## 472 2012-04-16     YES     YES          1  0.97724125  0.8795421282 -
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## 473 2012-04-17      NO     YES          1  0.58075033  0.5175699665 -
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## 474 2012-04-18      NO     YES          2 -0.21223151 -0.2063743570 -
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## 475 2012-04-19      NO     YES          1  0.07097629  0.0521771871 -
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## 476 2012-04-20      NO     YES          1  0.18425941  0.1555978047
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## 477 2012-04-21      NO      NO          1  0.12761785  0.1038874959
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## 478 2012-04-22      NO      NO          3 -0.66536399 -0.9303186804
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## 479 2012-04-23      NO     YES          2 -1.00521335 -1.2405805333
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## 480 2012-04-24      NO     YES          1 -0.32551463 -0.3097949746 -
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## 481 2012-04-25      NO     YES          1  0.07097629  0.0521771871 -
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## 482 2012-04-26      NO     YES          2  0.01433473  0.0004668783
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## 483 2012-04-27      NO     YES          1 -0.32551463 -0.3097949746 -
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## 484 2012-04-28      NO      NO          2 -0.66536399 -0.7751877539 -
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## 485 2012-04-29      NO      NO          1 -0.15558995 -0.1546640481 -
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## 486 2012-04-30      NO     YES          2 -0.32551463 -0.3097949746 -
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## 487 2012-05-01      NO     YES          2  0.75067501  0.6727008929
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## 488 2012-05-02      NO     YES          1  0.35418409  0.3107287312
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## 489 2012-05-03      NO     YES          2  0.46746721  0.4141493488
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## 490 2012-05-04      NO     YES          1  0.63739189  0.5692802753
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## 491 2012-05-05      NO      NO          2  0.58075033  0.5175699665
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## 492 2012-05-06      NO      NO          2  0.29754253  0.2590184224
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## 493 2012-05-07      NO     YES          2  0.24090097  0.2073081136 -
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## 494 2012-05-08      NO     YES          2  0.58075033  0.5175699665
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## 495 2012-05-09      NO     YES          2  0.35418409  0.3107287312
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## 496 2012-05-10      NO     YES          1  0.01433473  0.0004668783 -
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## 497 2012-05-11      NO     YES          1  0.29754253  0.2590184224 -
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## 498 2012-05-12      NO      NO          1  0.41082565  0.3624390400 -
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## 499 2012-05-13      NO      NO          1  0.69403345  0.6209905841 -
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## 500 2012-05-14      NO     YES          2  0.46746721  0.4141493488
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## 501 2012-05-15      NO     YES          2  0.63739189  0.5692802753
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## 502 2012-05-16      NO     YES          1  0.80731657  0.7244112017
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## 503 2012-05-17      NO     YES          1  0.58075033  0.5175699665 -
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## 504 2012-05-18      NO     YES          1  0.46746721  0.4141493488 -
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## 505 2012-05-19      NO      NO          1  0.63739189  0.5175699665 -
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## 506 2012-05-20      NO      NO          1  0.80731657  0.7244112017 -
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0.72226507
## 507 2012-05-21      NO     YES          2  0.58075033  0.5175699665
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## 508 2012-05-22      NO     YES          2  0.69403345  0.6209905841
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## 509 2012-05-23      NO     YES          2  0.69403345  0.6209905841
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## 510 2012-05-24      NO     YES          1  0.80731657  0.7244112017
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## 511 2012-05-25      NO     YES          1  0.97724125  0.9829627458
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## 512 2012-05-26      NO      NO          1  1.14716593  1.1380936722
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## 513 2012-05-27      NO      NO          1  0.92059969  0.8795421282
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## 514 2012-05-28     YES     YES          1  1.26044905  1.3449349075
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## 515 2012-05-29      NO     YES          1  1.14716593  1.2415142899
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## 516 2012-05-30      NO     YES          2  0.80731657  0.8278318193
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## 517 2012-05-31      NO     YES          1  0.92059969  0.8278318193 -
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## 518 2012-06-01      NO     YES          2  0.80731657  0.7244112017
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## 519 2012-06-02      NO      NO          1  0.46746721  0.4141493488 -
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## 520 2012-06-03      NO      NO          1  0.69403345  0.5175699665 -
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## 521 2012-06-04      NO     YES          1  0.58075033  0.5175699665 -
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## 522 2012-06-05      NO     YES          2  0.24090097  0.2073081136 -
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## 523 2012-06-06      NO     YES          1  0.24090097  0.2073081136
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## 524 2012-06-07      NO     YES          1  0.58075033  0.5175699665 -
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## 525 2012-06-08      NO     YES          1  0.97724125  0.8795421282 -
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## 526 2012-06-09      NO      NO          1  1.14716593  1.0863833634 -
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## 527 2012-06-10      NO      NO          1  1.26044905  1.2415142899 -
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## 528 2012-06-11      NO     YES          2  1.26044905  1.2415142899 -
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## 529 2012-06-12      NO     YES          2  0.92059969  0.9312524370
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## 530 2012-06-13      NO     YES          1  0.80731657  0.7244112017 -
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## 531 2012-06-14      NO     YES          1  0.80731657  0.7244112017 -
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0.39900801
## 532 2012-06-15      NO     YES          1  0.80731657  0.7244112017 -
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## 533 2012-06-16      NO      NO          1  0.75067501  0.6727008929 -
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## 534 2012-06-17      NO      NO          1  0.52410877  0.4658596576 -
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## 535 2012-06-18      NO     YES          2  0.41082565  0.3624390400
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## 536 2012-06-19      NO     YES          1  1.14716593  1.1898039810
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## 537 2012-06-20      NO     YES          1  1.82686465  1.7586173780 -
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## 538 2012-06-21      NO     YES          1  1.77022309  1.9654586133 -
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## 539 2012-06-22      NO     YES          1  1.48701529  1.6551967604 -
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## 540 2012-06-23      NO      NO          1  1.37373217  1.2415142899 -
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## 541 2012-06-24      NO      NO          1  1.48701529  1.3449349075 -
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## 542 2012-06-25      NO     YES          1  1.14716593  1.1380936722 -
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## 543 2012-06-26      NO     YES          1  0.75067501  0.5692802753 -
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## 544 2012-06-27      NO     YES          1  1.20380749  1.0863833634 -
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## 545 2012-06-28      NO     YES          1  1.37373217  1.2415142899 -
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## 546 2012-06-29      NO     YES          1  1.94014777  2.3274307750 -
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## 547 2012-06-30      NO      NO          1  1.60029841  1.7586173780 -
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## 548 2012-07-01      NO      NO          1  1.82686465  1.7586173780 -
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## 549 2012-07-02      NO     YES          1  1.48701529  1.4483555251 -
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## 550 2012-07-03      NO     YES          1  1.43037373  1.4483555251 -
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## 551 2012-07-04     YES     YES          1  1.77022309  1.7069070692 -
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## 552 2012-07-05      NO     YES          1  1.94014777  2.0688792309 -
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## 553 2012-07-06      NO     YES          1  1.82686465  1.8103276868 -
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## 554 2012-07-07      NO      NO          1  2.05343089  2.3274307750 -
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## 555 2012-07-08      NO      NO          1  1.71358153  2.0688792309 -
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## 556 2012-07-09      NO     YES          2  1.14716593  1.2415142899
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## 557 2012-07-10      NO     YES          2  1.14716593  1.1380936722
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## 559 2012-07-12      NO     YES          1  1.26044905  1.1380936722 -
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## 560 2012-07-13      NO     YES          2  1.37373217  1.2415142899 -
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## 561 2012-07-14      NO      NO          2  1.14716593  1.2415142899
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## 562 2012-07-15      NO      NO          1  1.26044905  1.4483555251
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## 563 2012-07-16      NO     YES          1  1.48701529  1.6034864516
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## 564 2012-07-17      NO     YES          1  1.82686465  1.8620379956 -
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## 565 2012-07-18      NO     YES          1  1.48701529  1.5517761428 -
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## 566 2012-07-19      NO     YES          1  1.48701529  1.5517761428 -
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## 567 2012-07-20      NO     YES          2  0.92059969  0.9312524370
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## 568 2012-07-21      NO      NO          3  0.58075033  0.5175699665
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## 569 2012-07-22      NO      NO          2  0.92059969  0.8278318193
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## 570 2012-07-23      NO     YES          1  1.43037373  1.5517761428 -
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## 571 2012-07-24      NO     YES          1  1.37373217  1.5000658339
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## 572 2012-07-25      NO     YES          1  1.26044905  1.1380936722 -
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## 573 2012-07-26      NO     YES          1  1.31709061  1.4483555251
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## 574 2012-07-27      NO     YES          1  1.60029841  1.7586173780 -
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## 575 2012-07-28      NO      NO          1  1.37373217  1.4483555251
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## 576 2012-07-29      NO      NO          1  1.26044905  1.2932245987
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## 577 2012-07-30      NO     YES          1  1.26044905  1.3449349075
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## 578 2012-07-31      NO     YES          1  1.14716593  1.1898039810
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## 579 2012-08-01      NO     YES          1  1.26044905  1.3449349075
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## 581 2012-08-03      NO     YES          2  1.48701529  1.7069070692
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## 582 2012-08-04      NO      NO          1  1.65693997  1.9137483045 -
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## 584 2012-08-06      NO     YES          2  1.37373217  1.5517761428
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## 587 2012-08-09      NO     YES          1  1.26044905  1.3449349075 -
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## 588 2012-08-10      NO     YES          2  1.26044905  1.3449349075
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## 589 2012-08-11      NO      NO          2  0.92059969  0.9312524370
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## 590 2012-08-12      NO      NO          1  1.14716593  1.0346730546 -
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## 591 2012-08-13      NO     YES          1  1.31709061  1.2932245987 -
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## 592 2012-08-14      NO     YES          1  1.26044905  1.3449349075
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## 593 2012-08-15      NO     YES          1  1.14716593  1.1380936722 -
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## 594 2012-08-16      NO     YES          1  1.31709061  1.2415142899 -
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## 595 2012-08-17      NO     YES          1  1.09052437  1.0346730546 -
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## 597 2012-08-19      NO      NO          2  0.80731657  0.7244112017
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## 598 2012-08-20      NO     YES          2  0.69403345  0.6209905841
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## 599 2012-08-21      NO     YES          1  0.80731657  0.7244112017
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## 601 2012-08-23      NO     YES          1  1.14716593  1.1380936722 -
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## 602 2012-08-24      NO     YES          2  1.14716593  1.1380936722 -
0.10807664
## 603 2012-08-25      NO      NO          2  0.92059969  0.8278318193
0.70006603
## 604 2012-08-26      NO      NO          2  0.80731657  0.8278318193
1.66983723
## 605 2012-08-27      NO     YES          1  1.26044905  1.3449349075
0.70006603
## 606 2012-08-28      NO     YES          1  1.20380749  1.1898039810 -
```

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0.46365942
## 607 2012-08-29      NO     YES          1  0.97724125  0.8795421282 -
0.59296225
## 608 2012-08-30      NO     YES          1  1.20380749  1.1898039810 -
0.10807664
## 609 2012-08-31      NO     YES          1  1.48701529  1.5517761428 -
0.07575094
## 610 2012-09-01      NO      NO          2  1.48701529  1.5517761428 -
0.20505377
## 611 2012-09-02      NO      NO          2  1.14716593  1.1898039810
1.34658016
## 612 2012-09-03     YES     YES          1  1.14716593  1.2415142899
1.28192875
## 613 2012-09-04      NO     YES          1  1.37373217  1.5517761428
0.70006603
## 614 2012-09-05      NO     YES          1  1.26044905  1.4483555251
0.70006603
## 615 2012-09-06      NO     YES          2  1.14716593  1.2415142899
1.34658016
## 616 2012-09-07      NO     YES          1  1.14716593  1.2415142899
0.70006603
## 617 2012-09-08      NO      NO          2  0.92059969  0.9312524370
1.60518582
## 618 2012-09-09      NO      NO          1  0.63739189  0.5175699665 -
0.81924220
## 619 2012-09-10      NO     YES          1  0.58075033  0.5175699665 -
0.85156790
## 620 2012-09-11      NO     YES          1  0.41082565  0.3624390400 -
0.36668230
## 621 2012-09-12      NO     YES          1  0.58075033  0.5175699665 -
0.04342523
## 622 2012-09-13      NO     YES          1  0.63739189  0.5692802753
0.24750613
## 623 2012-09-14      NO     YES          1  0.69403345  0.6209905841
0.63541461
## 624 2012-09-15      NO      NO          1  0.58075033  0.5175699665 -
1.11017356
## 625 2012-09-16      NO      NO          1  0.52410877  0.4658596576 -
0.30203089
## 626 2012-09-17      NO     YES          2  0.69403345  0.6209905841
0.63541461
## 627 2012-09-18      NO     YES          2  0.69403345  0.7244112017
1.60518582
## 628 2012-09-19      NO     YES          1  0.24090097  0.2073081136 -
0.26970518
## 629 2012-09-20      NO     YES          1  0.35418409  0.3107287312
0.02122618
## 630 2012-09-21      NO     YES          1  0.58075033  0.5175699665
0.37680896
## 631 2012-09-22      NO      NO          1  0.80731657  0.7244112017 -
```

