MRA - Assignment 2

Q3. Model Selection

```r
library(tidyverse)
```

```
-- Attaching core tidyverse packages ---------------------- tidyverse 2.0.0 --
v dplyr     1.1.4      v readr     2.1.5
v forcats   1.0.0      v stringr   1.5.1
v ggplot2   3.5.1      v tibble    3.2.1
v lubridate 1.9.3      v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becon
```

```r
library(dplyr)
library(olsrr)
```

```
Warning: package 'olsrr' was built under R version 4.4.2


Attaching package: 'olsrr'

The following object is masked from 'package:datasets':

    rivers
```

```
crime_data = read_csv("Crimes.csv")
```

```
Rows: 51 Columns: 4
-- Column specification ---------------------------------------------------
Delimiter: ","
dbl (4): VR, MR, M, P

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
crime_data
```

```
# A tibble: 51 x 4
       VR    MR     M     P
    <dbl> <dbl> <dbl> <dbl>
 1   761   9    41.8   9.1
 2   780  11.6  67.4  17.4
 3   593  10.2  44.7  20
 4   715   8.6  84.7  15.4
 5  1078  13.1  96.7  18.2
 6   567   5.8  81.8   9.9
 7   456   6.3  95.7   8.5
 8   686   5    82.7  10.2
 9  1206   8.9  93    17.8
10   723  11.4  67.7  13.5
# i 41 more rows
```

a) Use R to fit all possible models and compute AIC, BIC and R2 adj for each model. Report a table with your results.

```
crime_model = lm(VR ~ ., data = crime_data)
tab = ols_step_all_possible(crime_model)
results = tab$result[,c("predictors","aic","sbc","adjr")]
results
```

```
  predictors      aic       sbc      adjr
1         MR 692.3529 698.1484 0.7809632
2          M 752.9293 758.7248 0.2816104
3          P 755.4989 761.2944 0.2444882
4       MR M 671.5556 679.2829 0.8569988
```

```
5        MR P 694.3304 702.0577 0.7764989
6         M P 727.1934 734.9207 0.5742764
7      MR M P 669.7249 679.3840 0.8645242
```

b) Indicate the best model overall according to each of AIC, BIC and R2 adj.

```r
print(c(results$predictors[which.min(results$aic)],results$aic[which.min(results$aic)]))
```

```
[1] "MR M P"           "669.724867314439"
```

```r
print(c(results$predictors[which.min(results$sbc)],results$sbc[which.min(results$sbc)]))
```

```
[1] "MR M"             "679.282922911935"
```

```r
print(c(results$predictors[which.max(results$adjr)],results$adjr[which.max(results$adjr)]))
```

```
[1] "MR M P"           "0.864524166055133"
```

c) Implement a forward stepwise regression that uses BIC. You will start by fitting the null model (the model with no covariates) and computing its BIC. Then, consider all possible one covariate models and compute their BICs. Iterate until there is no improvement in your criteria.

```r
combinations = list(("1"),c("P","M","MR"),c("M + P","MR + P","MR + M"),c("MR + M + P"))
min = 100000000
min_combination = ""

for(i in 1:length(combinations)){
  flag = FALSE
  for(j in 1:length(combinations[[i]])){
    f = as.formula(paste("VR ~ ",paste(combinations[[i]][j])))
    crime_model = lm(f,data = crime_data)
    lm = sum(log(dnorm(crime_data$VR,fitted.values(crime_model),
                  sd = summary(crime_model)$sigma)))
    bic = -2 * lm + (i+1) * log(nrow(crime_data))
    if(bic < min){
      min = bic
      min_combination = combinations[[i]][j]
      flag = TRUE
```

```
    }
  }
  if(flag == FALSE){
    break
  }
}

print(min)
```

```
[1] 679.3748
```

```
print(min_combination)
```

```
[1] "MR + M"
```

d) Does the forward stepwise method find the best possible subset? Compare the solutions to item (a) and (c). Explain why solutions from stepwise regression might differ from the all possible regressions method in (a).

By looking at the BIC values, the best possible subset found using the all possible regressions was MR + M with a BIC value of 679.282922. The forward selection algorithm using the BIC found the same subset MR + M with a BIC value of 679.3748.

...write more

e) Explain how you could implement a backward selection algorithm using the F test as a decision rule. You can assume that the confidence level is = 0.05.

...write

Q4) Multiple regression

```
football = read_csv("football.csv")
```

```
Rows: 28 Columns: 10
-- Column specification ------------------------------------------------------
Delimiter: ","
dbl (10): y, x1, x2, x3, x4, x5, x6, x7, x8, x9
```

4

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.

football

```
# A tibble: 28 x 10
       y    x1    x2    x3    x4    x5    x6    x7    x8    x9
   <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
 1    10  2113  1985  38.9  64.7     4   868  59.7  2205  1917
 2    11  2003  2855  38.8  61.3     3   615  55    2096  1575
 3    11  2957  1737  40.1  60      14   914  65.6  1847  2175
 4    13  2285  2905  41.6  45.3    -4   957  61.4  1903  2476
 5    10  2971  1666  39.2  53.8    15   836  66.1  1457  1866
 6    11  2309  2927  39.7  74.1     8   786  61    1848  2339
 7    10  2528  2341  38.1  65.4    12   754  66.1  1564  2092
 8    11  2147  2737  37    78.3    -1   761  58    1821  1909
 9     4  1689  1414  42.1  47.6    -3   714  57    2577  2001
10     2  2566  1838  42.3  54.2    -1   797  58.9  2476  2254
# i 18 more rows
```

a)

```
football_model = lm(y ~ x2 + x7 + x8,data=football)
summary(football_model)
```

```
Call:
lm(formula = y ~ x2 + x7 + x8, data = football)

Residuals:
    Min      1Q  Median      3Q     Max
-3.0370 -0.7129 -0.2043  1.1101  3.7049

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.808372   7.900859  -0.229 0.820899
x2           0.003598   0.000695   5.177 2.66e-05 ***
x7           0.193960   0.088233   2.198 0.037815 *
x8          -0.004816   0.001277  -3.771 0.000938 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 1.706 on 24 degrees of freedom
Multiple R-squared:  0.7863,    Adjusted R-squared:  0.7596
F-statistic: 29.44 on 3 and 24 DF,  p-value: 3.273e-08
```

b) ...write stuff

```
y_bar = mean(football$y)

sst = sum((football$y - y_bar)^2)
sse = sum((football$y - fitted.values(football_model))^2)
ssr = sum((fitted.values(football_model) - y_bar)^2)

cat("sse = ",sse," , ","ssr = ",ssr," , ","sst = ",sst)
```

```
sse =  69.87  ,  ssr =  257.0943  ,  sst =  326.9643
```

The relationship between SSt, SSe, and SSr:

$SSt = SSe + SSr.$

```
sse + ssr
```

```
[1] 326.9643
```

```
p = 3
n = nrow(football)
df_sse = n - p - 1
df_ssr = p
df_sst = df_sse + df_ssr

cat("DF of sse = ",df_sse," , ","DF of ssr = ",df_ssr," , ","DF of sst = ",df_sst)
```

```
DF of sse =  24  ,  DF of ssr =  3  ,  DF of sst =  27
```

```
mst = sst / df_sst
mse = sse / df_sse
msr = ssr / df_ssr
cat("MSE = ",mse," , ","MSR = ",msr," , ","MST = ",mst)
```

```
MSE =  2.91125  ,  MSR =  85.69809  ,  MST =  12.10979
```

c)

```
X = model.matrix(football_model)
beta = solve(t(X)%*%X)%*%t(X)%*%football$y
sigma_2 = sse / (n - p - 1)
sigma = sigma_2 * solve(t(X)%*%X)

t_b1 = beta[2,1] / sqrt(sigma[2,2])
t_b2 = beta[3,1] / sqrt(sigma[3,3])
t_b3 = beta[4,1] / sqrt(sigma[4,4])

print(c("T_" = t_b1, "T_" = t_b2, "T_" = t_b3))
```

```
    T_.x2      T_.x7       T_.x8
 5.177090   2.198262  -3.771036
```

d)

```
r2 = 1 - (sse/sst)
r2_adj = 1 - (mse/mst)

print(c(r2 = r2,r2_adj = r2_adj))
```

```
       r2     r2_adj
0.7863069 0.7595953
```

e)

```
f_stat = msr/mse
c(f_stat = f_stat,"95% CI F distribution" = qf(0.95,p, n - p - 1))
```

```
             f_stat 95% CI F distribution
           29.436870             3.008787
```

Reject H0

f)

7

```r
c("Square of correlation coefficent" = cor(football$y, fitted.values(football_model))^2, "R2"
```

```
Square of correlation coefficent                                    R2
                  0.7863069                             0.7863069
```

g)

```r
X_Star = matrix(c(1,2300,56,2100),ncol=1)

Y_Star_mean = t(X_Star)%*%matrix(beta,ncol=1)

Y_Star_mean_upper = Y_Star_mean + qt(0.95,n-p-1) * sqrt(sigma_2 * t(X_Star)%*%solve(t(X)%*%(X
Y_Star_mean_lower = Y_Star_mean - qt(0.95,n-p-1) * sqrt(sigma_2 * t(X_Star)%*%solve(t(X)%*%(X

c(lower = Y_Star_mean_lower,upper = Y_Star_mean_upper)
```

```
   lower    upper
6.569655 7.863193
```

h)

```r
football_model_2 = lm(y ~ x7 + x8,data=football)
summary(football_model_2)
```

```
Call:
lm(formula = y ~ x7 + x8, data = football)

Residuals:
    Min      1Q  Median      3Q     Max
-3.7985 -1.5166 -0.5792  1.9927  4.5248

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 17.944319   9.862484   1.819  0.08084 .
x7           0.048371   0.119219   0.406  0.68839
x8          -0.006537   0.001758  -3.719  0.00102 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 2.432 on 25 degrees of freedom
Multiple R-squared:  0.5477,    Adjusted R-squared:  0.5115
F-statistic: 15.13 on 2 and 25 DF,  p-value: 4.935e-05
```

```r
y_bar_2 = mean(football$y)

sst_2 = sum((football$y - y_bar)^2)
sse_2 = sum((football$y - fitted.values(football_model_2))^2)
ssr_2 = sum((fitted.values(football_model_2) - y_bar)^2)

cat("sse = ",sse_2," , ","ssr = ",ssr_2," , ","sst = ",sst_2)
```

```
sse =  147.8981  ,  ssr =  179.0662  ,  sst =  326.9643
```

```r
p_2 = 2
n = nrow(football)
df_sse_2 = n - p_2 - 1
df_ssr_2 = p_2
df_sst_2 = df_sse_2 + df_ssr_2

cat("DF of sse = ",df_sse_2," , ","DF of ssr = ",df_ssr_2," , ","DF of sst = ",df_sst_2)
```

```
DF of sse =  25  ,  DF of ssr =  2  ,  DF of sst =  27
```

```r
mst_2 = sst_2 / df_sst_2
mse_2 = sse_2 / df_sse_2
msr_2 = ssr_2 / df_ssr_2
cat("MSE = ",mse_2," , ","MSR = ",msr_2," , ","MST = ",mst_2)
```

```
MSE =  5.915924  ,  MSR =  89.53309  ,  MST =  12.10979
```

i)

```r
f_stat_2 = msr_2/mse_2
c(f_stat = f_stat_2,"95% CI F distribution" = qf(0.95,p_2,n -p_2 -1))
```

```
             f_stat 95% CI F distribution
           15.13425              3.38519
```

j)

```
r2_2 = 1 - (sse_2/sst_2)
r2_adj_2 = 1 - (mse_2/mst_2)

print(c(r2 = r2_2,r2_adj = r2_adj_2))
```

```
        r2    r2_adj
0.5476628 0.5114759
```

k)

Y_Star_mean_upper - Y_Star_mean_lower

```
X = model.matrix(football_model_2)

beta = solve(t(X)%*%X)%*%t(X)%*%football$y
sigma_2 = sse / (n - p_2 - 1)
sigma = sigma_2 * solve(t(X)%*%X)

X_Star = matrix(c(1,56,2100),ncol=1)
Y_Star_mean = t(X_Star)%*%matrix(beta,ncol=1)

Y_Star_mean_upper = Y_Star_mean + qt(0.95,n - p_2 -1) * sqrt(sigma_2 * t(X_Star)%*%solve(t(X)
Y_Star_mean_lower = Y_Star_mean - qt(0.95,n - p_2 - 1) * sqrt(sigma_2 * t(X_Star)%*%solve(t(X)

c(lower = Y_Star_mean_lower,upper = Y_Star_mean_upper)
```

```
    lower     upper
6.300549 7.551936
```

l)

Q5)

```
bike_sharing = read.csv("bikesharing.csv")
bike_sharing
```

	instant	dteday	season	yr	mnth	holiday	weekday	workingday	weathersit
1	1	2011-01-01	1	0	1	0	6	0	2
2	2	2011-01-02	1	0	1	0	0	0	2
3	3	2011-01-03	1	0	1	0	1	1	1
4	4	2011-01-04	1	0	1	0	2	1	1
5	5	2011-01-05	1	0	1	0	3	1	1
6	6	2011-01-06	1	0	1	0	4	1	1
7	7	2011-01-07	1	0	1	0	5	1	2
8	8	2011-01-08	1	0	1	0	6	0	2
9	9	2011-01-09	1	0	1	0	0	0	1
10	10	2011-01-10	1	0	1	0	1	1	1
11	11	2011-01-11	1	0	1	0	2	1	2
12	12	2011-01-12	1	0	1	0	3	1	1
13	13	2011-01-13	1	0	1	0	4	1	1
14	14	2011-01-14	1	0	1	0	5	1	1
15	15	2011-01-15	1	0	1	0	6	0	2
16	16	2011-01-16	1	0	1	0	0	0	1
17	17	2011-01-17	1	0	1	1	1	0	2
18	18	2011-01-18	1	0	1	0	2	1	2
19	19	2011-01-19	1	0	1	0	3	1	2
20	20	2011-01-20	1	0	1	0	4	1	2
21	21	2011-01-21	1	0	1	0	5	1	1
22	22	2011-01-22	1	0	1	0	6	0	1
23	23	2011-01-23	1	0	1	0	0	0	1
24	24	2011-01-24	1	0	1	0	1	1	1
25	25	2011-01-25	1	0	1	0	2	1	2
26	26	2011-01-26	1	0	1	0	3	1	3
27	27	2011-01-27	1	0	1	0	4	1	1
28	28	2011-01-28	1	0	1	0	5	1	2
29	29	2011-01-29	1	0	1	0	6	0	1
30	30	2011-01-30	1	0	1	0	0	0	1
31	31	2011-01-31	1	0	1	0	1	1	2
32	32	2011-02-01	1	0	2	0	2	1	2
33	33	2011-02-02	1	0	2	0	3	1	2
34	34	2011-02-03	1	0	2	0	4	1	1
35	35	2011-02-04	1	0	2	0	5	1	2
36	36	2011-02-05	1	0	2	0	6	0	2
37	37	2011-02-06	1	0	2	0	0	0	1
38	38	2011-02-07	1	0	2	0	1	1	1
39	39	2011-02-08	1	0	2	0	2	1	1
40	40	2011-02-09	1	0	2	0	3	1	2
41	41	2011-02-10	1	0	2	0	4	1	1
42	42	2011-02-11	1	0	2	0	5	1	1

