

Bike rental prediction

The aim of this work is to predict the total amount of rented bike. The predictors are:

- instant: record index
- dteday : date
- season: season (1:winter, 2:spring, 3:summer, 4:fall)
- year: (0: 2011, 1:2012)
- month: month (1 to 12)
- holiday: weather day is holiday or not (extracted from [Web Link])
- weekdaynum: day of the week
- is_workingday: if day is neither weekend nor holiday is 1, otherwise is 0.
- weathersituation:
 - 1: Clear, Few clouds, Partly cloudy, Partly cloudy
 - 2: Mist + Cloudy, Mist + Broken clouds, Mist + Few clouds, Mist
 - 3: Light Snow, Light Rain + Thunderstorm + Scattered clouds, Light Rain + Scattered clouds
 - 4: Heavy Rain + Ice Pallets + Thunderstorm + Mist, Snow + Fog
- atemp_normalized: Normalized feeling temperature in Celsius. The values are derived via $(t_{\text{tmin}})/(t_{\text{max}}-t_{\text{min}})$, $t_{\text{min}}=-16$, $t_{\text{max}}=+50$ (only in hourly scale)
- humidity_normalized: Normalized humidity. The values are divided to 100 (max)
- windspeed_normalized: Normalized wind speed. The values are divided to 67 (max)

```
train <- read.csv(file.choose())
rownames(train) <- train$ID
train <- train[,2:13]
train2 <- train[,2:12]
```

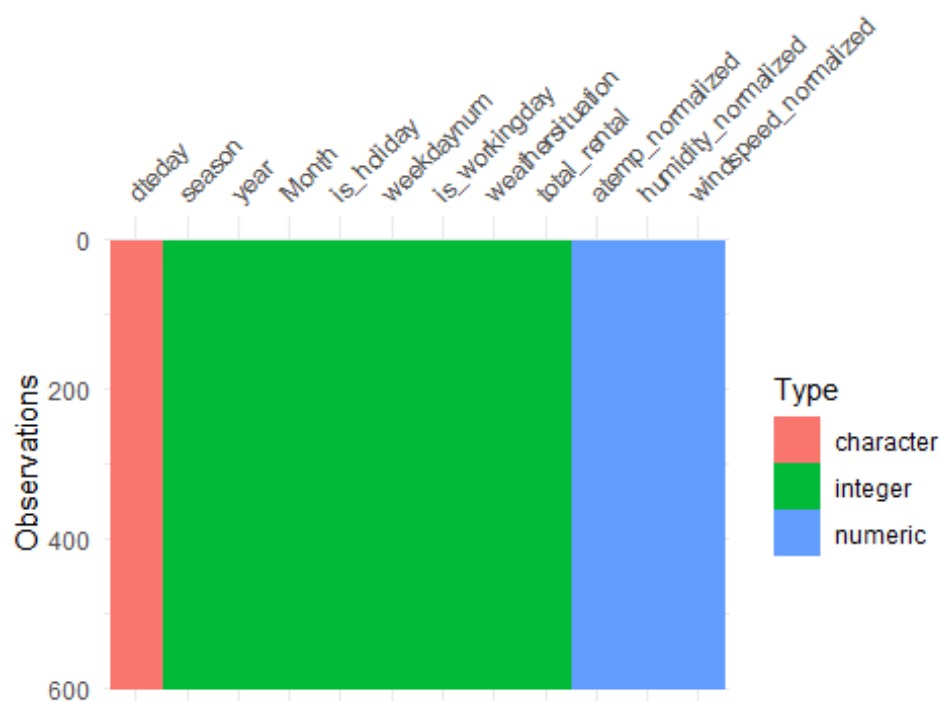
ID variables has been sected as row names and the date has been used with the only purpose to represent the outcome graphically. So, the final amount of variables used was 11.

```
str(train)

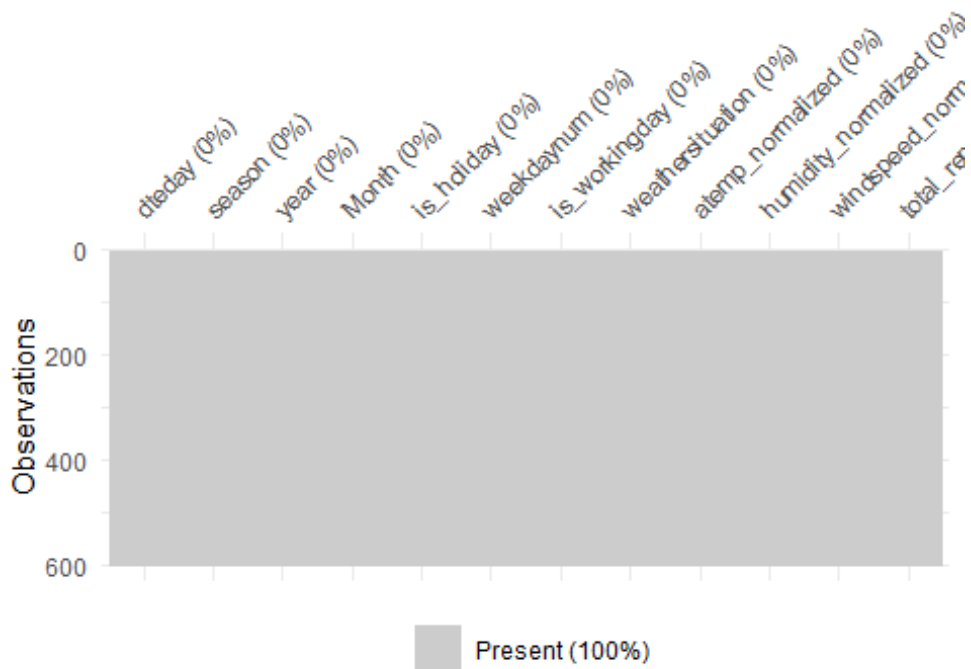
## 'data.frame':    599 obs. of  12 variables:
## $ dteday          : chr  "01-01-2011" "02-01-2011" "03-01-2011" "04-01-
## 2011" ...
## $ season          : int   1 1 1 1 1 1 1 1 1 1 ...
```

```
## $ year          : int  0 0 0 0 0 0 0 0 0 0 ...
## $ Month         : int  1 1 1 1 1 1 1 1 1 1 ...
## $ is_holiday    : int  0 0 0 0 0 0 0 0 0 0 ...
## $ weekdaynum    : int  6 0 1 2 3 4 5 6 0 1 ...
## $ is_workingday : int  0 0 1 1 1 1 1 0 0 1 ...
## $ weathersituation : int  2 2 1 1 1 1 2 2 1 1 ...
## $ atemp_normalized : num  0.364 0.354 0.189 0.212 0.229 ...
## $ humidity_normalized : num  0.806 0.696 0.437 0.59 0.437 ...
## $ windspeed_normalized : num  0.16 0.249 0.248 0.16 0.187 ...
## $ total_rental   : int  985 801 1349 1562 1600 1606 1510 959 822 1321 ...
```

```
library(visdat)
vis_dat(train)
```



```
vis_miss(train)
```



```
library(skimr)
```

```
skim(train)
```