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0.33435659
## 632 2012-09-23      NO      NO          1  0.12761785  0.1038874959 -
1.01319644
## 633 2012-09-24      NO     YES          1  0.07097629  0.0521771871 -
0.72226507
## 634 2012-09-25      NO     YES          1  0.58075033  0.5175699665 -
0.39900801
## 635 2012-09-26      NO     YES          1  0.69403345  0.6209905841
0.05355189
## 636 2012-09-27      NO     YES          2  0.58075033  0.5175699665
0.95867168
## 637 2012-09-28      NO     YES          2  0.68270514  0.6727008929
0.35094839
## 638 2012-09-29      NO      NO          1  0.22957266  0.2383342989 -
0.48951999
## 639 2012-09-30      NO      NO          1  0.16160279  0.1866239900 -
0.34082173
## 640 2012-10-01      NO     YES          2  0.13894616  0.0935454342
0.12466844
## 641 2012-10-02      NO     YES          3  0.56942202  0.4451755341
1.70216294
## 642 2012-10-03      NO     YES          2  0.84130151  0.8485159429
1.28192875
## 643 2012-10-04      NO     YES          2  0.88661475  0.8174897576
0.65481004
## 644 2012-10-05      NO     YES          1  0.67137683  0.6416747076 -
0.04342523
## 645 2012-10-06      NO      NO          1  0.32019916  0.3314128547
0.18931986
## 646 2012-10-07      NO      NO          2 -0.48411100 -0.5062941481
0.64834489
## 647 2012-10-08     YES     YES          2 -0.65403568 -0.6510830128
0.55783292
## 648 2012-10-09      NO     YES          2 -0.34817125 -0.2787687893
0.90048541
## 649 2012-10-10      NO     YES          1  0.01433473  0.1245716195
0.41559981
## 650 2012-10-11      NO     YES          1 -0.33684294 -0.2787687893 -
1.13603412
## 651 2012-10-12      NO     YES          1 -0.33684294 -0.2477426040 -
0.59296225
## 652 2012-10-13      NO      NO          1 -0.59739412 -0.5580044569 -
0.85156790
## 653 2012-10-14      NO      NO          1  0.15027448  0.1555978047
0.02769132
## 654 2012-10-15      NO     YES          2  0.39949734  0.2176501753
0.54490263
## 655 2012-10-16      NO     YES          1 -0.16691826 -0.1650061099 -
0.47658970
## 656 2012-10-17      NO     YES          1 -0.21223151 -0.1339799246
```

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0.33155297
## 657 2012-10-18      NO     YES          2  0.11628954  0.0935454342
0.62248433
## 658 2012-10-19      NO     YES          2  0.38816903  0.3314128547
1.22374248
## 659 2012-10-20      NO      NO          1 -0.06496345 -0.0719275540 -
0.38607772
## 660 2012-10-21      NO      NO          1 -0.18957488 -0.1650061099 -
0.78045135
## 661 2012-10-22      NO     YES          1 -0.03097852 -0.0202172452 -
0.50891541
## 662 2012-10-23      NO     YES          1  0.32019916  0.2176501753 -
0.01756467
## 663 2012-10-24      NO     YES          1  0.51278046  0.5899643988
0.01476104
## 664 2012-10-25      NO     YES          2  0.26355760  0.3520969782
1.17848649
## 665 2012-10-26      NO     YES          2  0.26355760  0.3314128547
1.17848649
## 666 2012-10-27      NO      NO          2  0.16160279  0.2176501753
0.58369348
## 667 2012-10-28      NO      NO          2 -0.13293332 -0.1650061099
0.39620438
## 668 2012-10-29      NO     YES          3 -0.59739412 -0.5580044569
1.37890587
## 669 2012-10-30      NO     YES          2 -1.08451153 -0.9613448657
1.45002242
## 670 2012-10-31      NO     YES          2 -0.80130373 -0.7338195069
0.35741353
## 671 2012-11-01      NO     YES          2 -0.74466217 -0.7648456922 -
0.34728688
## 672 2012-11-02      NO     YES          1 -0.80130373 -0.7338195069 -
0.70933479
## 673 2012-11-03      NO      NO          2 -0.86927360 -0.8165560010 -
0.85156790
## 674 2012-11-04      NO      NO          1 -0.98255672 -0.8786083716 -
0.58649711
## 675 2012-11-05      NO     YES          1 -1.02786997 -0.9613448657 -
0.87742847
## 676 2012-11-06      NO     YES          1 -1.22045128 -1.1371599156 -
0.37961258
## 677 2012-11-07      NO     YES          2 -1.15248140 -1.0751075451 -
0.48305484
## 678 2012-11-08      NO     YES          1 -0.84661698 -0.7027933216 -
1.84719967
## 679 2012-11-09      NO     YES          1 -0.76731880 -0.7338195069 -
0.47658970
## 680 2012-11-10      NO      NO          1 -0.60872243 -0.5580044569
0.11173816
## 681 2012-11-11      NO      NO          1 -0.41614112 -0.2477426040
```

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0.18285472
## 682 2012-11-12     YES     YES          1 -0.03097852 -0.0409013688
0.71946145
## 683 2012-11-13      NO     YES          2 -0.91458685 -0.7338195069
0.43499523
## 684 2012-11-14      NO     YES          1 -1.18646634 -1.0751075451 -
0.46365942
## 685 2012-11-15      NO     YES          2 -0.99388504 -0.9406607421 -
0.08221608
## 686 2012-11-16      NO     YES          1 -0.86927360 -0.7338195069 -
0.67700909
## 687 2012-11-17      NO      NO          1 -0.97122841 -0.9096345568 -
0.53477598
## 688 2012-11-18      NO      NO          1 -0.86927360 -0.7958718775
0.42206495
## 689 2012-11-19      NO     YES          2 -0.67669230 -0.5890306422 -
0.01756467
## 690 2012-11-20      NO     YES          2 -0.69934892 -0.5580044569
0.38973924
## 691 2012-11-21      NO     YES          1 -0.81263204 -0.7027933216 -
0.12100693
## 692 2012-11-22     YES     YES          1 -0.90325854 -0.7648456922 -
0.30849603
## 693 2012-11-23      NO     YES          1 -0.69934892 -0.7027933216 -
0.47012456
## 694 2012-11-24      NO      NO          1 -1.27709284 -1.1061337303 -
1.42696548
## 695 2012-11-25      NO      NO          1 -1.43568920 -1.2819487803 -
0.92914960
## 696 2012-11-26      NO     YES          1 -1.01654166 -0.9613448657 -
0.61882281
## 697 2012-11-27      NO     YES          2 -1.17513803 -1.1371599156
1.09443965
## 698 2012-11-28      NO     YES          1 -1.14115309 -1.0233972362 -
0.86449818
## 699 2012-11-29      NO     YES          1 -1.00521335 -1.0854496068 -
1.07784785
## 700 2012-11-30      NO     YES          1 -1.57162895 -1.4474217685
0.82936885
## 701 2012-12-01      NO      NO          2 -1.15248140 -1.1371599156
1.21081219
## 702 2012-12-02      NO      NO          2 -0.43879775 -0.4132155922
1.21727733
## 703 2012-12-03      NO     YES          1 -0.04230683 -0.0512434305
0.60308891
## 704 2012-12-04      NO     YES          1 -0.09894839 -0.1029537393
0.31215754
## 705 2012-12-05      NO     YES          1 -0.32551463 -0.3097949746 -
1.04552214
## 706 2012-12-06      NO     YES          1 -1.45834583 -1.3957114597 -
```

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0.72226507
## 707 2012-12-07      NO     YES          2 -0.94857179 -1.0854496068
0.82936885
## 708 2012-12-08      NO      NO          2 -0.66536399 -0.6717671363
1.99309430
## 709 2012-12-09      NO      NO          2 -0.55208087 -0.5166362098
1.60518582
## 710 2012-12-10      NO     YES          2 -0.32551463 -0.3097949746
1.99309430
## 711 2012-12-11      NO     YES          2 -0.89193023 -1.1371599156 -
0.20505377
## 712 2012-12-12      NO     YES          2 -1.11849647 -1.3440011509 -
0.52831083
## 713 2012-12-13      NO     YES          1 -1.23177959 -1.2405805333 -
0.65761366
## 714 2012-12-14      NO     YES          1 -1.23177959 -1.2405805333
0.44146037
## 715 2012-12-15      NO      NO          1 -0.77864711 -0.9303186804 -
0.07575094
## 716 2012-12-16      NO      NO          2 -0.77864711 -0.8268980627
1.54053440
## 717 2012-12-17      NO     YES          2 -0.55208087 -0.5166362098
1.79914006
## 718 2012-12-18      NO     YES          1 -0.49543931 -0.4649259010 -
0.07575094
## 719 2012-12-19      NO     YES          1 -1.00521335 -1.1371599156 -
0.07575094
## 720 2012-12-20      NO     YES          2 -0.89193023 -1.0337392980
0.50611178
## 721 2012-12-21      NO     YES          2 -1.00521335 -1.3440011509 -
1.17482497
## 722 2012-12-22      NO      NO          1 -1.34506271 -1.5508423862 -
1.17482497
## 723 2012-12-23      NO      NO          1 -1.45834583 -1.3440011509 -
0.78691649
## 724 2012-12-24      NO     YES          2 -1.45834583 -1.5508423862
1.08797451
## 725 2012-12-25     YES     YES          2 -1.17513803 -1.2922908421
0.66774032
## 726 2012-12-26      NO     YES          3 -1.51498739 -1.3440011509
1.54053440
## 727 2012-12-27      NO     YES          2 -1.45834583 -1.5508423862 -
0.20505377
## 728 2012-12-28      NO     YES          2 -1.45834583 -1.5508423862 -
0.20505377
## 729 2012-12-29      NO      NO          2 -1.45834583 -1.4474217685
0.76471744
## 730 2012-12-30      NO      NO          1 -1.34506271 -1.5508423862 -
0.78691649
## 731 2012-12-31      NO     YES          2 -1.45834583 -1.4474217685 -
```

```
0.26970518
##       WINDSPEED CASUAL REGISTERED Count     MONTH
## 1    0.75557339    331        654   985   January
## 2    0.75557339    131        670   801   January
## 3    0.93616826    120       1229  1349   January
## 4   -0.68918562    108       1454  1562   January
## 5    0.03319388     82       1518  1600   January
## 6   -1.23097025     88       1518  1606   January
## 7   -0.32799587    148       1362  1510   January
## 8    0.75557339     68        891   959   January
## 9    2.20033239     54        768   822   January
## 10   0.39438363     41       1280  1321   January
## 11  -1.05037537     43       1220  1263   January
## 12   1.65854777     25       1137  1162   January
## 13   1.29735801     38       1368  1406   January
## 14  -0.86978050     54       1367  1421   January
## 15  -0.14740099    222       1026  1248   January
## 16   0.39438363    251        953  1204   January
## 17   0.03319388    117        883  1000   January
## 18   0.21378876      9        674   683   January
## 19  -0.50859075     78       1572  1650   January
## 20   0.39438363     83       1844  1927   January
## 21   1.65854777     75       1468  1543   January
## 22  -0.32799587     93        888   981   January
## 23   0.39438363    150        836   986   January
## 24   0.03319388     86       1330  1416   January
## 25  -0.68918562    186       1799  1985   January
## 26   1.65854777     34        472   506   January
## 27  -0.14740099     15        416   431   January
## 28  -1.05037537     38       1129  1167   January
## 29  -0.68918562    123        975  1098   January
## 30  -2.31453951    140        956  1096   January
## 31   0.03319388     42       1459  1501   January
## 32  -2.31453951     47       1313  1360  February
## 33   0.57497851     72       1454  1526  February
## 34   1.29735801     61       1489  1550  February
## 35  -0.68918562     88       1620  1708  February
## 36  -0.50859075    100        905  1005  February
## 37  -1.05037537    354       1269  1623  February
## 38  -2.31453951    120       1592  1712  February
## 39   2.56152214     64       1466  1530  February
## 40  -0.14740099     53       1552  1605  February
## 41   0.39438363     47       1491  1538  February
## 42  -1.23097025    149       1597  1746  February
## 43  -0.50859075    288       1184  1472  February
## 44   1.29735801    397       1192  1589  February
## 45   2.92271190    208       1705  1913  February
## 46   0.75557339    140       1675  1815  February
## 47   0.39438363    218       1897  2115  February
## 48   0.39438363    259       2216  2475  February
```

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## 49   0.57497851    579       2348  2927  February
## 50   4.00628115    532       1103  1635  February
## 51  -0.32799587    639       1173  1812  February
## 52   1.29735801    195        912  1107  February
## 53   0.75557339     74       1376  1450  February
## 54  -1.23097025    139       1778  1917  February
## 55   1.11676314    100       1707  1807  February
## 56   2.01973752    120       1341  1461  February
## 57   0.21378876    424       1545  1969  February
## 58  -0.68918562    694       1708  2402  February
## 59   1.20706058     81       1365  1446  February
## 60   0.21378876    137       1714  1851     March
## 61   1.20706058    231       1903  2134     March
## 62   0.03319388    123       1562  1685     March
## 63   0.03319388    214       1730  1944     March
## 64   1.20706058    640       1437  2077     March
## 65   1.47795289    114        491   605     March
## 66   2.38092727    244       1628  1872     March
## 67  -0.86978050    316       1817  2133     March
## 68   0.75557339    191       1700  1891     March
## 69   0.75557339     46        577   623     March
## 70   0.75557339    247       1730  1977     March
## 71   0.03319388    724       1408  2132     March
## 72   1.29735801    982       1435  2417     March
## 73  -0.68918562    359       1687  2046     March
## 74   0.03319388    289       1767  2056     March
## 75   0.03319388    321       1871  2192     March
## 76   0.39438363    424       2320  2744     March
## 77   0.39438363    884       2355  3239     March
## 78   2.20033239   1424       1693  3117     March
## 79   0.39438363   1047       1424  2471     March
## 80   1.20706058    401       1676  2077     March
## 81   0.57497851    460       2243  2703     March
## 82   0.39438363    203       1918  2121     March
## 83   0.39438363    166       1699  1865     March
## 84   0.75557339    300       1910  2210     March
## 85   0.03319388    981       1515  2496     March
## 86  -0.14740099    472       1221  1693     March
## 87   0.39438363    222       1806  2028     March
## 88   0.75557339    317       2108  2425     March
## 89   0.39438363    168       1368  1536     March
## 90   0.39438363    179       1506  1685     March
## 91   0.75557339    307       1920  2227     April
## 92  -0.32799587    898       1354  2252     April
## 93   0.03319388   1651       1598  3249     April
## 94   2.20033239    734       2381  3115     April
## 95   2.74211702    167       1628  1795     April
## 96   0.93616826    413       2395  2808     April
## 97   0.03319388    571       2570  3141     April
## 98   0.39438363    172       1299  1471     April
```