43	43 2011-02-12	1	0	2	0	6	0	1
44	44 2011-02-13	1	0	2	0	0	0	1
45	45 2011-02-14	1	0	2	0	1	1	1
46	46 2011-02-15	1	0	2	0	2	1	1
47	47 2011-02-16	1	0	2	0	3	1	1
48	48 2011-02-17	1	0	2	0	4	1	1
49	49 2011-02-18	1	0	2	0	5	1	1
50	50 2011-02-19	1	0	2	0	6	0	1
51	51 2011-02-20	1	0	2	0	0	0	1
52	52 2011-02-21	1	0	2	1	1	0	2
53	53 2011-02-22	1	0	2	0	2	1	1
54	54 2011-02-23	1	0	2	0	3	1	1
55	55 2011-02-24	1	0	2	0	4	1	2
56	56 2011-02-25	1	0	2	0	5	1	2
57	57 2011-02-26	1	0	2	0	6	0	1
58	58 2011-02-27	1	0	2	0	0	0	1
59	59 2011-02-28	1	0	2	0	1	1	2
60	60 2011-03-01	1	0	3	0	2	1	1
61	61 2011-03-02	1	0	3	0	3	1	1
62	62 2011-03-03	1	0	3	0	4	1	1
63	63 2011-03-04	1	0	3	0	5	1	2
64	64 2011-03-05	1	0	3	0	6	0	2
65	65 2011-03-06	1	0	3	0	0	0	2
66	66 2011-03-07	1	0	3	0	1	1	1
67	67 2011-03-08	1	0	3	0	2	1	1
68	68 2011-03-09	1	0	3	0	3	1	2
69	69 2011-03-10	1	0	3	0	4	1	3
70	70 2011-03-11	1	0	3	0	5	1	2
71	71 2011-03-12	1	0	3	0	6	0	1
72	72 2011-03-13	1	0	3	0	0	0	1
73	73 2011-03-14	1	0	3	0	1	1	1
74	74 2011-03-15	1	0	3	0	2	1	2
75	75 2011-03-16	1	0	3	0	3	1	2
76	76 2011-03-17	1	0	3	0	4	1	1
77	77 2011-03-18	1	0	3	0	5	1	1
78	78 2011-03-19	1	0	3	0	6	0	1
79	79 2011-03-20	1	0	3	0	0	0	1
80	80 2011-03-21	2	0	3	0	1	1	2
81	81 2011-03-22	2	0	3	0	2	1	1
82	82 2011-03-23	2	0	3	0	3	1	2
83	83 2011-03-24	2	0	3	0	4	1	2
84	84 2011-03-25	2	0	3	0	5	1	1
85	85 2011-03-26	2	0	3	0	6	0	1

86	86	2011-03-27	2	0	3	0	0	0	2
87	87	2011-03-28	2	0	3	0	1	1	1
88	88	2011-03-29	2	0	3	0	2	1	1
89	89	2011-03-30	2	0	3	0	3	1	2
90	90	2011-03-31	2	0	3	0	4	1	3
91	91	2011-04-01	2	0	4	0	5	1	2
92	92	2011-04-02	2	0	4	0	6	0	2
93	93	2011-04-03	2	0	4	0	0	0	1
94	94	2011-04-04	2	0	4	0	1	1	1
95	95	2011-04-05	2	0	4	0	2	1	2
96	96	2011-04-06	2	0	4	0	3	1	1
97	97	2011-04-07	2	0	4	0	4	1	1
98	98	2011-04-08	2	0	4	0	5	1	2
99	99	2011-04-09	2	0	4	0	6	0	2
100	100	2011-04-10	2	0	4	0	0	0	2
101	101	2011-04-11	2	0	4	0	1	1	2
102	102	2011-04-12	2	0	4	0	2	1	2
103	103	2011-04-13	2	0	4	0	3	1	2
104	104	2011-04-14	2	0	4	0	4	1	1
105	105	2011-04-15	2	0	4	1	5	0	1
106	106	2011-04-16	2	0	4	0	6	0	3
107	107	2011-04-17	2	0	4	0	0	0	1
108	108	2011-04-18	2	0	4	0	1	1	1
109	109	2011-04-19	2	0	4	0	2	1	2
110	110	2011-04-20	2	0	4	0	3	1	1
111	111	2011-04-21	2	0	4	0	4	1	1
112	112	2011-04-22	2	0	4	0	5	1	2
113	113	2011-04-23	2	0	4	0	6	0	2
114	114	2011-04-24	2	0	4	0	0	0	2
115	115	2011-04-25	2	0	4	0	1	1	1
116	116	2011-04-26	2	0	4	0	2	1	1
117	117	2011-04-27	2	0	4	0	3	1	2
118	118	2011-04-28	2	0	4	0	4	1	2
119	119	2011-04-29	2	0	4	0	5	1	1
120	120	2011-04-30	2	0	4	0	6	0	1
121	121	2011-05-01	2	0	5	0	0	0	2
122	122	2011-05-02	2	0	5	0	1	1	2
123	123	2011-05-03	2	0	5	0	2	1	2
124	124	2011-05-04	2	0	5	0	3	1	2
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126	126	2011-05-06	2	0	5	0	5	1	1
127	127	2011-05-07	2	0	5	0	6	0	1
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132	132	2011-05-12	2	0	5	0	4	1	1
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276	276	2011-10-03	4	0	10	0	1	1	2
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291	291	2011-10-18	4	0	10	0	2	1	2
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428	428	2012-03-03	1	1	3	0	6	0	2
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446	446	2012-03-21	2	1	3	0	3	1	2
447	447	2012-03-22	2	1	3	0	4	1	1
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450	450	2012-03-25	2	1	3	0	0	0	2
451	451	2012-03-26	2	1	3	0	1	1	1
452	452	2012-03-27	2	1	3	0	2	1	1
453	453	2012-03-28	2	1	3	0	3	1	1
454	454	2012-03-29	2	1	3	0	4	1	1
455	455	2012-03-30	2	1	3	0	5	1	2
456	456	2012-03-31	2	1	3	0	6	0	2
457	457	2012-04-01	2	1	4	0	0	0	2
458	458	2012-04-02	2	1	4	0	1	1	1
459	459	2012-04-03	2	1	4	0	2	1	1
460	460	2012-04-04	2	1	4	0	3	1	1
461	461	2012-04-05	2	1	4	0	4	1	1
462	462	2012-04-06	2	1	4	0	5	1	1
463	463	2012-04-07	2	1	4	0	6	0	1
464	464	2012-04-08	2	1	4	0	0	0	1
465	465	2012-04-09	2	1	4	0	1	1	1
466	466	2012-04-10	2	1	4	0	2	1	1
467	467	2012-04-11	2	1	4	0	3	1	1
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470	470	2012-04-14	2	1	4	0	6	0	1
471	471	2012-04-15	2	1	4	0	0	0	1
472	472	2012-04-16	2	1	4	1	1	0	1