Data summary

```
Name          train
Number of rows 599
Number of columns 12
```

Column type frequency:

```
character      1
numeric       11
```


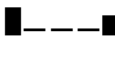

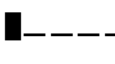

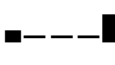





```
Group variables  None
```

Variable type: character

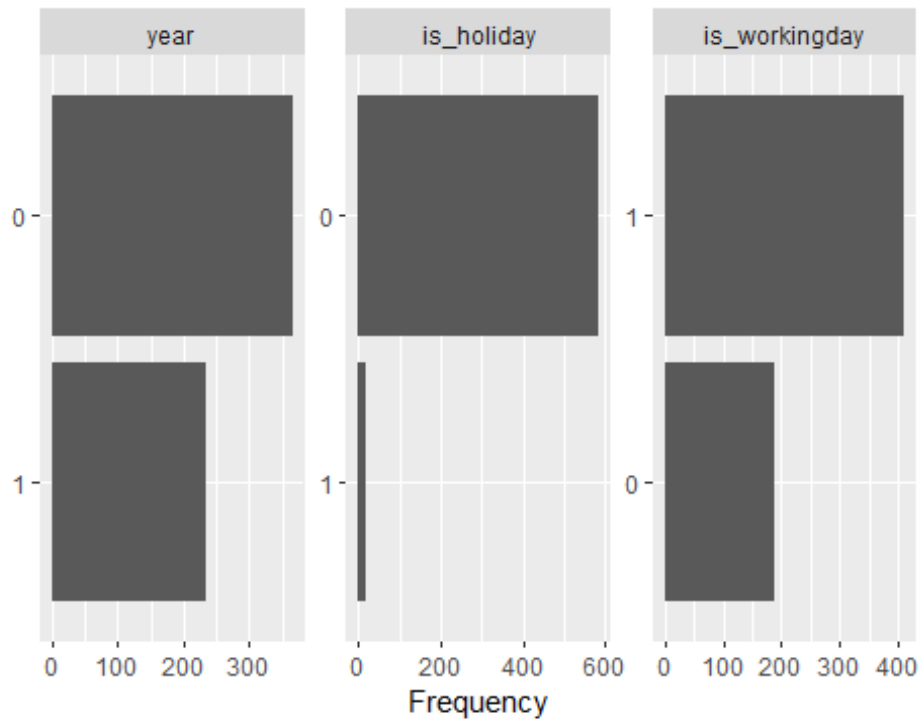
skim_variable	n_missing	complete_rate	min	max	empty	n_unique	whitespace
dteday	0	1	10	10	0	599	0