```
## 99  -0.68918562    879       1576  2455     April
## 100 -0.68918562   1188       1707  2895     April
## 101  1.20706058    855       2493  3348     April
## 102  1.11676314    257       1777  2034     April
## 103  0.75557339    209       1953  2162     April
## 104 -0.68918562    529       2738  3267     April
## 105  0.75557339    642       2484  3126     April
## 106  1.65854777    121        674   795     April
## 107  1.65854777   1558       2186  3744     April
## 108 -0.32799587    669       2760  3429     April
## 109 -0.32799587    409       2795  3204     April
## 110  0.75557339    613       3331  3944     April
## 111  1.83914264    745       3444  4189     April
## 112  0.39438363    177       1506  1683     April
## 113  0.39438363   1462       2574  4036     April
## 114  0.03319388   1710       2481  4191     April
## 115  0.39438363    773       3300  4073     April
## 116  1.65854777    678       3722  4400     April
## 117  1.11676314    547       3325  3872     April
## 118  1.65854777    569       3489  4058     April
## 119  1.11676314    878       3717  4595     April
## 120  0.39438363   1965       3347  5312     April
## 121 -1.05037537   1138       2213  3351       May
## 122  0.03319388    847       3554  4401       May
## 123  1.83914264    603       3848  4451       May
## 124  1.65854777    255       2378  2633       May
## 125  0.75557339    614       3819  4433       May
## 126 -0.32799587    894       3714  4608       May
## 127 -0.32799587   1612       3102  4714       May
## 128 -1.23097025   1401       2932  4333       May
## 129  0.03319388    664       3698  4362       May
## 130 -0.86978050    694       4109  4803       May
## 131 -0.68918562    550       3632  4182       May
## 132  0.03319388    695       4169  4864       May
## 133 -0.32799587    692       3413  4105       May
## 134 -0.68918562    902       2507  3409       May
## 135 -0.68918562   1582       2971  4553       May
## 136 -0.68918562    773       3185  3958       May
## 137  1.29735801    678       3445  4123       May
## 138  0.39438363    536       3319  3855       May
## 139 -1.14067281    735       3840  4575       May
## 140 -1.05037537    909       4008  4917       May
## 141 -0.86978050   2258       3547  5805       May
## 142 -0.68918562   1576       3084  4660       May
## 143  0.39438363    836       3438  4274       May
## 144  0.03319388    659       3833  4492       May
## 145 -0.68918562    740       4238  4978       May
## 146 -0.14740099    758       3919  4677       May
## 147  0.75557339    871       3808  4679       May
## 148  0.39438363   2001       2757  4758       May
```

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## 149  0.39438363   2355       2433  4788       May
## 150 -1.05037537   1549       2549  4098       May
## 151 -0.86978050    673       3309  3982       May
## 152  0.03319388    513       3461  3974      June
## 153  1.29735801    736       4232  4968      June
## 154  1.11676314    898       4414  5312      June
## 155 -1.05037537   1869       3473  5342      June
## 156 -0.32799587   1685       3221  4906      June
## 157 -0.68918562    673       3875  4548      June
## 158 -0.14740099    763       4070  4833      June
## 159 -0.68918562    676       3725  4401      June
## 160 -0.50859075    563       3352  3915      June
## 161 -0.68918562    815       3771  4586      June
## 162 -0.50859075   1729       3237  4966      June
## 163 -0.32799587   1467       2993  4460      June
## 164  1.29735801    863       4157  5020      June
## 165  0.93616826    727       4164  4891      June
## 166 -0.32799587    769       4411  5180      June
## 167  0.03319388    545       3222  3767      June
## 168 -0.68918562    863       3981  4844      June
## 169 -0.86978050   1807       3312  5119      June
## 170 -1.05037537   1639       3105  4744      June
## 171 -0.32799587    699       3311  4010      June
## 172 -0.32799587    774       4061  4835      June
## 173 -0.14740099    661       3846  4507      June
## 174  0.39438363    746       4044  4790      June
## 175  0.39438363    969       4022  4991      June
## 176  0.03319388   1782       3420  5202      June
## 177 -1.05037537   1920       3385  5305      June
## 178 -0.68918562    854       3854  4708      June
## 179 -0.32799587    732       3916  4648      June
## 180  0.93616826    848       4377  5225      June
## 181  0.03319388   1027       4488  5515      June
## 182 -0.68918562   1246       4116  5362      July
## 183 -1.05037537   2204       2915  5119      July
## 184 -0.14740099   2282       2367  4649      July
## 185 -1.23097025   3065       2978  6043      July
## 186 -1.05037537   1031       3634  4665      July
## 187 -0.32799587    784       3845  4629      July
## 188 -0.32799587    754       3838  4592      July
## 189  0.39438363    692       3348  4040      July
## 190 -0.32799587   1988       3348  5336      July
## 191  0.03319388   1743       3138  4881      July
## 192  1.11676314    723       3363  4086      July
## 193  0.03319388    662       3596  4258      July
## 194 -0.32799587    748       3594  4342      July
## 195  0.75557339    888       4196  5084      July
## 196  0.03319388   1318       4220  5538      July
## 197  0.39438363   2418       3505  5923      July
## 198  0.39438363   2006       3296  5302      July
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## 199  0.39438363    841       3617  4458      July
## 200 -0.68918562    752       3789  4541      July
## 201 -1.05037537    644       3688  4332      July
## 202  0.39438363    632       3152  3784      July
## 203 -1.05037537    562       2825  3387      July
## 204 -0.68918562    987       2298  3285      July
## 205 -0.50859075   1050       2556  3606      July
## 206 -1.23097025    568       3272  3840      July
## 207  0.39438363    750       3840  4590      July
## 208  0.21378876    755       3901  4656      July
## 209  0.03319388    606       3784  4390      July
## 210  0.03319388    670       3176  3846      July
## 211 -0.32799587   1559       2916  4475      July
## 212 -0.32799587   1524       2778  4302      July
## 213 -0.14740099    729       3537  4266    August
## 214  0.39438363    801       4044  4845    August
## 215 -0.68918562    467       3107  3574    August
## 216  0.21378876    799       3777  4576    August
## 217  0.39438363   1023       3843  4866    August
## 218  0.39438363   1521       2773  4294    August
## 219  0.03319388   1298       2487  3785    August
## 220 -0.50859075    846       3480  4326    August
## 221 -0.32799587    907       3695  4602    August
## 222  0.21378876    884       3896  4780    August
## 223 -0.32799587    812       3980  4792    August
## 224 -0.68918562   1051       3854  4905    August
## 225  0.03319388   1504       2646  4150    August
## 226  0.21378876   1338       2482  3820    August
## 227  0.39438363    775       3563  4338    August
## 228  0.57497851    721       4004  4725    August
## 229 -0.32799587    668       4026  4694    August
## 230  0.75557339    639       3166  3805    August
## 231 -1.23097025    797       3356  4153    August
## 232 -0.68918562   1914       3277  5191    August
## 233  0.75557339   1249       2624  3873    August
## 234  1.29735801    833       3925  4758    August
## 235 -0.14740099   1281       4614  5895    August
## 236  1.29735801    949       4181  5130    August
## 237  1.29735801    435       3107  3542    August
## 238 -1.05037537    768       3893  4661    August
## 239  3.01300933    226        889  1115    August
## 240  2.38092727   1415       2919  4334    August
## 241 -0.32799587    729       3905  4634    August
## 242 -0.68918562    775       4429  5204    August
## 243 -1.23097025    688       4370  5058    August
## 244 -0.68918562    783       4332  5115 September
## 245 -0.68918562    875       3852  4727 September
## 246 -0.32799587   1935       2549  4484 September
## 247  0.03319388   2521       2419  4940 September
## 248 -0.32799587   1236       2115  3351 September
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## 249  2.01973752    204       2506  2710 September
## 250 -1.05037537    118       1878  1996 September
## 251 -0.32799587    153       1689  1842 September
## 252 -0.68918562    417       3127  3544 September
## 253 -0.68918562   1750       3595  5345 September
## 254 -1.05037537   1633       3413  5046 September
## 255 -1.23097025    690       4023  4713 September
## 256 -0.68918562    701       4062  4763 September
## 257 -0.50859075    647       4138  4785 September
## 258  0.93616826    428       3231  3659 September
## 259 -0.14740099    742       4018  4760 September
## 260  0.03319388   1434       3077  4511 September
## 261  0.03319388   1353       2921  4274 September
## 262 -0.32799587    691       3848  4539 September
## 263 -0.32799587    438       3203  3641 September
## 264 -1.14067281    539       3813  4352 September
## 265 -1.05037537    555       4240  4795 September
## 266 -1.23097025    258       2137  2395 September
## 267 -1.23097025   1776       3647  5423 September
## 268 -1.77275488   1544       3466  5010 September
## 269 -0.68918562    684       3946  4630 September
## 270 -1.05037537    477       3643  4120 September
## 271 -0.86978050    480       3427  3907 September
## 272  0.03319388    653       4186  4839 September
## 273  0.03319388    830       4372  5202 September
## 274  1.65854777    480       1949  2429   October
## 275  0.39438363    616       2302  2918   October
## 276 -1.05037537    330       3240  3570   October
## 277  0.39438363    486       3970  4456   October
## 278 -0.32799587    559       4267  4826   October
## 279 -0.68918562    639       4126  4765   October
## 280 -2.31453951    949       4036  4985   October
## 281 -2.31453951   2235       3174  5409   October
## 282 -1.23097025   2397       3114  5511   October
## 283 -2.31453951   1514       3603  5117   October
## 284 -0.50859075    667       3896  4563   October
## 285  0.75557339    217       2199  2416   October
## 286 -0.68918562    290       2623  2913   October
## 287  0.03319388    529       3115  3644   October
## 288  0.21378876   1899       3318  5217   October
## 289  0.93616826   1748       3293  5041   October
## 290 -0.32799587    713       3857  4570   October
## 291 -1.05037537    637       4111  4748   October
## 292  0.03319388    254       2170  2424   October
## 293  2.74211702    471       3724  4195   October
## 294  0.39438363    676       3628  4304   October
## 295 -1.23097025   1499       2809  4308   October
## 296 -1.05037537   1619       2762  4381   October
## 297 -1.05037537    699       3488  4187   October
## 298 -0.68918562    695       3992  4687   October
```