473	473 2012-04-17	2	1	4	0	2	1	1
474	474 2012-04-18	2	1	4	0	3	1	2
475	475 2012-04-19	2	1	4	0	4	1	1
476	476 2012-04-20	2	1	4	0	5	1	1
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491	491 2012-05-05	2	1	5	0	6	0	2
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493	493 2012-05-07	2	1	5	0	1	1	2
494	494 2012-05-08	2	1	5	0	2	1	2
495	495 2012-05-09	2	1	5	0	3	1	2
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499	499 2012-05-13	2	1	5	0	0	0	1
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561	561	2012-07-14	3	1	7	0	6	0	2
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568	568	2012-07-21	3	1	7	0	6	0	3
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571	571	2012-07-24	3	1	7	0	2	1	1
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600	600	2012-08-22	3	1	8	0	3	1	1
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624	624	2012-09-15	3	1	9	0	6	0	1
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627	627	2012-09-18	3	1	9	0	2	1	2
628	628	2012-09-19	3	1	9	0	3	1	1
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630	630	2012-09-21	3	1	9	0	5	1	1
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634	634	2012-09-25	4	1	9	0	2	1	1
635	635	2012-09-26	4	1	9	0	3	1	1
636	636	2012-09-27	4	1	9	0	4	1	2
637	637	2012-09-28	4	1	9	0	5	1	2
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649	649	2012-10-10	4	1	10	0	3	1	1
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664	664	2012-10-25	4	1	10	0	4	1	2
665	665	2012-10-26	4	1	10	0	5	1	2
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702	702	2012-12-02	4	1	12	0	0	0	2
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716	716	2012-12-16	4	1	12	0	0	0	2
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718	718	2012-12-18	4	1	12	0	2	1	1
719	719	2012-12-19	4	1	12	0	3	1	1
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721	721	2012-12-21	1	1	12	0	5	1	2
722	722	2012-12-22	1	1	12	0	6	0	1
723	723	2012-12-23	1	1	12	0	0	0	1
724	724	2012-12-24	1	1	12	0	1	1	2
725	725	2012-12-25	1	1	12	1	2	0	2
726	726	2012-12-26	1	1	12	0	3	1	3
727	727	2012-12-27	1	1	12	0	4	1	2
728	728	2012-12-28	1	1	12	0	5	1	2
729	729	2012-12-29	1	1	12	0	6	0	2
730	730	2012-12-30	1	1	12	0	0	0	1

	731	2012-12-31	1	1	12	0	1	1			2

	temp	atemp	hum	windspeed	casual	registered	cnt
1	0.3441670	0.3636250	0.805833	0.1604460	331	654	985
2	0.3634780	0.3537390	0.696087	0.2485390	131	670	801
3	0.1963640	0.1894050	0.437273	0.2483090	120	1229	1349
4	0.2000000	0.2121220	0.590435	0.1602960	108	1454	1562
5	0.2269570	0.2292700	0.436957	0.1869000	82	1518	1600
6	0.2043480	0.2332090	0.518261	0.0895652	88	1518	1606
7	0.1965220	0.2088390	0.498696	0.1687260	148	1362	1510
8	0.1650000	0.1622540	0.535833	0.2668040	68	891	959
9	0.1383330	0.1161750	0.434167	0.3619500	54	768	822
10	0.1508330	0.1508880	0.482917	0.2232670	41	1280	1321
11	0.1690910	0.1914640	0.686364	0.1221320	43	1220	1263
12	0.1727270	0.1604730	0.599545	0.3046270	25	1137	1162
13	0.1650000	0.1508830	0.470417	0.3010000	38	1368	1406
14	0.1608700	0.1884130	0.537826	0.1265480	54	1367	1421
15	0.2333330	0.2481120	0.498750	0.1579630	222	1026	1248
16	0.2316670	0.2342170	0.483750	0.1884330	251	953	1204
17	0.1758330	0.1767710	0.537500	0.1940170	117	883	1000
18	0.2166670	0.2323330	0.861667	0.1467750	9	674	683
19	0.2921740	0.2984220	0.741739	0.2083170	78	1572	1650
20	0.2616670	0.2550500	0.538333	0.1959040	83	1844	1927
21	0.1775000	0.1578330	0.457083	0.3532420	75	1468	1543
22	0.0591304	0.0790696	0.400000	0.1719700	93	888	981
23	0.0965217	0.0988391	0.436522	0.2466000	150	836	986
24	0.0973913	0.1179300	0.491739	0.1583300	86	1330	1416
25	0.2234780	0.2345260	0.616957	0.1297960	186	1799	1985
26	0.2175000	0.2036000	0.862500	0.2938500	34	472	506
27	0.1950000	0.2197000	0.687500	0.1138370	15	416	431
28	0.2034780	0.2233170	0.793043	0.1233000	38	1129	1167
29	0.1965220	0.2121260	0.651739	0.1453650	123	975	1098
30	0.2165220	0.2503220	0.722174	0.0739826	140	956	1096
31	0.1808330	0.1862500	0.603750	0.1871920	42	1459	1501
32	0.1921740	0.2345300	0.829565	0.0532130	47	1313	1360
33	0.2600000	0.2544170	0.775417	0.2643080	72	1454	1526
34	0.1869570	0.1778780	0.437826	0.2777520	61	1489	1550
35	0.2113040	0.2285870	0.585217	0.1278390	88	1620	1708
36	0.2333330	0.2430580	0.929167	0.1610790	100	905	1005
37	0.2858330	0.2916710	0.568333	0.1418000	354	1269	1623
38	0.2716670	0.3036580	0.738333	0.0454083	120	1592	1712
39	0.2208330	0.1982460	0.537917	0.3619500	64	1466	1530
40	0.1347830	0.1442830	0.494783	0.1888390	53	1552	1605
41	0.1443480	0.1495480	0.437391	0.2219350	47	1491	1538