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## 299 -0.32799587    404       3490  3894   October
## 300 -0.50859075    240       2419  2659   October
## 301  0.57497851    456       3291  3747   October
## 302  2.01973752     57        570   627   October
## 303  0.21378876    885       2446  3331   October
## 304 -0.86978050    362       3307  3669   October
## 305 -0.50859075    410       3658  4068  November
## 306 -1.14067281    370       3816  4186  November
## 307 -0.68918562    318       3656  3974  November
## 308  1.65854777    470       3576  4046  November
## 309  0.39438363   1156       2770  3926  November
## 310 -1.23097025    952       2697  3649  November
## 311 -1.23097025    373       3662  4035  November
## 312 -1.23097025    376       3829  4205  November
## 313 -2.31453951    305       3804  4109  November
## 314  0.39438363    190       2743  2933  November
## 315  1.38765545    440       2928  3368  November
## 316  0.39438363   1275       2792  4067  November
## 317  1.29735801   1004       2713  3717  November
## 318  1.29735801    595       3891  4486  November
## 319 -0.14740099    449       3746  4195  November
## 320 -0.68918562    145       1672  1817  November
## 321  1.29735801    139       2914  3053  November
## 322 -0.32799587    245       3147  3392  November
## 323  0.75557339    943       2720  3663  November
## 324  0.03319388    787       2733  3520  November
## 325 -0.50859075    220       2545  2765  November
## 326 -1.05037537     69       1538  1607  November
## 327  2.38092727    112       2454  2566  November
## 328 -0.50859075    560        935  1495  November
## 329 -1.05037537   1095       1697  2792  November
## 330 -1.23097025   1249       1819  3068  November
## 331  0.75557339    810       2261  3071  November
## 332 -0.68918562    253       3614  3867  November
## 333  1.29735801     96       2818  2914  November
## 334  1.11676314    188       3425  3613  November
## 335  0.39438363    182       3545  3727  December
## 336 -1.23097025    268       3672  3940  December
## 337 -1.23097025    706       2908  3614  December
## 338 -1.05037537    634       2851  3485  December
## 339 -1.23097025    233       3578  3811  December
## 340  0.39438363    126       2468  2594  December
## 341  0.57497851     50        655   705  December
## 342  0.39438363    150       3172  3322  December
## 343 -1.23097025    261       3359  3620  December
## 344  0.39438363    502       2688  3190  December
## 345 -2.31453951    377       2366  2743  December
## 346 -1.23097025    143       3167  3310  December
## 347 -0.32799587    155       3368  3523  December
## 348 -1.23097025    178       3562  3740  December
```

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## 349  1.11676314    181       3528  3709  December
## 350  0.93616826    178       3399  3577  December
## 351  0.57497851    275       2464  2739  December
## 352 -0.32799587    220       2211  2431  December
## 353 -0.32799587    260       3143  3403  December
## 354 -2.31453951    216       3534  3750  December
## 355  0.75557339    107       2553  2660  December
## 356 -2.31453951    227       2841  3068  December
## 357  0.75557339    163       2046  2209  December
## 358 -0.32799587    155        856  1011  December
## 359 -0.50859075    303        451   754  December
## 360  0.57497851    430        887  1317  December
## 361 -0.68918562    103       1059  1162  December
## 362  0.75557339    255       2047  2302  December
## 363 -0.86978050    254       2169  2423  December
## 364 -1.05037537    491       2508  2999  December
## 365  0.03319388    665       1820  2485  December
## 366  0.75557339    686       1608  2294   January
## 367  1.47795289    244       1707  1951   January
## 368  2.01973752     89       2147  2236   January
## 369  0.03319388     95       2273  2368   January
## 370 -1.23097025    140       3132  3272   January
## 371 -0.14740099    307       3791  4098   January
## 372  0.03319388   1070       3451  4521   January
## 373  0.21378876    599       2826  3425   January
## 374 -1.05037537    106       2270  2376   January
## 375 -0.32799587    173       3425  3598   January
## 376 -0.68918562     92       2085  2177   January
## 377  0.03319388    269       3828  4097   January
## 378  2.01973752    174       3040  3214   January
## 379  0.39438363    333       2160  2493   January
## 380  0.57497851    284       2027  2311   January
## 381  1.20706058    217       2081  2298   January
## 382  1.65854777    127       2808  2935   January
## 383  2.56152214    109       3267  3376   January
## 384  0.75557339    130       3162  3292   January
## 385  0.21378876    115       3048  3163   January
## 386  0.75557339     67       1234  1301   January
## 387  0.03319388    196       1781  1977   January
## 388 -0.68918562    145       2287  2432   January
## 389 -0.86978050    439       3900  4339   January
## 390 -0.32799587    467       3803  4270   January
## 391 -1.05037537    244       3831  4075   January
## 392  1.65854777    269       3187  3456   January
## 393  0.21378876    775       3248  4023   January
## 394  0.57497851    558       2685  3243   January
## 395  0.03319388    126       3498  3624   January
## 396  0.93616826    324       4185  4509   January
## 397 -0.32799587    304       4275  4579  February
## 398 -0.50859075    190       3571  3761  February
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## 399 -0.14740099    310       3841  4151  February
## 400 -0.68918562    384       2448  2832  February
## 401 -0.32799587    318       2629  2947  February
## 402 -0.68918562    206       3578  3784  February
## 403 -0.14740099    199       4176  4375  February
## 404 -0.68918562    109       2693  2802  February
## 405  0.39438363    163       3667  3830  February
## 406 -0.68918562    227       3604  3831  February
## 407  0.75557339    192       1977  2169  February
## 408  2.38092727     73       1456  1529  February
## 409 -0.68918562     94       3328  3422  February
## 410 -1.05037537    135       3787  3922  February
## 411 -0.32799587    141       4028  4169  February
## 412 -1.23097025     74       2931  3005  February
## 413  0.03319388    349       3805  4154  February
## 414  0.39438363   1435       2883  4318  February
## 415  0.75557339    618       2071  2689  February
## 416  0.39438363    502       2627  3129  February
## 417  0.21378876    163       3614  3777  February
## 418  0.93616826    394       4379  4773  February
## 419  0.03319388    516       4546  5062  February
## 420 -0.14740099    246       3241  3487  February
## 421  2.74211702    317       2415  2732  February
## 422  0.39438363    515       2874  3389  February
## 423  0.75557339    253       4069  4322  February
## 424 -0.68918562    229       4134  4363  February
## 425 -0.68918562     65       1769  1834  February
## 426  0.39438363    325       4665  4990     March
## 427 -0.32799587    246       2948  3194     March
## 428 -0.32799587    956       3110  4066     March
## 429  1.47795289    710       2713  3423     March
## 430  0.21378876    203       3130  3333     March
## 431  0.39438363    221       3735  3956     March
## 432  1.65854777    432       4484  4916     March
## 433  3.10330677    486       4896  5382     March
## 434  2.38092727    447       4122  4569     March
## 435  0.75557339    968       3150  4118     March
## 436  0.39438363   1658       3253  4911     March
## 437  0.21378876    838       4460  5298     March
## 438  0.39438363    762       5085  5847     March
## 439 -1.05037537    997       5315  6312     March
## 440 -0.86978050   1005       5187  6192     March
## 441 -1.23097025    548       3830  4378     March
## 442 -1.05037537   3155       4681  7836     March
## 443 -0.68918562   2207       3685  5892     March
## 444 -0.32799587    982       5171  6153     March
## 445 -0.68918562   1051       5042  6093     March
## 446 -1.23097025   1122       5108  6230     March
## 447 -1.14067281   1334       5537  6871     March
## 448 -1.05037537   2469       5893  8362     March
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## 449  0.03319388   1033       2339  3372     March
## 450  0.57497851   1532       3464  4996     March
## 451  3.10330677    795       4763  5558     March
## 452  0.03319388    531       4571  5102     March
## 453  1.29735801    674       5024  5698     March
## 454  1.29735801    834       5299  6133     March
## 455 -0.50859075    796       4663  5459     March
## 456  0.75557339   2301       3934  6235     March
## 457 -0.32799587   2347       3694  6041     April
## 458  1.29735801   1208       4728  5936     April
## 459 -1.23097025   1348       5424  6772     April
## 460  0.03319388   1058       5378  6436     April
## 461  0.03319388   1192       5265  6457     April
## 462  1.47795289   1807       4653  6460     April
## 463  0.75557339   3252       3605  6857     April
## 464  0.39438363   2230       2939  5169     April
## 465  2.01973752    905       4680  5585     April
## 466  0.21378876    819       5099  5918     April
## 467  1.29735801    482       4380  4862     April
## 468  1.11676314    663       4746  5409     April
## 469 -0.32799587   1252       5146  6398     April
## 470 -0.32799587   2795       4665  7460     April
## 471  0.75557339   2846       4286  7132     April
## 472  0.75557339   1198       5172  6370     April
## 473  0.75557339    989       5702  6691     April
## 474  0.03319388    347       4020  4367     April
## 475 -1.23097025    846       5719  6565     April
## 476  0.03319388   1340       5950  7290     April
## 477  0.93616826   2541       4083  6624     April
## 478  1.83914264    120        907  1027     April
## 479  1.65854777    195       3019  3214     April
## 480  0.57497851    518       5115  5633     April
## 481 -1.23097025    655       5541  6196     April
## 482 -0.14740099    475       4551  5026     April
## 483  1.83914264   1014       5219  6233     April
## 484 -0.68918562   1120       3100  4220     April
## 485 -0.68918562   2229       4075  6304     April
## 486 -0.32799587    665       4907  5572     April
## 487 -0.68918562    653       5087  5740       May
## 488 -0.14740099    667       5502  6169       May
## 489 -0.68918562    764       5657  6421       May
## 490 -0.86978050   1069       5227  6296       May
## 491 -0.68918562   2496       4387  6883       May
## 492 -0.32799587   2135       4224  6359       May
## 493  0.39438363   1008       5265  6273       May
## 494  1.11676314    738       4990  5728       May
## 495  0.03319388    620       4097  4717       May
## 496  1.83914264   1026       5546  6572       May
## 497  0.75557339   1319       5711  7030       May
## 498 -0.68918562   2622       4807  7429       May
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## 499  0.21378876   2172       3946  6118       May
## 500  0.39438363    342       2501  2843       May
## 501 -0.68918562    625       4490  5115       May
## 502 -0.68918562    991       6433  7424       May
## 503  0.03319388   1242       6142  7384       May
## 504 -0.68918562   1521       6118  7639       May
## 505 -1.23097025   3410       4884  8294       May
## 506  1.65854777   2704       4425  7129       May
## 507  0.75557339    630       3729  4359       May
## 508 -1.05037537    819       5254  6073       May
## 509 -1.05037537    766       4494  5260       May
## 510 -0.32799587   1059       5711  6770       May
## 511 -0.68918562   1417       5317  6734       May
## 512  0.03319388   2855       3681  6536       May
## 513  0.39438363   3283       3308  6591       May
## 514 -0.32799587   2557       3486  6043       May
## 515  1.29735801    880       4863  5743       May
## 516 -0.68918562    745       6110  6855       May
## 517  0.03319388   1100       6238  7338       May
## 518  0.39438363    533       3594  4127      June
## 519  0.03319388   2795       5325  8120      June
## 520 -0.14740099   2494       5147  7641      June
## 521  1.29735801   1071       5927  6998      June
## 522  0.03319388    968       6033  7001      June
## 523 -1.23097025   1027       6028  7055      June
## 524 -0.32799587   1038       6456  7494      June
## 525 -0.32799587   1488       6248  7736      June
## 526 -0.32799587   2708       4790  7498      June
## 527 -0.86978050   2224       4374  6598      June
## 528  0.03319388   1017       5647  6664      June
## 529  0.03319388    477       4495  4972      June
## 530  2.38092727   1173       6248  7421      June
## 531  0.75557339   1180       6183  7363      June
## 532 -0.32799587   1563       6102  7665      June
## 533 -0.14740099   2963       4739  7702      June
## 534 -0.32799587   2634       4344  6978      June
## 535 -0.14740099    653       4446  5099      June
## 536 -0.68918562    968       5857  6825      June
## 537 -1.05037537    872       5339  6211      June
## 538 -0.86978050    778       5127  5905      June
## 539 -0.32799587    964       4859  5823      June
## 540  0.03319388   2657       4801  7458      June
## 541 -0.68918562   2551       4340  6891      June
## 542  1.29735801   1139       5640  6779      June
## 543  2.01973752   1077       6365  7442      June
## 544  1.20706058   1077       6258  7335      June
## 545 -0.32799587    921       5958  6879      June
## 546  0.03319388    829       4634  5463      June
## 547 -0.50859075   1455       4232  5687      June
## 548 -0.68918562   1421       4110  5531      July
```

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## 549  0.03319388    904       5323  6227      July
## 550 -0.68918562   1052       5608  6660      July
## 551 -0.68918562   2562       4841  7403      July
## 552  0.21378876   1405       4836  6241      July
## 553 -0.68918562   1366       4841  6207      July
## 554 -0.32799587   1448       3392  4840      July
## 555 -1.05037537   1203       3469  4672      July
## 556 -0.32799587    998       5571  6569      July
## 557 -0.68918562    954       5336  6290      July
## 558 -0.50859075    975       6289  7264      July
## 559 -0.68918562   1032       6414  7446      July
## 560 -1.05037537   1511       5988  7499      July
## 561 -1.05037537   2355       4614  6969      July
## 562 -0.68918562   1920       4111  6031      July
## 563 -0.86978050   1088       5742  6830      July
## 564 -0.86978050    921       5865  6786      July
## 565 -0.68918562    799       4914  5713      July
## 566 -0.68918562    888       5703  6591      July
## 567 -0.32799587    747       5123  5870      July
## 568  0.75557339   1264       3195  4459      July
## 569 -1.05037537   2544       4866  7410      July
## 570 -0.68918562   1135       5831  6966      July
## 571  0.21378876   1140       6452  7592      July
## 572 -0.32799587   1383       6790  8173      July
## 573  0.75557339   1036       5825  6861      July
## 574 -0.50859075   1259       5645  6904      July
## 575 -0.32799587   2234       4451  6685      July
## 576 -0.32799587   2153       4444  6597      July
## 577 -0.32799587   1040       6065  7105      July
## 578 -0.32799587    968       6248  7216      July
## 579 -0.68918562   1074       6506  7580    August
## 580 -0.86978050    983       6278  7261    August
## 581  0.39438363   1328       5847  7175    August
## 582  0.75557339   2345       4479  6824    August
## 583  0.75557339   1707       3757  5464    August
## 584 -0.68918562   1233       5780  7013    August
## 585 -0.68918562   1278       5995  7273    August
## 586 -0.86978050   1263       6271  7534    August
## 587 -0.32799587   1196       6090  7286    August
## 588  1.11676314   1065       4721  5786    August
## 589  0.03319388   2247       4052  6299    August
## 590 -0.68918562   2182       4362  6544    August
## 591 -1.05037537   1207       5676  6883    August
## 592  0.03319388   1128       5656  6784    August
## 593  0.03319388   1198       6149  7347    August
## 594 -0.32799587   1338       6267  7605    August
## 595  0.21378876   1483       5665  7148    August
## 596  0.03319388   2827       5038  7865    August
## 597 -1.05037537   1208       3341  4549    August
## 598 -0.86978050   1026       5504  6530    August
```

```
## 599 -1.77275488   1081       5925  7006    August
## 600 -2.31453951   1094       6281  7375    August
## 601 -1.23097025   1363       6402  7765    August
## 602 -1.77275488   1325       6257  7582    August
## 603  0.93616826   1829       4224  6053    August
## 604  0.39438363   1483       3772  5255    August
## 605 -0.68918562    989       5928  6917    August
## 606 -0.14740099    935       6105  7040    August
## 607 -0.68918562   1177       6520  7697    August
## 608 -1.14067281   1172       6541  7713    August
## 609 -0.32799587   1433       5917  7350    August
## 610 -0.86978050   2352       3788  6140 September
## 611 -1.23097025   2613       3197  5810 September
## 612 -0.68918562   1965       4069  6034 September
## 613  0.75557339    867       5997  6864 September
## 614  0.03319388    832       6280  7112 September
## 615 -0.50859075    611       5592  6203 September
## 616 -0.68918562   1045       6459  7504 September
## 617  0.75557339   1557       4419  5976 September
## 618  0.75557339   2570       5657  8227 September
## 619  1.11676314   1118       6407  7525 September
## 620 -1.05037537   1070       6697  7767 September
## 621 -0.68918562   1050       6820  7870 September
## 622 -1.23097025   1054       6750  7804 September
## 623 -1.05037537   1379       6630  8009 September
## 624  0.93616826   3160       5554  8714 September
## 625 -1.05037537   2166       5167  7333 September
## 626 -0.32799587   1022       5847  6869 September
## 627  1.47795289    371       3702  4073 September
## 628  0.75557339    788       6803  7591 September
## 629 -1.05037537    939       6781  7720 September
## 630 -0.14740099   1250       6917  8167 September
## 631  1.11676314   2512       5883  8395 September
## 632  0.57497851   2454       5453  7907 September
## 633 -0.68918562   1001       6435  7436 September
## 634  0.75557339    845       6693  7538 September
## 635  0.75557339    787       6946  7733 September
## 636 -1.23097025    751       6642  7393 September
## 637 -0.37856244   1045       6370  7415 September
## 638  0.31492189   2589       5966  8555 September
## 639 -0.43635280   2015       4874  6889 September
## 640 -1.18762748    763       6015  6778   October
## 641 -0.95646604    315       4324  4639   October
## 642 -1.47657928    728       6844  7572   October
## 643 -0.86978050    891       6437  7328   October
## 644 -0.98536122   1516       6640  8156   October
## 645  0.89282549   3031       4934  7965   October
## 646 -0.49414316    781       2729  3510   October
## 647 -0.03182027    874       4604  5478   October
## 648  0.02597009    601       5791  6392   October
```

```
## 649 -0.43635280    780       6911  7691   October
## 650  0.02597009    834       6736  7570   October
## 651  0.51718815   1060       6222  7282   October
## 652 -0.34966726   2252       4857  7109   October
## 653  1.00840621   2080       4559  6639   October
## 654  1.06619657    760       5115  5875   October
## 655 -0.14740099    922       6612  7534   October
## 656 -1.10094194    979       6482  7461   October
## 657  0.51718815   1008       6501  7509   October
## 658 -0.63861906    753       4671  5424   October
## 659 -0.72530460   2806       5284  8090   October
## 660 -0.32077208   2132       4692  6824   October
## 661 -1.24541784    830       6228  7058   October
## 662 -1.21652266    841       6625  7466   October
## 663 -1.44768410    795       6898  7693   October
## 664 -0.63861906    875       6484  7359   October
## 665 -0.63861906   1182       6262  7444   October
## 666  0.54608333   2643       5209  7852   October
## 667  2.53985076    998       3461  4459   October
## 668  4.93815071      2         20    22   October
## 669  1.49962427     87       1009  1096   October
## 670 -0.34966726    419       5147  5566   October
## 671 -0.46524798    466       5520  5986  November
## 672  1.00840621    618       5229  5847  November
## 673  0.97951103   1029       4109  5138  November
## 674 -0.08961063   1201       3906  5107  November
## 675  0.48829297    378       4881  5259  November
## 676 -0.14740099    466       5220  5686  November
## 677  1.35514837    326       4709  5035  November
## 678  1.99084234    340       4975  5315  November
## 679  0.17044599    709       5283  5992  November
## 680 -1.62105518   2090       4446  6536  November
## 681 -0.75419978   2290       4562  6852  November
## 682 -0.08961063   1097       5172  6269  November
## 683  1.81747126    327       3767  4094  November
## 684  0.02597009    373       5122  5495  November
## 685 -0.46524798    320       5125  5445  November
## 686 -0.23408653    484       5214  5698  November
## 687 -0.14740099   1313       4316  5629  November
## 688  0.45939779    922       3747  4669  November
## 689  0.40160743    449       5050  5499  November
## 690 -1.33210338    534       5100  5634  November
## 691 -1.01425640    615       4531  5146  November
## 692 -1.67884554    955       1470  2425  November
## 693 -0.37856244   1603       2307  3910  November
## 694  2.13531824    532       1745  2277  November
## 695 -0.55193352    309       2115  2424  November
## 696 -1.70774072    337       4750  5087  November
## 697  0.66166405    123       3836  3959  November
## 698  0.14155081    198       5062  5260  November
```

```
## 699 -0.50859075    243       5080  5323  November
## 700 -2.31453951    362       5306  5668  November
## 701 -1.44768410    951       4240  5191  December
## 702 -0.68918562    892       3757  4649  December
## 703 -1.05037537    555       5679  6234  December
## 704  0.03319388    551       6055  6606  December
## 705  1.11676314    331       5398  5729  December
## 706 -0.14740099    340       5035  5375  December
## 707 -0.68918562    349       4659  5008  December
## 708 -1.05037537   1153       4429  5582  December
## 709 -0.68918562    441       2787  3228  December
## 710  0.39438363    329       4841  5170  December
## 711  1.47795289    282       5219  5501  December
## 712  0.21378876    310       5009  5319  December
## 713  0.03319388    425       5107  5532  December
## 714 -1.05037537    429       5182  5611  December
## 715 -1.05037537    767       4280  5047  December
## 716 -1.05037537    538       3248  3786  December
## 717 -1.05037537    212       4373  4585  December
## 718  0.21378876    433       5124  5557  December
## 719 -0.68918562    333       4934  5267  December
## 720 -0.32799587    314       3814  4128  December
## 721  2.38092727    221       3402  3623  December
## 722  2.74211702    205       1544  1749  December
## 723 -0.68918562    408       1379  1787  December
## 724 -1.23097025    174        746   920  December
## 725 -0.32799587    440        573  1013  December
## 726  1.65854777      9        432   441  December
## 727  1.47795289    247       1867  2114  December
## 728 -0.68918562    644       2451  3095  December
## 729 -1.23097025    159       1182  1341  December
## 730  2.01973752    364       1432  1796  December
## 731 -0.32799587    439       2290  2729  December
```

Q. 2 Basic regression in R: In dfbStd, run a regression model fitAll using COUNT as the DV, and all the variables as independent variables.

```
fitAll <- lm(formula = Count ~ ., data = dfbStd)
summary(fitAll)
```

```
## Warning in summary.lm(fitAll): essentially perfect fit: summary may be
## unreliable
```

```
##
## Call:
## lm(formula = Count ~ ., data = dfbStd)
##
## Residuals:
##        Min         1Q     Median         3Q        Max
## -2.130e-11 -1.608e-13  1.820e-14  1.972e-13  2.883e-11
##
```

```
## Coefficients:
##                   Estimate Std. Error    t value Pr(>|t|)
## (Intercept)    -4.289e-11  7.537e-12 -5.691e+00 1.85e-08 ***
## DATE            2.909e-15  5.104e-16  5.698e+00 1.77e-08 ***
## HOLIDAYYES     -4.205e-14  3.764e-13 -1.120e-01   0.9111
## WEEKDAYYES     -8.479e-13  2.125e-13 -3.990e+00 7.29e-05 ***
## WEATHERSIT      3.566e-13  1.447e-13  2.465e+00   0.0140 *
## TEMP            3.776e-13  4.324e-13  8.730e-01   0.3828
## ATEMP           4.367e-13  4.049e-13  1.079e+00   0.2812
## HUMIDITY        1.400e-13  8.356e-14  1.676e+00   0.0942 .
## WINDSPEED       7.337e-14  6.537e-14  1.122e+00   0.2621
## CASUAL          1.000e+00  1.612e-16  6.204e+15  < 2e-16 ***
## REGISTERED      1.000e+00  8.696e-17  1.150e+16  < 2e-16 ***
## MONTHAugust    -1.965e-13  3.362e-13 -5.840e-01   0.5591
## MONTHDecember   1.561e-13  3.439e-13  4.540e-01   0.6501
## MONTHFebruary   2.302e-13  3.202e-13  7.190e-01   0.4724
## MONTHJanuary   -7.314e-14  3.410e-13 -2.150e-01   0.8302
## MONTHJuly      -2.267e-13  3.643e-13 -6.220e-01   0.5339
## MONTHJune      -2.030e-13  3.283e-13 -6.180e-01   0.5366
## MONTHMarch      1.247e-13  2.839e-13  4.390e-01   0.6607
## MONTHMay       -6.726e-14  2.953e-13 -2.280e-01   0.8199
## MONTHNovember   1.349e-13  3.157e-13  4.270e-01   0.6694
## MONTHOctober   -2.730e-15  2.900e-13 -9.000e-03   0.9925
## MONTHSeptember -1.123e-13  3.088e-13 -3.640e-01   0.7162
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.52e-12 on 709 degrees of freedom
## Multiple R-squared:      1,  Adjusted R-squared:      1
## F-statistic: 5.648e+31 on 21 and 709 DF,  p-value: < 2.2e-16
```

a) Does this appear to be a good model? Why or why not? Fitall by keeping all the variables in model, Output shows, model with R square and adjusted R square equal to 1, but this is not good model. Because, dependent variable Count itself is derived from sum of the two independent variables registered and casual present in the regression equation.

b) According to your model, what is the effect of humidity on the total bike count in a formal interpretation? Does this finding align with your answer to Part (a)? On average unite change in humidity corresponds to 1.400e-13 change in count of bike users, keeping everything else constant.

3. 3.a.

```
dfbOrg<-
  dfbOrg %>%
  mutate(BADWEATHER =  ifelse(WEATHERSIT == 3 | WEATHERSIT == 4, 'YES',
'NO'))

dfbOrg
```

```
## # A tibble: 731 x 13
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2011-01-01 NO      NO               2  11    11       81          17
331
##  2 2011-01-02 NO      NO               2   9     6.5     71.5        17
131
##  3 2011-01-03 NO      YES              1   1     4       44          18
120
##  4 2011-01-04 NO      YES              1   2     2.5     64           9
108
##  5 2011-01-05 NO      YES              1   2.5   1       42.5        13
82
##  6 2011-01-06 NO      YES              1   2     2       52           6
88
##  7 2011-01-07 NO      YES              2   1     3       47.5        11
148
##  8 2011-01-08 NO      NO               2   1     5       51          17
68
##  9 2011-01-09 NO      NO               1   2     8.5     46          25
54
## 10 2011-01-10 NO      YES              1   2     6       50          15
41
## # … with 721 more rows, and 4 more variables: REGISTERED <dbl>, Count
<dbl>,
## #   MONTH <chr>, BADWEATHER <chr>
```

3.b.

```
plot1<-
  dfbOrg %>%
  ggplot(aes(x = ATEMP, y = Count, color = BADWEATHER)) +
  geom_point()

ggplotly(plot1)
```

For bad weather, count of city bikes used in any temperature is comparatively less than that of the city bikes used in good weather.

3.c.

```
plot2<-
  dfbOrg %>%
  ggplot(aes(x = ATEMP, y = CASUAL, color = BADWEATHER)) +
  geom_point()

ggplotly(plot2)
```

```
plot3<-
  dfbOrg %>%
  ggplot(aes(x = ATEMP, y = REGISTERED, color = BADWEATHER)) +
  geom_point()

ggplotly(plot3)
```

iv.Keep ATEMP in the x-axis, but change the y-axis to COUNT. Remove the color variable and add a geom_smooth() without any parameters. How does the overall relationship between temperature and bike usage look? Does this remind you of Lab 2? Why do you think the effects are similar?

c) Make two more scatterplots (and continue using the differentiated coloring for BADWEATHER) by keeping ATEMP on the x-axis and changing the variable on the y-axis: One plot for CASUAL and another for REGISTERED. Given the plots:

d) How is temperature associated with casual usage? Is that different from how it is associated with registered usage? For casual users, as the temperature increases variance in count of casual users increases, we see datapoints scattered and distant from each other. Whereas for Registered user it is different, distribution is uniform with increase in temperature and less variance with respect to casual users.

ii) How is bad weather associated with casual usage? Is that different from how it is associated with registered usage? For bad weather and equal temperature, we see a smaller number of casual users as compared to registered users. During bad weather and low temperatures, we see few or negligible number of casual usages. But this count increase somewhat around temperature 20 degrees. After that we see almost no casual usage after approx 23 degrees due to bad weather conditions.

iii) Do your answers in (i) and (ii) make logical sense? Why or why not? Yes, because registered bikeshare members are more inclined towards using city bike in any temperature / weather conditions. Whereas casual bike users are not.

iv) Keep ATEMP in the x-axis, but change the y-axis to COUNT. Remove the color variable and add a geom_smooth() without any parameters. How does the overall relationship between temperature and bike usage look? Does this remind you of Lab 2? Why do you think the effects are similar? Yes, it appears similar to that of lab2. It signifies that, we see maximum count of trips when temperature is moderate, not too high not too low. whereas for extreme temperature bikeshare usage is comparatively less.Because users are more interested to use city bike in moderate temperature, but when it gets too hot or too cold, they simply avoid commute using city bikes.

```
plot4<-
  dfbOrg %>%
  ggplot(aes(x = ATEMP, y = Count)) +
  geom_point() +
  geom_smooth()

ggplotly(plot4)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```

4. More linear regression: Using dfbOrg, run another regression for COUNT using the variables MONTH, WEEKDAY, BADWEATHER, TEMP, ATEMP, and HUMIDITY.

```
fit2 <- lm(Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP + HUMIDITY,
data = dfbOrg)
summary(fit2)

##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP +
##     HUMIDITY, data = dfbOrg)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3729.0 -1005.1  -190.3  1115.0  3750.1
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3967.981    335.628  11.823  < 2e-16 ***
## MONTHAugust     -209.660    291.004  -0.720  0.47147
## MONTHDecember    105.664    265.660   0.398  0.69094
## MONTHFebruary   -802.319    273.000  -2.939  0.00340 **
## MONTHJanuary    -858.334    293.371  -2.926  0.00355 **
## MONTHJuly       -676.644    312.956  -2.162  0.03094 *
## MONTHJune       -189.229    286.067  -0.661  0.50851
## MONTHMarch      -242.020    249.333  -0.971  0.33204
## MONTHMay         279.730    259.634   1.077  0.28166
## MONTHNovember    651.966    257.460   2.532  0.01154 *
## MONTHOctober    1072.312    246.970   4.342 1.62e-05 ***
## MONTHSeptember   742.473    267.293   2.778  0.00562 **
## WEEKDAYYES        69.745    110.118   0.633  0.52670
## BADWEATHERYES  -1954.835    316.601  -6.174 1.11e-09 ***
## TEMP             184.596     42.011   4.394 1.28e-05 ***
## ATEMP            -48.640     36.621  -1.328  0.18454
## HUMIDITY         -25.341      3.623  -6.995 6.09e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1341 on 714 degrees of freedom
## Multiple R-squared:  0.5315, Adjusted R-squared:  0.521
## F-statistic: 50.64 on 16 and 714 DF,  p-value: < 2.2e-16
```

a) What is the resulting adjusted R2? What does it mean? Answer: 0.521, It means that this model explains around 52.1% variation in Count of bikeshare usage with the help of independent variables.