42	0.1890910	0.2135090	0.506364	0.1085500	149	1597 1746
43	0.2225000	0.2329540	0.544167	0.2033670	288	1184 1472
44	0.3165220	0.3241130	0.457391	0.2608830	397	1192 1589
45	0.4150000	0.3983500	0.375833	0.4179080	208	1705 1913
46	0.2660870	0.2542740	0.314348	0.2913740	140	1675 1815
47	0.3182610	0.3162000	0.423478	0.2517910	218	1897 2115
48	0.4358330	0.4286580	0.505000	0.2301040	259	2216 2475
49	0.5216670	0.5119830	0.516667	0.2649250	579	2348 2927
50	0.3991670	0.3914040	0.187917	0.5074630	532	1103 1635
51	0.2852170	0.2773300	0.407826	0.2232350	639	1173 1812
52	0.3033330	0.2840750	0.605000	0.3078460	195	912 1107
53	0.1822220	0.1860330	0.577778	0.1956830	74	1376 1450
54	0.2217390	0.2457170	0.423043	0.0941130	139	1778 1917
55	0.2956520	0.2891910	0.697391	0.2504960	100	1707 1807
56	0.3643480	0.3504610	0.712174	0.3465390	120	1341 1461
57	0.2825000	0.2821920	0.537917	0.1865710	424	1545 1969
58	0.3434780	0.3511090	0.680000	0.1252480	694	1708 2402
59	0.4072730	0.4001180	0.876364	0.2896860	81	1365 1446
60	0.2666670	0.2638790	0.535000	0.2164250	137	1714 1851
61	0.3350000	0.3200710	0.449583	0.3078330	231	1903 2134
62	0.1983330	0.2001330	0.318333	0.2257540	123	1562 1685
63	0.2616670	0.2556790	0.610417	0.2033460	214	1730 1944
64	0.3841670	0.3787790	0.789167	0.2518710	640	1437 2077
65	0.3765220	0.3662520	0.948261	0.3432870	114	491 605
66	0.2617390	0.2384610	0.551304	0.3413520	244	1628 1872
67	0.2925000	0.3024000	0.420833	0.1206500	316	1817 2133
68	0.2958330	0.2866080	0.775417	0.2201500	191	1700 1891
69	0.3890910	0.3856680	0.000000	0.2618770	46	577 623
70	0.3165220	0.3050000	0.649565	0.2329700	247	1730 1977
71	0.3291670	0.3257500	0.594583	0.2207750	724	1408 2132
72	0.3843480	0.3800910	0.527391	0.2706040	982	1435 2417
73	0.3252170	0.3320000	0.496957	0.1369260	359	1687 2046
74	0.3173910	0.3181780	0.655652	0.1843090	289	1767 2056
75	0.3652170	0.3669300	0.776522	0.2031170	321	1871 2192
76	0.4150000	0.4103330	0.602917	0.2095790	424	2320 2744
77	0.5400000	0.5270090	0.525217	0.2310170	884	2355 3239
78	0.4725000	0.4665250	0.379167	0.3681670	1424	1693 3117
79	0.3325000	0.3257500	0.473750	0.2077210	1047	1424 2471
80	0.4304350	0.4097350	0.737391	0.2887830	401	1676 2077
81	0.4416670	0.4406420	0.624583	0.2257500	460	2243 2703
82	0.3469570	0.3379390	0.839565	0.2342610	203	1918 2121
83	0.2850000	0.2708330	0.805833	0.2437870	166	1699 1865
84	0.2641670	0.2563120	0.495000	0.2307250	300	1910 2210

85	0.2658330	0.2575710	0.394167	0.2095710	981	1515	2496
86	0.2530430	0.2503390	0.493913	0.1843000	472	1221	1693
87	0.2643480	0.2575740	0.302174	0.2122040	222	1806	2028
88	0.3025000	0.2929080	0.314167	0.2269960	317	2108	2425
89	0.3000000	0.2973500	0.646667	0.1728880	168	1368	1536
90	0.2683330	0.2575750	0.918333	0.2176460	179	1506	1685
91	0.3000000	0.2834540	0.686250	0.2587080	307	1920	2227
92	0.3150000	0.3156370	0.653750	0.1971460	898	1354	2252
93	0.3783330	0.3787670	0.480000	0.1822130	1651	1598	3249
94	0.5733330	0.5429290	0.426250	0.3855710	734	2381	3115
95	0.4141670	0.3983500	0.642083	0.3880670	167	1628	1795
96	0.3908330	0.3876080	0.470833	0.2630630	413	2395	2808
97	0.4375000	0.4336960	0.602917	0.1623120	571	2570	3141
98	0.3358330	0.3244790	0.836250	0.2269920	172	1299	1471
99	0.3425000	0.3415290	0.877500	0.1330830	879	1576	2455
100	0.4266670	0.4267370	0.857500	0.1467670	1188	1707	2895
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102	0.5025000	0.4930540	0.739167	0.2748790	257	1777	2034
103	0.4125000	0.4172830	0.819167	0.2506170	209	1953	2162
104	0.4675000	0.4627420	0.540417	0.1107000	529	2738	3267
105	0.4466670	0.4419130	0.671250	0.2263750	642	2484	3126
106	0.4308330	0.4254920	0.888333	0.3408080	121	674	795
107	0.4566670	0.4456960	0.479583	0.3034960	1558	2186	3744
108	0.5125000	0.5031460	0.542500	0.1635670	669	2760	3429
109	0.5058330	0.4892580	0.665833	0.1579710	409	2795	3204
110	0.5950000	0.5643920	0.614167	0.2419250	613	3331	3944
111	0.4591670	0.4538920	0.407083	0.3252580	745	3444	4189
112	0.3366670	0.3219540	0.729583	0.2195210	177	1506	1683
113	0.4600000	0.4501210	0.887917	0.2307250	1462	2574	4036
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117	0.6200000	0.5751420	0.835417	0.3122000	547	3325	3872
118	0.6175000	0.5789290	0.700833	0.3209080	569	3489	4058
119	0.5100000	0.4974630	0.457083	0.2400630	878	3717	4595
120	0.4725000	0.4640210	0.503333	0.2350750	1965	3347	5312
121	0.4516670	0.4482040	0.762083	0.1063540	1138	2213	3351
122	0.5491670	0.5328330	0.730000	0.1834540	847	3554	4401
123	0.6166670	0.5820790	0.697083	0.3426670	603	3848	4451
124	0.4141670	0.4046500	0.737083	0.3289960	255	2378	2633
125	0.4591670	0.4419170	0.444167	0.2953920	614	3819	4433
126	0.4791670	0.4741170	0.590000	0.2282460	894	3714	4608
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133 0.5125000 0.4943000 0.863333 0.1797250   692      3413 4105
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230	0.7116670	0.6622580	0.654583	0.2332080	639	3166	3805
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232	0.6975000	0.6489960	0.674167	0.1044670	1914	3277	5191
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234	0.6916670	0.6382540	0.470000	0.2767500	833	3925	4758
235	0.6408330	0.6060670	0.455417	0.1467630	1281	4614	5895
236	0.6733330	0.6306920	0.605000	0.2531080	949	4181	5130
237	0.6841670	0.6458540	0.771667	0.2108330	435	3107	3542
238	0.7000000	0.6597330	0.761250	0.0839625	768	3893	4661
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256	0.6508330	0.6035540	0.712500	0.1418040	701	4062	4763