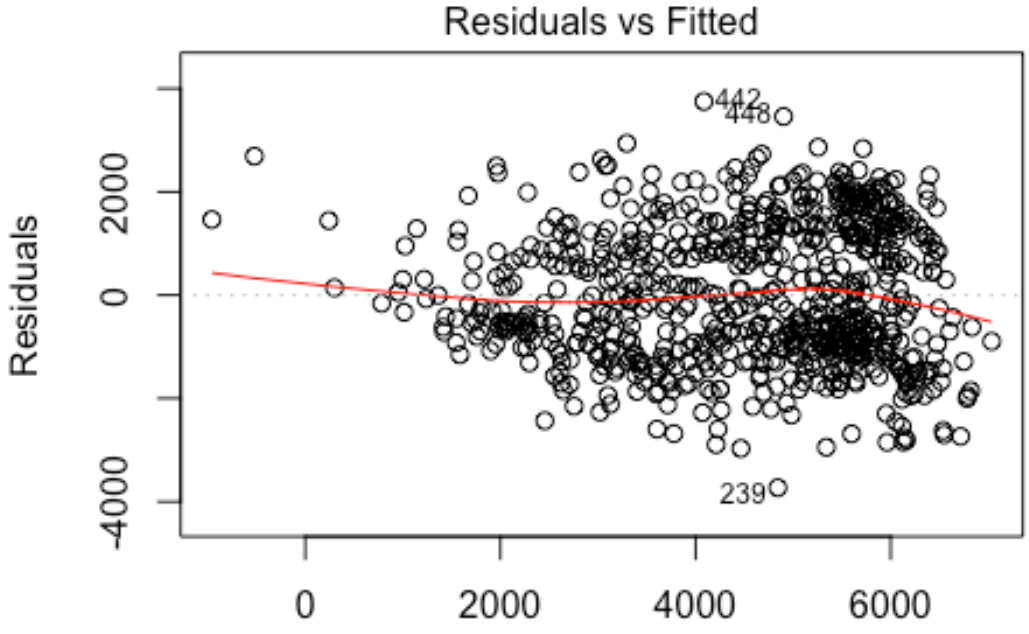
b) State precisely how BADWEATHER is associated with the predicted COUNT. Answer: On average, number of rides with bad weather are less than 1954.835 of that of the number of rides with good weather keeping everything else constant

c) What is the predicted count of rides on a weekday in January, when the weather is BAD, and the temperature is 20o and feels like 18o, and the humidity is 60%? Answer: 2520.506 = i.e. approximately 2521

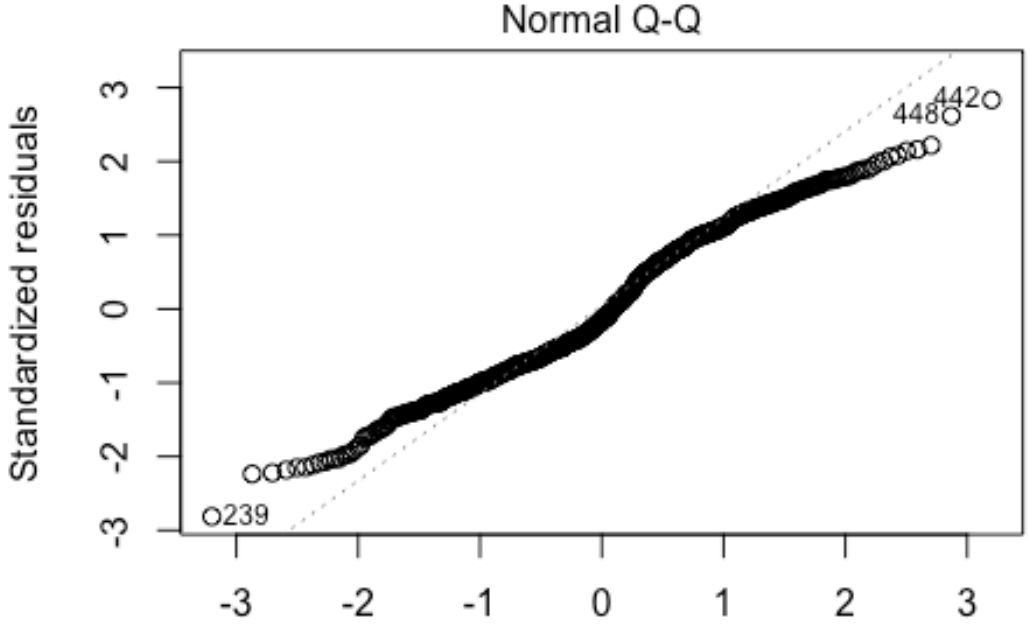
d) Do you have any concerns about this model or your predicted COUNT in Q3-c? Why or why not? Answer: The count according to the plot is comparatively higher than as predicted by the model, in plot count is around 2800-7500. This raises concerns about the accuracy of the model.

5.Regression diagnostics: Run the regression diagnostics for the model developed in Q4. Discuss whether the model complies with the assumptions of multiple linear regression. If you think you can mitigate a violation, take action, and check the diagnostics again.

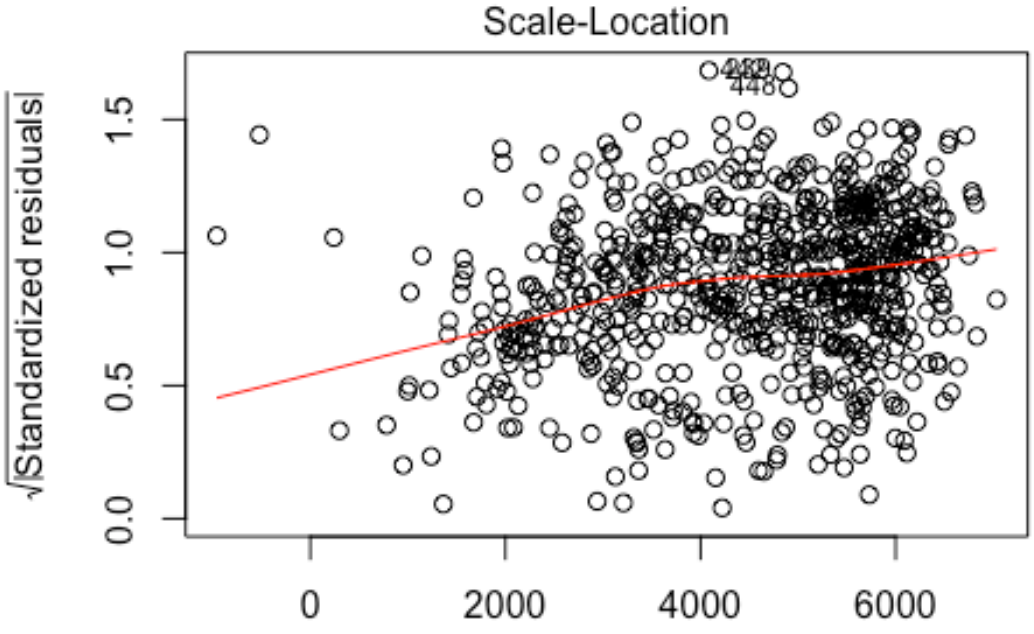
```
plot(fit2)
```



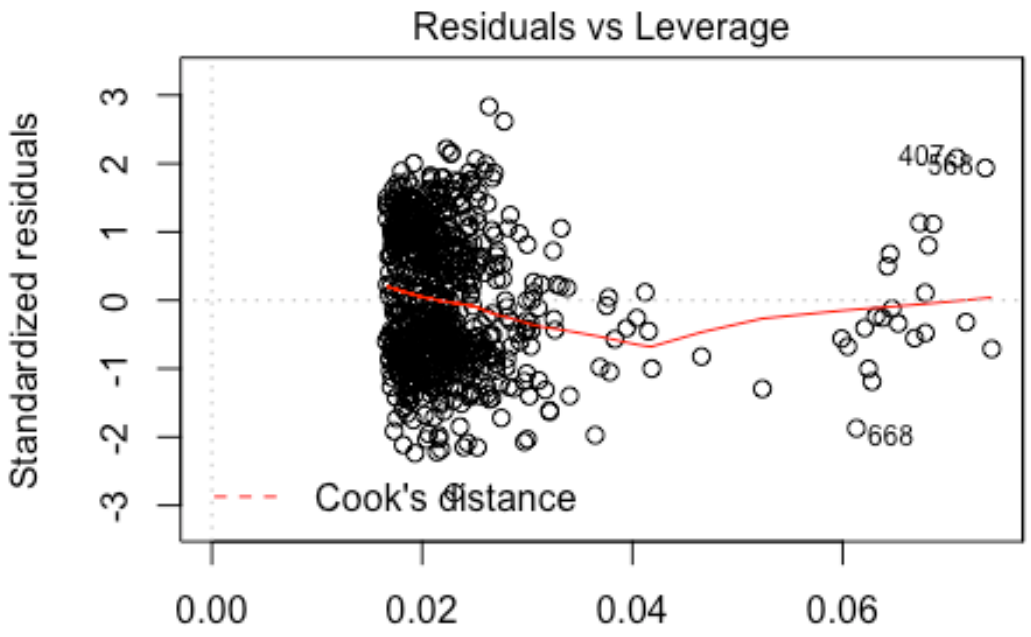
unt ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP +



unt ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP +



unt ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP +



unt ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP +

```
car::vif(fit2)
```

```
## Registered S3 methods overwritten by 'car':
##   method                           from
##   influence.merMod                 lme4
##   cooks.distance.influence.merMod lme4
##   dfbeta.influence.merMod          lme4
##   dfbetas.influence.merMod         lme4
```

```
##                 GVIF Df GVIF^(1/(2*Df))
## MONTH       8.480466 11        1.102049
## WEEKDAY     1.009743  1        1.004859
## BADWEATHER  1.137470  1        1.066522
## TEMP       55.856782  1        7.473739
## ATEMP      50.923158  1        7.136046
## HUMIDITY    1.275120  1        1.129212
```

```
#rectification of multicollinerlity
#Dropping Temp variable

fit2 <- lm(Count ~ WEEKDAY + BADWEATHER+ HUMIDITY + ATEMP + MONTH, data =
dfbOrg)
car::vif(fit2)
```

```
##                GVIF Df GVIF^(1/(2*Df))
## WEEKDAY    1.007712  1        1.003848
## BADWEATHER 1.137441  1        1.066509
## HUMIDITY   1.275073  1        1.129191
## ATEMP      5.596197  1        2.365628
## MONTH      6.353495 11        1.087679
```

```
summary(fit2)
```

```
##
## Call:
## lm(formula = Count ~ WEEKDAY + BADWEATHER + HUMIDITY + ATEMP +
##     MONTH, data = dfbOrg)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3760.9 -1058.5  -207.5  1154.8  3822.9
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)     4503.4952   316.6962  14.220  < 2e-16 ***
## WEEKDAYYES        91.4446   111.4065   0.821  0.41202
## BADWEATHERYES  -1961.8521   320.6243  -6.119 1.55e-09 ***
## HUMIDITY         -25.4375     3.6686  -6.934 9.16e-12 ***
## ATEMP            103.1721    12.2943   8.392 2.55e-16 ***
## MONTHAugust      -70.1865   292.9479  -0.240  0.81072
## MONTHDecember      0.6468   267.9485   0.002  0.99807
## MONTHFebruary  -1016.9096   272.0127  -3.738  0.00020 ***
## MONTHJanuary   -1386.5736   271.0121  -5.116 4.01e-07 ***
## MONTHJuly       -585.3680   316.2385  -1.851  0.06458 .
## MONTHJune        -17.4214   286.9867  -0.061  0.95161
## MONTHMarch      -285.6783   252.3046  -1.132  0.25790
## MONTHMay         378.1598   261.9562   1.444  0.14929
## MONTHNovember    462.3246   257.0456   1.799  0.07250 .
## MONTHOctober    1033.8276   249.9540   4.136 3.95e-05 ***
## MONTHSeptember   841.6233   269.7273   3.120  0.00188 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1358 on 715 degrees of freedom
## Multiple R-squared:  0.5189, Adjusted R-squared:  0.5088
## F-statistic: 51.41 on 15 and 715 DF,  p-value: < 2.2e-16
```

Answer: Plot () diagnostic results: • From residual vs fitted plot, model is catching non-linear relationships. • From Normal Q-Q plot, residual is no aligned with dotted line hence normality assumption of linear equation may be violated. • From graph of standardized residuals, we see points are not fanned out. Hence no heteroscedasticity. • From last graph, we see there are some outliers beyond cook's distance line, hence they might affect overall coefficients of regression equation. VIF diagnostic results: VIF for TEMP, ATMP, MONTH is very high. Let us remove TEMP, to improve performance of model.

6.Even more regression: Run a simple linear regression to determine the effect of bad weather on COUNT when none of the other variables is included in the model.

a.Compare the coefficient with the corresponding value in Q4. Are they different? Why or why not? Answer: Yes, coefficient of BADWEATHERYES is less than that of previous model. Because the coefficient of BADWETHER is impacted because of other independent variables in model.

```
fit3 <- lm(Count~BADWEATHER, data = dfbOrg)
summary(fit3)

##
## Call:
## lm(formula = Count ~ BADWEATHER, data = dfbOrg)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4153.2 -1257.7     1.8  1404.8  4129.8
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4584.24      70.63  64.908  < 2e-16 ***
## BADWEATHERYES -2780.95     416.69  -6.674 4.93e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1882 on 729 degrees of freedom
## Multiple R-squared:  0.05758,    Adjusted R-squared:  0.05629
## F-statistic: 44.54 on 1 and 729 DF,  p-value: 4.934e-11
```

b) A consultant has indicated that bike use is affected differently by bad weather on weekdays versus non-weekdays, as people go to work on weekdays. How can you add this domain knowledge to the regression model you built in (a)? Why? Answer: We can add interaction term between two variables i.e. BADWEATHER and WEEKDAY. In order to corporate effect of interaction between weekdays and bad weather in combination on count of bikeshare.

6.c.Run a new model with your addition from (b). Is this a better or worse model than your original model in (a)? How do you decide? Answer: R squared and adjusted squared values are not improved allot. Also, anova comparison show high p values thus additional interaction term does not really adds any significant value to the model.

```
fit4 <- lm(Count~BADWEATHER + WEEKDAY + (BADWEATHER * WEEKDAY) , data =
dfbOrg)
summary(fit4)

##
## Call:
## lm(formula = Count ~ BADWEATHER + WEEKDAY + (BADWEATHER * WEEKDAY),
##     data = dfbOrg)
```

```
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -4206.7 -1262.1    -3.7  1405.3  4261.5
##
## Coefficients:
##                            Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  4452.5      131.5  33.861  < 2e-16 ***
## BADWEATHERYES               -2637.1      852.2  -3.095  0.00205 **
## WEEKDAYYES                    185.3      155.9   1.188  0.23514
## BADWEATHERYES:WEEKDAYYES     -201.2      977.1  -0.206  0.83695
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1883 on 727 degrees of freedom
## Multiple R-squared:  0.05941,    Adjusted R-squared:  0.05553
## F-statistic: 15.31 on 3 and 727 DF,  p-value: 1.15e-09
```

```
anova(fit3, fit4)
```

```
## Analysis of Variance Table
##
## Model 1: Count ~ BADWEATHER
## Model 2: Count ~ BADWEATHER + WEEKDAY + (BADWEATHER * WEEKDAY)
##   Res.Df        RSS Df Sum of Sq      F Pr(>F)
## 1    729 2581793230
## 2    727 2576788128  2   5005101 0.7061 0.4939
```

Using your model from (c), i) interpret the average effect of bad weather on the COUNT depending on whether it is a weekday or not, and Answer: On average, count of city bike with bad weather is 2637.1 less than that of count of city bikes with good weather and it is not a weekday keeping everything else constant.

ii) quantify the effect of bad weather on the COUNT in different scenarios (be sure to calculate all effect sizes for the four alternatives (2x2) here). • On average count of city bike usage with bad weather is 2637.1 less than that of count of city bikes with good weather and weather it is not a weekday, keeping everything else constant. • On average, count of bike usage is 185.3 more on weekdays as compared to when the weather is good and it is not a weekday, keeping everything else as constant • On average, count of bike usage is 201.2 less on bad weather weekday as compared to that of good weather non weekday, keeping everything else constant. • BadweatherNO & WeekdayNo is reference category.

7.Predictive analytics: 7.a.

```
set.seed(333)
```

7.b.

```
dfwTrain <- dfbOrg %>% sample_frac(.8)

dfwTest <- dplyr::setdiff(dfbOrg, dfwTrain)
```

7.c.

```
fitOrg <- lm(Count ~ MONTH + WEEKDAY + BADWEATHER  + ATEMP + HUMIDITY, data =
dfwTrain)

summary(fitOrg)

##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + ATEMP + HUMIDITY,
##     data = dfwTrain)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3730.4 -1059.6  -123.3  1136.4  3935.6
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     4682.429    349.954  13.380  < 2e-16 ***
## MONTHAugust     -180.796    325.897  -0.555 0.579273
## MONTHDecember    -66.799    295.882  -0.226 0.821467
## MONTHFebruary  -1120.863    303.118  -3.698 0.000239 ***
## MONTHJanuary   -1437.306    303.674  -4.733 2.79e-06 ***
## MONTHJuly       -526.826    347.187  -1.517 0.129718
## MONTHJune        -71.630    310.819  -0.230 0.817820
## MONTHMarch      -494.433    280.474  -1.763 0.078463 .
## MONTHMay         330.771    288.889   1.145 0.252700
## MONTHNovember    423.187    290.993   1.454 0.146419
## MONTHOctober     988.645    281.837   3.508 0.000487 ***
## MONTHSeptember   663.921    302.925   2.192 0.028806 *
## WEEKDAYYES        88.645    124.513   0.712 0.476797
## BADWEATHERYES  -2141.259    368.143  -5.816 1.00e-08 ***
## ATEMP            101.880     13.638   7.470 3.03e-13 ***
## HUMIDITY         -26.229      4.101  -6.396 3.32e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1354 on 569 degrees of freedom
## Multiple R-squared:  0.5219, Adjusted R-squared:  0.5093
## F-statistic:  41.4 on 15 and 569 DF,  p-value: < 2.2e-16

tidy(fitOrg)

## # A tibble: 16 x 5
##    term           estimate std.error statistic  p.value
##    <chr>             <dbl>     <dbl>     <dbl>    <dbl>
##  1 (Intercept)      4682.     350.      13.4   1.08e-35
```

```
##  2 MONTHAugust      -181.     326.      -0.555 5.79e- 1
##  3 MONTHDecember     -66.8    296.      -0.226 8.21e- 1
##  4 MONTHFebruary   -1121.     303.      -3.70  2.39e- 4
##  5 MONTHJanuary    -1437.     304.      -4.73  2.79e- 6
##  6 MONTHJuly         -527.     347.      -1.52  1.30e- 1
##  7 MONTHJune          -71.6    311.      -0.230 8.18e- 1
##  8 MONTHMarch        -494.     280.      -1.76  7.85e- 2
##  9 MONTHMay           331.     289.       1.14  2.53e- 1
## 10 MONTHNovember      423.     291.       1.45  1.46e- 1
## 11 MONTHOctober       989.     282.       3.51  4.87e- 4
## 12 MONTHSeptember     664.     303.       2.19  2.88e- 2
## 13 WEEKDAYYES          88.6    125.       0.712 4.77e- 1
## 14 BADWEATHERYES    -2141.     368.      -5.82  1.00e- 8
## 15 ATEMP              102.      13.6      7.47  3.03e-13
## 16 HUMIDITY           -26.2      4.10    -6.40  3.32e-10
```

```
resultsOrg <- dfwTest %>%
            mutate(predictedCount = predict(fitOrg, dfwTest))
resultsOrg
```

```
## # A tibble: 146 x 14
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2011-01-10 NO      YES              1   2     6       50          15
41
##  2 2011-01-11 NO      YES              2   1     3.5     57           7
43
##  3 2011-01-13 NO      YES              1   2     7       48.5        20
38
##  4 2011-01-16 NO      NO               1   2.5   2       49.5        15
251
##  5 2011-01-19 NO      YES              2   5.5   2.5     71.5        10
78
##  6 2011-01-20 NO      YES              2   4     2       56          15
83
##  7 2011-01-23 NO      NO               1   4    10       42          15
150
##  8 2011-01-25 NO      YES              2   2     4       65           9
186
##  9 2011-02-13 NO      NO               1   9.5   6       36          20
397
## 10 2011-02-15 NO      YES              1   4     3.5     32          17
140
## # … with 136 more rows, and 5 more variables: REGISTERED <dbl>, Count
<dbl>,
## #   MONTH <chr>, BADWEATHER <chr>, predictedCount <dbl>
```

```r
performance <-
   metric_set(rmse, mae)
performance(resultsOrg, truth= Count, estimate = predictedCount)
```

```
## # A tibble: 2 x 3
##   .metric .estimator .estimate
##   <chr>   <chr>          <dbl>
## 1 rmse    standard       1386.
## 2 mae     standard       1175.
```

```r
fitNew <- lm(Count ~ MONTH + WEEKDAY + BADWEATHER + ATEMP + WINDSPEED, data =
dfwTrain)

summary(fitNew)
```

```
##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + ATEMP + WINDSPEED,
##     data = dfwTrain)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3669.9 -1095.6  -254.2  1225.5  3390.7
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3946.68     346.17  11.401  < 2e-16 ***
## MONTHAugust     -347.73     335.03  -1.038  0.29976
## MONTHDecember   -593.19     304.28  -1.950  0.05173 .
## MONTHFebruary  -1330.86     311.81  -4.268 2.31e-05 ***
## MONTHJanuary   -1653.54     312.17  -5.297 1.69e-07 ***
## MONTHJuly       -588.34     358.14  -1.643  0.10098
## MONTHJune        -38.73     319.34  -0.121  0.90350
## MONTHMarch      -678.62     287.44  -2.361  0.01856 *
## MONTHMay         -22.98     295.09  -0.078  0.93796
## MONTHNovember    104.36     299.57   0.348  0.72769
## MONTHOctober     541.13     288.37   1.876  0.06110 .
## MONTHSeptember   205.82     309.85   0.664  0.50678
## WEEKDAYYES       104.18     127.81   0.815  0.41532
## BADWEATHERYES  -2779.63     360.40  -7.713 5.54e-14 ***
## ATEMP             87.51      13.93   6.280 6.73e-10 ***
## WINDSPEED        -34.08      10.99  -3.101  0.00202 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1390 on 569 degrees of freedom
## Multiple R-squared:  0.496,  Adjusted R-squared:  0.4827
## F-statistic: 37.33 on 15 and 569 DF,  p-value: < 2.2e-16
```

```r
tidy(fitNew)
```

```
## # A tibble: 16 x 5
##    term           estimate std.error statistic  p.value
##    <chr>             <dbl>     <dbl>     <dbl>    <dbl>
##  1 (Intercept)      3947.      346.    11.4    2.92e-27
##  2 MONTHAugust      -348.      335.    -1.04   3.00e- 1
##  3 MONTHDecember    -593.      304.    -1.95   5.17e- 2
##  4 MONTHFebruary   -1331.      312.    -4.27   2.31e- 5
##  5 MONTHJanuary    -1654.      312.    -5.30   1.69e- 7
##  6 MONTHJuly        -588.      358.    -1.64   1.01e- 1
##  7 MONTHJune         -38.7     319.    -0.121  9.04e- 1
##  8 MONTHMarch       -679.      287.    -2.36   1.86e- 2
##  9 MONTHMay          -23.0     295.    -0.0779 9.38e- 1
## 10 MONTHNovember     104.      300.     0.348  7.28e- 1
## 11 MONTHOctober      541.      288.     1.88   6.11e- 2
## 12 MONTHSeptember    206.      310.     0.664  5.07e- 1
## 13 WEEKDAYYES        104.      128.     0.815  4.15e- 1
## 14 BADWEATHERYES   -2780.      360.    -7.71   5.54e-14
## 15 ATEMP              87.5      13.9    6.28   6.73e-10
## 16 WINDSPEED         -34.1      11.0   -3.10   2.02e- 3

resultsNew <- dfwTest %>%
            mutate(predictedCount = predict(fitNew, dfwTest))
resultsNew

## # A tibble: 146 x 14
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2011-01-10 NO      YES              1   2     6       50          15
41
##  2 2011-01-11 NO      YES              2   1     3.5     57           7
43
##  3 2011-01-13 NO      YES              1   2     7       48.5        20
38
##  4 2011-01-16 NO      NO               1   2.5   2       49.5        15
251
##  5 2011-01-19 NO      YES              2   5.5   2.5     71.5        10
78
##  6 2011-01-20 NO      YES              2   4     2       56          15
83
##  7 2011-01-23 NO      NO               1   4    10       42          15
150
##  8 2011-01-25 NO      YES              2   2     4       65           9
186
##  9 2011-02-13 NO      NO               1   9.5   6       36          20
397
## 10 2011-02-15 NO      YES              1   4     3.5     32          17
140
## # … with 136 more rows, and 5 more variables: REGISTERED <dbl>, Count
```

```
<dbl>,
## #   MONTH <chr>, BADWEATHER <chr>, predictedCount <dbl>

performance <-
   metric_set(rmse, mae)
performance(resultsNew, truth= Count, estimate = predictedCount)

## # A tibble: 2 x 3
##   .metric .estimator .estimate
##   <chr>   <chr>          <dbl>
## 1 rmse    standard       1405.
## 2 mae     standard       1196.

# comparision of two models
summary(fitOrg)

##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + ATEMP + HUMIDITY,
##     data = dfwTrain)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3730.4 -1059.6  -123.3  1136.4  3935.6
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)     4682.429    349.954  13.380  < 2e-16 ***
## MONTHAugust     -180.796    325.897  -0.555 0.579273
## MONTHDecember    -66.799    295.882  -0.226 0.821467
## MONTHFebruary  -1120.863    303.118  -3.698 0.000239 ***
## MONTHJanuary   -1437.306    303.674  -4.733 2.79e-06 ***
## MONTHJuly       -526.826    347.187  -1.517 0.129718
## MONTHJune        -71.630    310.819  -0.230 0.817820
## MONTHMarch      -494.433    280.474  -1.763 0.078463 .
## MONTHMay         330.771    288.889   1.145 0.252700
## MONTHNovember    423.187    290.993   1.454 0.146419
## MONTHOctober     988.645    281.837   3.508 0.000487 ***
## MONTHSeptember   663.921    302.925   2.192 0.028806 *
## WEEKDAYYES        88.645    124.513   0.712 0.476797
## BADWEATHERYES  -2141.259    368.143  -5.816 1.00e-08 ***
## ATEMP            101.880     13.638   7.470 3.03e-13 ***
## HUMIDITY         -26.229      4.101  -6.396 3.32e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1354 on 569 degrees of freedom
## Multiple R-squared:  0.5219, Adjusted R-squared:  0.5093
## F-statistic:  41.4 on 15 and 569 DF,  p-value: < 2.2e-16

summary(fitNew)
```

```
##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + ATEMP + WINDSPEED,
##     data = dfwTrain)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3669.9 -1095.6  -254.2  1225.5  3390.7
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     3946.68     346.17  11.401  < 2e-16 ***
## MONTHAugust     -347.73     335.03  -1.038  0.29976
## MONTHDecember   -593.19     304.28  -1.950  0.05173 .
## MONTHFebruary  -1330.86     311.81  -4.268 2.31e-05 ***
## MONTHJanuary   -1653.54     312.17  -5.297 1.69e-07 ***
## MONTHJuly       -588.34     358.14  -1.643  0.10098
## MONTHJune        -38.73     319.34  -0.121  0.90350
## MONTHMarch      -678.62     287.44  -2.361  0.01856 *
## MONTHMay         -22.98     295.09  -0.078  0.93796
## MONTHNovember    104.36     299.57   0.348  0.72769
## MONTHOctober     541.13     288.37   1.876  0.06110 .
## MONTHSeptember   205.82     309.85   0.664  0.50678
## WEEKDAYYES       104.18     127.81   0.815  0.41532
## BADWEATHERYES  -2779.63     360.40  -7.713 5.54e-14 ***
## ATEMP             87.51      13.93   6.280 6.73e-10 ***
## WINDSPEED        -34.08      10.99  -3.101  0.00202 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1390 on 569 degrees of freedom
## Multiple R-squared:  0.496,  Adjusted R-squared:  0.4827
## F-statistic: 37.33 on 15 and 569 DF,  p-value: < 2.2e-16
```

First model fitOrg, is better for predictive analytics. As when we compare the RMSE and MAE values, these are lower than that of fitNew model. For exploratory analysis as well fitOrg is better because it has better values of R square ad adjusted R square.