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261	0.5075000	0.4905370	0.695000	0.1784830	1353	2921	4274
262	0.5491670	0.5296750	0.690000	0.1517420	691	3848	4539
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267	0.6066670	0.5644120	0.862500	0.0783833	1776	3647	5423
268	0.6341670	0.5726370	0.845000	0.0503792	1544	3466	5010
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271	0.6350000	0.5751580	0.848750	0.1486290	480	3427	3907
272	0.6166670	0.5745120	0.699167	0.1728830	653	4186	4839
273	0.5641670	0.5448290	0.647500	0.2064750	830	4372	5202
274	0.4100000	0.4128630	0.753750	0.2922960	480	1949	2429
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276	0.3841670	0.3920460	0.760833	0.0833458	330	3240	3570
277	0.4841670	0.4728580	0.710000	0.2058540	486	3970	4456
278	0.5383330	0.5271380	0.647917	0.1772500	559	4267	4826
279	0.4941670	0.4804250	0.620833	0.1349540	639	4126	4765
280	0.5108330	0.5044040	0.684167	0.0223917	949	4036	4985
281	0.5216670	0.5132420	0.701250	0.0454042	2235	3174	5409
282	0.5408330	0.5239830	0.727500	0.0634500	2397	3114	5511
283	0.5708330	0.5429250	0.733750	0.0423042	1514	3603	5117
284	0.5666670	0.5460960	0.808750	0.1430420	667	3896	4563
285	0.5433330	0.5177170	0.906250	0.2481500	217	2199	2416
286	0.5891670	0.5518040	0.896667	0.1417870	290	2623	2913
287	0.5508330	0.5296750	0.716250	0.2238830	529	3115	3644
288	0.5066670	0.4987250	0.483333	0.2580830	1899	3318	5217
289	0.5116670	0.5031540	0.486667	0.2817170	1748	3293	5041
290	0.5341670	0.5107250	0.579583	0.1753790	713	3857	4570
291	0.5325000	0.5227210	0.701667	0.1100870	637	4111	4748
292	0.5417390	0.5138480	0.895217	0.2433390	254	2170	2424
293	0.4758330	0.4665250	0.636250	0.4222750	471	3724	4195
294	0.4275000	0.4235960	0.574167	0.2213960	676	3628	4304
295	0.4225000	0.4254920	0.629167	0.0926667	1499	2809	4308
296	0.4216670	0.4223330	0.741250	0.0995125	1619	2762	4381
297	0.4633330	0.4570670	0.772083	0.1187920	699	3488	4187
298	0.4716670	0.4633750	0.622917	0.1666580	695	3992	4687
299	0.4841670	0.4728460	0.720417	0.1486420	404	3490	3894

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326 0.4166670 0.4216960 0.962500 0.1187920     69      1538 1607
327 0.4408330 0.4305370 0.757917 0.3358250    112      2454 2566
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329 0.3750000 0.3806710 0.643750 0.0988958   1095      1697 2792
330 0.3758330 0.3850870 0.681667 0.0684208   1249      1819 3068
331 0.4591670 0.4558000 0.698333 0.2089540    810      2261 3071
332 0.5034780 0.4901220 0.743043 0.1421220    253      3614 3867
333 0.4583330 0.4513750 0.830833 0.2580920     96      2818 2914
334 0.3250000 0.3112210 0.613333 0.2711580    188      3425 3613
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337 0.2991670 0.3106040 0.612917 0.0957833    706      2908 3614
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530	0.6558330	0.6111170	0.582083	0.3432790	1173	6248	7421
531	0.6483330	0.6243830	0.569583	0.2537330	1180	6183	7363
532	0.6391670	0.5997540	0.589583	0.1766170	1563	6102	7665
533	0.6316670	0.5947080	0.504167	0.1666670	2963	4739	7702
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542	0.7158330	0.6540420	0.504167	0.3003830	1139	5640	6779
543	0.6308330	0.5947040	0.373333	0.3476420	1077	6365	7442
544	0.6975000	0.6407920	0.360000	0.2717750	1077	6258	7335
545	0.7491670	0.6755120	0.422500	0.1716500	921	5958	6879
546	0.8341670	0.7866130	0.488750	0.1654170	829	4634	5463
547	0.7650000	0.6875080	0.601250	0.1610710	1455	4232	5687
548	0.8158330	0.7506290	0.518750	0.1685290	1421	4110	5531
549	0.7816670	0.7020380	0.447083	0.1952670	904	5323	6227
550	0.7808330	0.7026500	0.492083	0.1262370	1052	5608	6660
551	0.7891670	0.7323370	0.538750	0.1349500	2562	4841	7403
552	0.8275000	0.7613670	0.457917	0.1940290	1405	4836	6241
553	0.8283330	0.7525330	0.450833	0.1461420	1366	4841	6207
554	0.8616670	0.8049130	0.492083	0.1635540	1448	3392	4840
555	0.8225000	0.7903960	0.573750	0.1256290	1203	3469	4672
556	0.7108330	0.6540540	0.683333	0.1809750	998	5571	6569
557	0.7208330	0.6647960	0.667500	0.1517370	954	5336	6290