8. More predictive analytics: In this final question, experiment with the time component. In a way, you will almost treat the data as a time series. We will cover time series data later, so this is just a little experiment. Taking into account date, you can't split your data randomly (well, evidently, you would not want to use future data to predict the past). Instead, you have to split your data by time. Start with dfbOrg and use the variables you used in fitOrg from Q7c. Split your data into training using the year "2011" data, and test using the "2012" data. Has the performance improved over the random split that assumed cross-sectional data? Why do you think so? Split again by assigning 1.5 years of data to the training set and 6 months of data to the test set. Does this look any better? Discuss your findings.

```r
dfwTrain <-
  dfbOrg %>%
  filter(as.numeric(format(DATE,'%Y')) == 2011)

dfwTest <- dfbOrg %>%
  filter(as.numeric(format(DATE,'%Y')) == 2012)

fitNew2 <- lm(Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP, data =
dfwTrain)

summary(fitNew2)

##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP,
##     data = dfwTrain)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3164.6  -316.4    49.4   392.3  2209.1
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     2363.64     203.72  11.602  < 2e-16 ***
## MONTHAugust      582.40     206.58   2.819 0.005088 **
## MONTHDecember     83.14     184.57   0.450 0.652665
## MONTHFebruary   -994.48     197.94  -5.024 8.09e-07 ***
## MONTHJanuary   -1183.04     227.22  -5.207 3.29e-07 ***
## MONTHJuly        622.99     226.06   2.756 0.006160 **
## MONTHJune        977.41     205.39   4.759 2.86e-06 ***
## MONTHMarch      -689.75     183.56  -3.758 0.000201 ***
## MONTHMay         883.39     178.45   4.950 1.16e-06 ***
## MONTHNovember    555.85     175.40   3.169 0.001665 **
## MONTHOctober     949.20     170.03   5.582 4.77e-08 ***
## MONTHSeptember   832.96     185.66   4.486 9.84e-06 ***
## WEEKDAYYES        16.07      77.06   0.209 0.834953
## BADWEATHERYES  -1757.89     178.86  -9.828  < 2e-16 ***
## TEMP              88.18      29.86   2.953 0.003357 **
## ATEMP            -31.31      25.57  -1.225 0.221550
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 662 on 349 degrees of freedom
## Multiple R-squared:  0.7789, Adjusted R-squared:  0.7694
## F-statistic: 81.99 on 15 and 349 DF,  p-value: < 2.2e-16

tidy(fitNew2)

## # A tibble: 16 x 5
##    term           estimate std.error statistic  p.value
##    <chr>             <dbl>     <dbl>     <dbl>    <dbl>
```

```
##  1 (Intercept)      2364.      204.     11.6   1.53e-26
##  2 MONTHAugust       582.      207.      2.82  5.09e- 3
##  3 MONTHDecember      83.1     185.      0.450 6.53e- 1
##  4 MONTHFebruary    -994.      198.     -5.02  8.09e- 7
##  5 MONTHJanuary    -1183.      227.     -5.21  3.29e- 7
##  6 MONTHJuly         623.      226.      2.76  6.16e- 3
##  7 MONTHJune         977.      205.      4.76  2.86e- 6
##  8 MONTHMarch       -690.      184.     -3.76  2.01e- 4
##  9 MONTHMay          883.      178.      4.95  1.16e- 6
## 10 MONTHNovember     556.      175.      3.17  1.67e- 3
## 11 MONTHOctober      949.      170.      5.58  4.77e- 8
## 12 MONTHSeptember    833.      186.      4.49  9.84e- 6
## 13 WEEKDAYYES         16.1      77.1     0.209 8.35e- 1
## 14 BADWEATHERYES   -1758.      179.     -9.83  2.76e-20
## 15 TEMP               88.2      29.9     2.95  3.36e- 3
## 16 ATEMP             -31.3      25.6    -1.22  2.22e- 1
```

```
resultsNew2 <- dfwTest %>%
            mutate(predictedCount2 = predict(fitNew2, dfwTest))
resultsNew2
```

```
## # A tibble: 366 x 14
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2012-01-01 NO      NO               1  11    11       65          17
686
##  2 2012-01-02 YES     YES              1   4     2       36.5        21
244
##  3 2012-01-03 NO      YES              1   2     8       42.5        24
89
##  4 2012-01-04 NO      YES              2   2     7       42.5        13
95
##  5 2012-01-05 NO      YES              1   3.5   2       56           6
140
##  6 2012-01-06 NO      YES              1   9     7       50          12
307
##  7 2012-01-07 NO      NO               1  10.5   9.5     45          13
1070
##  8 2012-01-08 NO      NO               1   7     5.5     49          14
599
##  9 2012-01-09 NO      YES              2   2     1       70           7
106
## 10 2012-01-10 NO      YES              1   4     4       81          11
173
## # … with 356 more rows, and 5 more variables: REGISTERED <dbl>, Count
<dbl>,
## #   MONTH <chr>, BADWEATHER <chr>, predictedCount2 <dbl>
```

```r
performance <-
   metric_set(rmse, mae)
performance(resultsNew2, truth= Count, estimate = predictedCount2)
```

```
## # A tibble: 2 x 3
##   .metric .estimator .estimate
##   <chr>   <chr>          <dbl>
## 1 rmse    standard       2422.
## 2 mae     standard       2219.
```

```r
dfwTrainPart3 <- subset(dfbOrg, DATE>= "2011-01-01" & DATE <= "2012-06-30")

dfwTestPart3 <- subset(dfbOrg, DATE>= "2012-07-01")


fitNew3 <- lm(Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP, data =
dfwTrainPart3)

summary(fitNew3)
```

```
##
## Call:
## lm(formula = Count ~ MONTH + WEEKDAY + BADWEATHER + TEMP + ATEMP,
##     data = dfwTrainPart3)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3200.2  -868.1   -80.8   822.8  3337.3
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     2598.34     257.48  10.091  < 2e-16 ***
## MONTHAugust    -1537.59     296.77  -5.181 3.14e-07 ***
## MONTHDecember   -757.06     271.24  -2.791 0.005441 **
## MONTHFebruary   -809.29     239.20  -3.383 0.000769 ***
## MONTHJanuary    -830.55     259.92  -3.195 0.001480 **
## MONTHJuly      -1617.90     320.76  -5.044 6.27e-07 ***
## MONTHJune        -83.19     253.79  -0.328 0.743186
## MONTHMarch      -327.20     214.72  -1.524 0.128146
## MONTHMay          43.98     223.93   0.196 0.844387
## MONTHNovember   -499.41     261.90  -1.907 0.057076 .
## MONTHOctober    -342.59     254.70  -1.345 0.179175
## MONTHSeptember  -955.22     274.13  -3.485 0.000534 ***
## WEEKDAYYES       -47.74     109.07  -0.438 0.661793
## BADWEATHERYES  -2022.89     288.96  -7.001 7.73e-12 ***
## TEMP             231.19      38.62   5.987 3.94e-09 ***
## ATEMP            -97.80      33.66  -2.905 0.003821 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 1148 on 531 degrees of freedom
## Multiple R-squared:  0.5623, Adjusted R-squared:  0.5499
## F-statistic: 45.48 on 15 and 531 DF,  p-value: < 2.2e-16

tidy(fitNew3)

## # A tibble: 16 x 5
##    term           estimate std.error statistic  p.value
##    <chr>             <dbl>     <dbl>     <dbl>    <dbl>
##  1 (Intercept)      2598.      257.     10.1   5.03e-22
##  2 MONTHAugust     -1538.      297.     -5.18  3.14e- 7
##  3 MONTHDecember    -757.      271.     -2.79  5.44e- 3
##  4 MONTHFebruary    -809.      239.     -3.38  7.69e- 4
##  5 MONTHJanuary     -831.      260.     -3.20  1.48e- 3
##  6 MONTHJuly       -1618.      321.     -5.04  6.27e- 7
##  7 MONTHJune         -83.2     254.     -0.328 7.43e- 1
##  8 MONTHMarch       -327.      215.     -1.52  1.28e- 1
##  9 MONTHMay           44.0     224.      0.196 8.44e- 1
## 10 MONTHNovember    -499.      262.     -1.91  5.71e- 2
## 11 MONTHOctober     -343.      255.     -1.35  1.79e- 1
## 12 MONTHSeptember   -955.      274.     -3.48  5.34e- 4
## 13 WEEKDAYYES        -47.7     109.     -0.438 6.62e- 1
## 14 BADWEATHERYES   -2023.      289.     -7.00  7.73e-12
## 15 TEMP              231.       38.6     5.99  3.94e- 9
## 16 ATEMP             -97.8      33.7    -2.91  3.82e- 3

resultsNew3 <- dfwTestPart3 %>%
            mutate(predictedCount3 = predict(fitNew3, dfwTestPart3))
resultsNew3

## # A tibble: 184 x 14
##    DATE       HOLIDAY WEEKDAY WEATHERSIT  TEMP ATEMP HUMIDITY WINDSPEED
CASUAL
##    <date>     <chr>   <chr>        <dbl> <dbl> <dbl>    <dbl>     <dbl>
<dbl>
##  1 2012-07-01 NO      NO               1  32    33       44           9
1421
##  2 2012-07-02 NO      YES              1  29    30       51          13
904
##  3 2012-07-03 NO      YES              1  28.5  30       54.5         9
1052
##  4 2012-07-04 YES     YES              1  31.5  32.5     51.5         9
2562
##  5 2012-07-05 NO      YES              1  33    36       47.5        14
1405
##  6 2012-07-06 NO      YES              1  32    33.5     39.5         9
1366
##  7 2012-07-07 NO      NO               1  34    38.5     46.5        11
1448
##  8 2012-07-08 NO      NO               1  31    36       59           7
1203
```

```
##  9 2012-07-09 NO      YES              2  26    28       65          11
998
## 10 2012-07-10 NO      YES              2  26    27       74           9
954
## # … with 174 more rows, and 5 more variables: REGISTERED <dbl>, Count
<dbl>,
## #   MONTH <chr>, BADWEATHER <chr>, predictedCount3 <dbl>
```

```
performance <-
   metric_set(rmse, mae)
performance(resultsNew3, truth= Count, estimate = predictedCount3)
```

```
## # A tibble: 2 x 3
##   .metric .estimator .estimate
##   <chr>   <chr>          <dbl>
## 1 rmse    standard       2475.
## 2 mae     standard       2268.
```

No, performance has not been improved over random split of data RMSE and MAE values are more than FitNEW model of Q.7. As we have used continuous data set, to predict future values. It is causing overfitting of data hence for future predictions we are getting more error. No, the performance has not been improved yet. RMSE and MAE values have increased.

9) Data-informed decision making: Based on your quick analysis of the Capital Bikeshare data, what are some actions you would take if you were managing Capital Bikeshare's pricing and promotions? How do you think you would use your predictions? Answer: • Provide offers to the casual bike users when temperature is high and whether is bad • When temperature is extreme (too high or too low), will try to provide more discounts and promote city bike use to increase the count • Provide incentives to users in order to get registered with city bikes, because registered user have high chances of boosting city bike usage in any temperature and weather conditions as compare to casual users. • From model fit2, we see month of January, February, July, November, October and September have lower p-value, hence significant in defining Count/Usage. • We can see coefficients are positive for months November, October and September, thus we can charge more in this month to increase revenue.

10) Data-driven solutions to "the" big challenge of bikeshare: We can collect data regarding number of bikes available at each station every 15 mins, depending on that we can predict number of drop-off and pick-up probabilities at each station. • Depending on this probability we can make decision to add more bikes to or take out bikes from that bike hub. • We can track each user's day to day commuting path, pick-up hub and drop-off hub & corresponding timings, based on this data we can cluster users. We can use this information for rebalancing purpose. • There are some of the stations in image with same number of bikes in the morning and evening. Which Means those have not been used actively by users. We can either eliminate these stations and save unnecessary efforts in rebalancing and also save on cost of unused bikes at each station.