558	0.7166670	0.6502710	0.633333	0.1517330	975	6289 7264
559	0.7158330	0.6546830	0.529583	0.1467750	1032	6414 7446
560	0.7316670	0.6679330	0.485833	0.0808500	1511	5988 7499
561	0.7033330	0.6660420	0.699167	0.1436790	2355	4614 6969
562	0.7458330	0.7051960	0.717917	0.1666670	1920	4111 6031
563	0.7633330	0.7241250	0.645000	0.1641870	1088	5742 6830
564	0.8183330	0.7556830	0.505833	0.1144290	921	5865 6786
565	0.7933330	0.7455830	0.577083	0.1374420	799	4914 5713
566	0.7700000	0.7146420	0.600417	0.1654290	888	5703 6591
567	0.6658330	0.6130250	0.844167	0.2089670	747	5123 5870
568	0.5958330	0.5499120	0.865417	0.2133000	1264	3195 4459
569	0.6675000	0.6231250	0.762500	0.0939208	2544	4866 7410
570	0.7416670	0.6900170	0.694167	0.1386830	1135	5831 6966
571	0.7508330	0.7064500	0.655000	0.2114540	1140	6452 7592
572	0.7241670	0.6540540	0.450000	0.1648000	1383	6790 8173
573	0.7766670	0.7392630	0.596667	0.2848130	1036	5825 6861
574	0.7816670	0.7342170	0.594583	0.1529920	1259	5645 6904
575	0.7558330	0.6976040	0.613333	0.1573500	2234	4451 6685
576	0.7216670	0.6679330	0.623750	0.1703960	2153	4444 6597
577	0.7308330	0.6849870	0.668750	0.1536170	1040	6065 7105
578	0.7133330	0.6628960	0.704167	0.1654250	968	6248 7216
579	0.7175000	0.6673080	0.677500	0.1411790	1074	6506 7580
580	0.7525000	0.7070880	0.659583	0.1293540	983	6278 7261
581	0.7658330	0.7228670	0.642500	0.2157920	1328	5847 7175
582	0.7933330	0.7512670	0.613333	0.2574580	2345	4479 6824
583	0.7691670	0.7310790	0.652500	0.2904210	1707	3757 5464
584	0.7525000	0.7102460	0.654167	0.1293540	1233	5780 7013
585	0.7358330	0.6976210	0.703750	0.1169080	1278	5995 7273
586	0.7500000	0.7077170	0.672917	0.1107000	1263	6271 7534
587	0.7558330	0.6995080	0.620417	0.1561000	1196	6090 7286
588	0.7158330	0.6679420	0.715833	0.2388130	1065	4721 5786
589	0.6925000	0.6382670	0.732917	0.2064790	2247	4052 6299
590	0.7008330	0.6445790	0.530417	0.1225120	2182	4362 6544
591	0.7208330	0.6622540	0.545417	0.1362120	1207	5676 6883
592	0.7266670	0.6767790	0.686667	0.1691580	1128	5656 6784
593	0.7066670	0.6540370	0.619583	0.1697710	1198	6149 7347
594	0.7191670	0.6546880	0.519167	0.1417960	1338	6267 7605
595	0.7233330	0.2424000	0.570833	0.2313540	1483	5665 7148
596	0.6783330	0.6180710	0.603333	0.1778670	2827	5038 7865
597	0.6358330	0.6035540	0.711667	0.0864500	1208	3341 4549
598	0.6358330	0.5959670	0.734167	0.1299790	1026	5504 6530
599	0.6491670	0.6010250	0.673750	0.0727708	1081	5925 7006
600	0.6675000	0.6218540	0.677083	0.0702833	1094	6281 7375

```
601 0.6958330 0.6370080 0.635833 0.0845958    1363    6402 7765
602 0.7025000 0.6471000 0.615000 0.0721458    1325    6257 7582
603 0.6616670 0.6186960 0.712917 0.2444080    1829    4224 6053
604 0.6533330 0.5959960 0.845833 0.2288580    1483    3772 5255
605 0.7033330 0.6546880 0.730417 0.1287330     989    5928 6917
606 0.7283330 0.6660500 0.620000 0.1909250     935    6105 7040
607 0.6850000 0.6357330 0.552083 0.1125620    1177    6520 7697
608 0.7066670 0.6527790 0.590417 0.0771167    1172    6541 7713
609 0.7641670 0.6894000 0.587500 0.1685330    1433    5917 7350
610 0.7533330 0.7026540 0.638333 0.1131870    2352    3788 6140
611 0.6966670 0.6490000 0.815000 0.0640708    2613    3197 5810
612 0.7075000 0.6616290 0.790833 0.1511210    1965    4069 6034
613 0.7258330 0.6868880 0.755000 0.2363210     867    5997 6864
614 0.7366670 0.7089830 0.741250 0.1878080     832    6280 7112
615 0.6966670 0.6553290 0.810417 0.1424210     611    5592 6203
616 0.7033330 0.6572040 0.736250 0.1716460    1045    6459 7504
617 0.6591670 0.6111210 0.799167 0.2811040    1557    4419 5976
618 0.6100000 0.5789250 0.547500 0.2244960    2570    5657 8227
619 0.5833330 0.5656540 0.503750 0.2587130    1118    6407 7525
620 0.5775000 0.5542920 0.520000 0.0920542    1070    6697 7767
621 0.5991670 0.5700750 0.577083 0.1318460    1050    6820 7870
622 0.6125000 0.5795580 0.637083 0.0827208    1054    6750 7804
623 0.6333330 0.5940830 0.672500 0.1038630    1379    6630 8009
624 0.6083330 0.5858670 0.501667 0.2475210    3160    5554 8714
625 0.5800000 0.5631250 0.570000 0.0901833    2166    5167 7333
626 0.5808330 0.5530500 0.734583 0.1517420    1022    5847 6869
627 0.6233330 0.5650670 0.872500 0.3575870     371    3702 4073
628 0.5525000 0.5404040 0.536667 0.2151750     788    6803 7591
629 0.5466670 0.5321920 0.618333 0.1181670     939    6781 7720
630 0.5991670 0.5719710 0.668750 0.1542290    1250    6917 8167
631 0.6500000 0.6104880 0.646667 0.2835830    2512    5883 8395
632 0.5291670 0.5189330 0.467083 0.2232580    2454    5453 7907
633 0.5141670 0.5025130 0.492917 0.1424040    1001    6435 7436
634 0.5500000 0.5441790 0.570000 0.2363210     845    6693 7538
635 0.6350000 0.5966130 0.630833 0.2444000     787    6946 7733
636 0.6500000 0.6079750 0.690833 0.1343420     751    6642 7393
637 0.6191670 0.5858630 0.690000 0.1641790    1045    6370 7415
638 0.5425000 0.5302960 0.542917 0.2276040    2589    5966 8555
639 0.5266670 0.5176630 0.583333 0.1349580    2015    4874 6889
640 0.5208330 0.5120000 0.649167 0.0908042     763    6015 6778
641 0.5908330 0.5423330 0.871667 0.1044750     315    4324 4639
642 0.6575000 0.5991330 0.793750 0.0665458     728    6844 7572
643 0.6575000 0.6079750 0.722917 0.1175460     891    6437 7328
```

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644 0.6150000 0.5801870 0.627500 0.1063500   1516    6640 8156
645 0.5541670 0.5385210 0.664167 0.2680250   3031    4934 7965
646 0.4158330 0.4198130 0.708333 0.1411620    781    2729 3510
647 0.3833330 0.3876080 0.709583 0.1896790    874    4604 5478
648 0.4466670 0.4381120 0.761667 0.1903000    601    5791 6392
649 0.5141670 0.5031420 0.630833 0.1878210    780    6911 7691
650 0.4350000 0.4311670 0.463333 0.1815960    834    6736 7570
651 0.4375000 0.4330710 0.539167 0.2350920   1060    6222 7282
652 0.3933330 0.3913960 0.494583 0.1461420   2252    4857 7109
653 0.5216670 0.5082040 0.640417 0.2786120   2080    4559 6639
654 0.5616670 0.5391500 0.707500 0.2960370    760    5115 5875
655 0.4683330 0.4608460 0.558333 0.1822210    922    6612 7534
656 0.4558330 0.4501080 0.692917 0.1013710    979    6482 7461
657 0.5225000 0.5126250 0.728333 0.2369370   1008    6501 7509
658 0.5633330 0.5378960 0.815000 0.1349540    753    4671 5424
659 0.4841670 0.4728420 0.572917 0.1175370   2806    5284 8090
660 0.4641670 0.4564290 0.510000 0.1660540   2132    4692 6824
661 0.4875000 0.4829420 0.568333 0.0814833    830    6228 7058
662 0.5441670 0.5303040 0.641667 0.0945458    841    6625 7466
663 0.5875000 0.5587210 0.636250 0.0727792    795    6898 7693
664 0.5500000 0.5296880 0.800417 0.1243750    875    6484 7359
665 0.5458330 0.5227500 0.807083 0.1324670   1182    6262 7444
666 0.5300000 0.5151330 0.720000 0.2356920   2643    5209 7852
667 0.4775000 0.4677710 0.694583 0.3980080    998    3461 4459
668 0.4400000 0.4394000 0.880000 0.3582000      2      20   22
669 0.3181820 0.3099090 0.825455 0.2130090     87    1009 1096
670 0.3575000 0.3611000 0.666667 0.1666670    419    5147 5566
671 0.3658330 0.3699420 0.581667 0.1573460    466    5520 5986
672 0.3550000 0.3560420 0.522083 0.2661750    618    5229 5847
673 0.3433330 0.3238460 0.491250 0.2705290   1029    4109 5138
674 0.3258330 0.3295380 0.532917 0.1791080   1201    3906 5107
675 0.3191670 0.3080750 0.494167 0.2363250    378    4881 5259
676 0.2808330 0.2815670 0.567083 0.1735130    466    5220 5686
677 0.2958330 0.2746210 0.547500 0.3041080    326    4709 5035
678 0.3521740 0.3418910 0.333478 0.3478350    340    4975 5315
679 0.3616670 0.3554130 0.540833 0.2145580    709    5283 5992
680 0.3891670 0.3939370 0.645417 0.0578458   2090    4446 6536
681 0.4208330 0.4217130 0.659167 0.1275000   2290    4562 6852
682 0.4850000 0.4753830 0.741667 0.1735170   1097    5172 6269
683 0.3433330 0.3232250 0.662917 0.3420460    327    3767 4094
684 0.2891670 0.2815630 0.552083 0.1996250    373    5122 5495
685 0.3216670 0.3244920 0.620417 0.1529870    320    5125 5445
686 0.3450000 0.3472040 0.524583 0.1710250    484    5214 5698
```

```
687 0.3250000 0.3263830 0.545417 0.1797290    1313     4316 5629
688 0.3425000 0.3377460 0.692917 0.2276120     922     3747 4669
689 0.3808330 0.3756210 0.623333 0.2350670     449     5050 5499
690 0.3741670 0.3806670 0.685000 0.0827250     534     5100 5634
691 0.3533330 0.3648920 0.613750 0.1032460     615     4531 5146
692 0.3400000 0.3503710 0.580417 0.0528708     955     1470 2425
693 0.3683330 0.3787790 0.568750 0.1480210    1603     2307 3910
694 0.2783330 0.2487420 0.404583 0.3768710     532     1745 2277
695 0.2458330 0.2575830 0.468333 0.1505000     309     2115 2424
696 0.3133330 0.3390040 0.535417 0.0466500     337     4750 5087
697 0.2916670 0.2815580 0.786667 0.2375620     123     3836 3959
698 0.2966670 0.2897620 0.506250 0.2108210     198     5062 5260
699 0.2808700 0.2984220 0.555652 0.1155220     243     5080 5323
700 0.2983330 0.3238670 0.649583 0.0584708     362     5306 5668
701 0.2983330 0.3169040 0.806667 0.0597042     951     4240 5191
702 0.3475000 0.3592080 0.823333 0.1243790     892     3757 4649
703 0.4525000 0.4557960 0.767500 0.0827208     555     5679 6234
704 0.4758330 0.4690540 0.733750 0.1741290     551     6055 6606
705 0.4383330 0.4280120 0.485000 0.3240210     331     5398 5729
706 0.2558330 0.2582040 0.508750 0.1747540     340     5035 5375
707 0.3208330 0.3219580 0.764167 0.1306000     349     4659 5008
708 0.3816670 0.3895080 0.911250 0.1013790    1153     4429 5582
709 0.3841670 0.3901460 0.905417 0.1579750     441     2787 3228
710 0.4358330 0.4355750 0.925000 0.1903080     329     4841 5170
711 0.3533330 0.3383630 0.596667 0.2960370     282     5219 5501
712 0.2975000 0.2973380 0.538333 0.1629370     310     5009 5319
713 0.2958330 0.2941880 0.485833 0.1741290     425     5107 5532
714 0.2816670 0.2941920 0.642917 0.1312290     429     5182 5611
715 0.3241670 0.3383830 0.650417 0.1063500     767     4280 5047
716 0.3625000 0.3699380 0.838750 0.1007420     538     3248 3786
717 0.3933330 0.4015000 0.907083 0.0982583     212     4373 4585
718 0.4108330 0.4097080 0.666250 0.2214040     433     5124 5557
719 0.3325000 0.3421620 0.625417 0.1840920     333     4934 5267
720 0.3300000 0.3352170 0.667917 0.1324630     314     3814 4128
721 0.3266670 0.3017670 0.556667 0.3743830     221     3402 3623
722 0.2658330 0.2361130 0.441250 0.4073460     205     1544 1749
723 0.2458330 0.2594710 0.515417 0.1330830     408     1379 1787
724 0.2313040 0.2589000 0.791304 0.0772304     174      746  920
725 0.2913040 0.2944650 0.734783 0.1687260     440      573 1013
726 0.2433330 0.2203330 0.823333 0.3165460       9      432  441
727 0.2541670 0.2266420 0.652917 0.3501330     247     1867 2114
728 0.2533330 0.2550460 0.590000 0.1554710     644     2451 3095
729 0.2533330 0.2424000 0.752917 0.1243830     159     1182 1341
```

```
730 0.2558330 0.2317000 0.483333 0.3507540      364        1432 1796
731 0.2158330 0.2234870 0.577500 0.1548460      439        2290 2729
```

a)

```r
bike_sharing$mnth = as.factor(bike_sharing$mnth)
```

b)

```r
bike_model = lm(cnt ~ hum + windspeed + temp + mnth, data = bike_sharing)
summary(bike_model)
```

```
Call:
lm(formula = cnt ~ hum + windspeed + temp + mnth, data = bike_sharing)

Residuals:
    Min      1Q  Median      3Q     Max
-5345.2  -997.8  -162.3  1115.5  3411.3

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  3914.561    352.443  11.107  < 2e-16 ***
hum         -4205.372    379.303 -11.087  < 2e-16 ***
windspeed   -4807.145    674.576  -7.126 2.52e-12 ***
temp         7262.317    673.126  10.789  < 2e-16 ***
mnth2          -9.116    247.020  -0.037 0.970572
mnth3         486.786    259.701   1.874 0.061281 .
mnth4         757.273    287.355   2.635 0.008588 **
mnth5         892.579    336.832   2.650 0.008229 **
mnth6         202.492    385.904   0.525 0.599940
mnth7        -524.788    422.957  -1.241 0.215101
mnth8         117.049    395.509   0.296 0.767357
mnth9        1178.208    348.989   3.376 0.000775 ***
mnth10       1522.113    290.321   5.243 2.08e-07 ***
mnth11       1162.629    255.896   4.543 6.50e-06 ***
mnth12        785.963    246.182   3.193 0.001472 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 1325 on 716 degrees of freedom
Multiple R-squared:  0.5415,    Adjusted R-squared:  0.5325
F-statistic:  60.4 on 14 and 716 DF,  p-value: < 2.2e-16
```

c)

```
anova(bike_model)
```

```
Analysis of Variance Table

Response: cnt
            Df      Sum Sq     Mean Sq F value     Pr(>F)
hum          1    27757373    27757373  15.822 7.666e-05 ***
windspeed    1   196708994   196708994 112.127 < 2.2e-16 ***
temp         1  1038171824  1038171824 591.776 < 2.2e-16 ***
mnth        11   220794669    20072243  11.441 < 2.2e-16 ***
Residuals  716  1256102532     1754333
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

d)

By looking at the summary chart of the model, we can see the following.

Months **with** significant difference compared to January, given Hum, Temp, and Windspeed:

April, May, September, October, November, December.

Months **without** significant difference compared to January, given Hum, Temp, and Windspeed

February, March, June, July, August.

e)

```
t(matrix(coef(bike_model)))%*%matrix(c(1,0.4,0.3,0.65,0,0,0,0,0,0,0,0,0,0,0))
```

```
         [,1]
[1,] 5510.775
```

```r
X_Star = matrix(nrow = 0,ncol = 15)
for(i in 1:12){
  x = c(1,0.4,0.3,0.65,0,0,0,0,0,0,0,0,0,0,0)
  if(i!=1){
    x[3+i] = 1
  }
  X_Star = rbind(X_Star,x)
}


result = X_Star%*%matrix(coef(bike_model))
dimnames(result) = list(c("Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov",
knitr::kable(result)
```

	Predicted value
Jan	5510.775
Feb	5501.659
Mar	5997.560
Apr	6268.048
May	6403.354
Jun	5713.266
Jul	4985.987
Aug	5627.824
Sep	6688.983
Oct	7032.888
Nov	6673.404
Dec	6296.737