Variable type: numeric

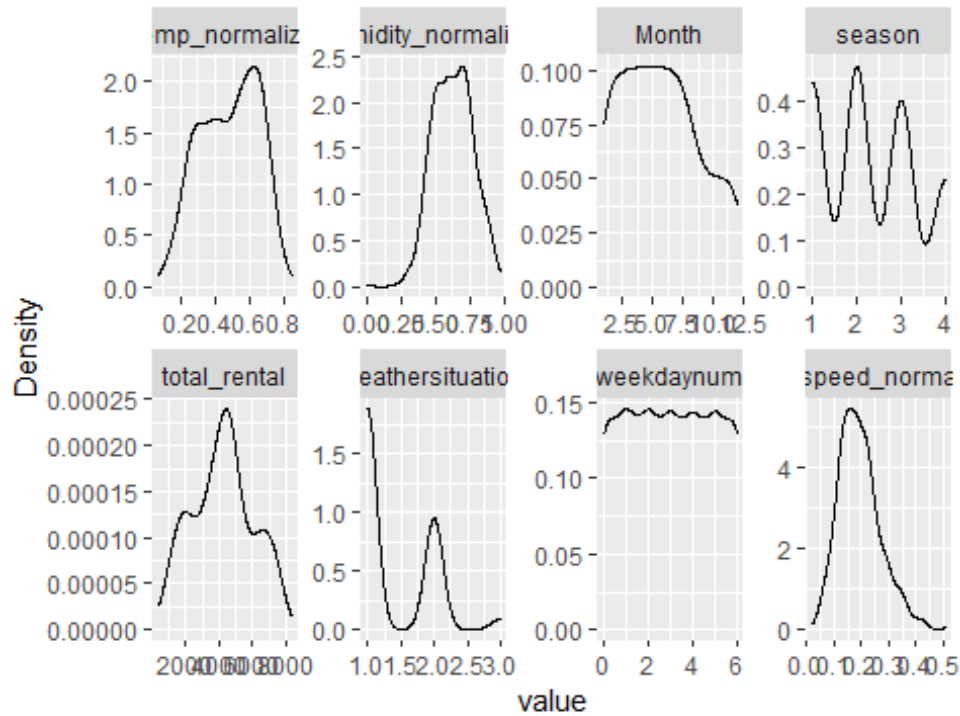
skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
---------------	-----------	---------------	------	----	----	-----	-----	-----	------	------

skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
season	0	1	2.27	1.03	1.00	1.00	2.00	3.00	4.00	
year	0	1	0.39	0.49	0.00	0.00	0.00	1.00	1.00	
Month	0	1	5.68	3.21	1.00	3.00	5.00	8.00	12.00	
is_holiday	0	1	0.03	0.16	0.00	0.00	0.00	0.00	1.00	
weekdaynum	0	1	2.99	2.00	0.00	1.00	3.00	5.00	6.00	
is_workingday	0	1	0.69	0.46	0.00	0.00	1.00	1.00	1.00	
weathersituation	0	1	1.39	0.55	1.00	1.00	1.00	2.00	3.00	
atemp_normalized	0	1	0.48	0.17	0.08	0.34	0.50	0.62	0.84	
humidity_normalized	0	1	0.62	0.15	0.00	0.51	0.62	0.73	0.97	
windspeed_normalized	0	1	0.19	0.08	0.02	0.14	0.18	0.23	0.51	
total_rental	0	1	4220.60	1819.67	431.00	2904.00	4294.00	5353.50	8362.00	

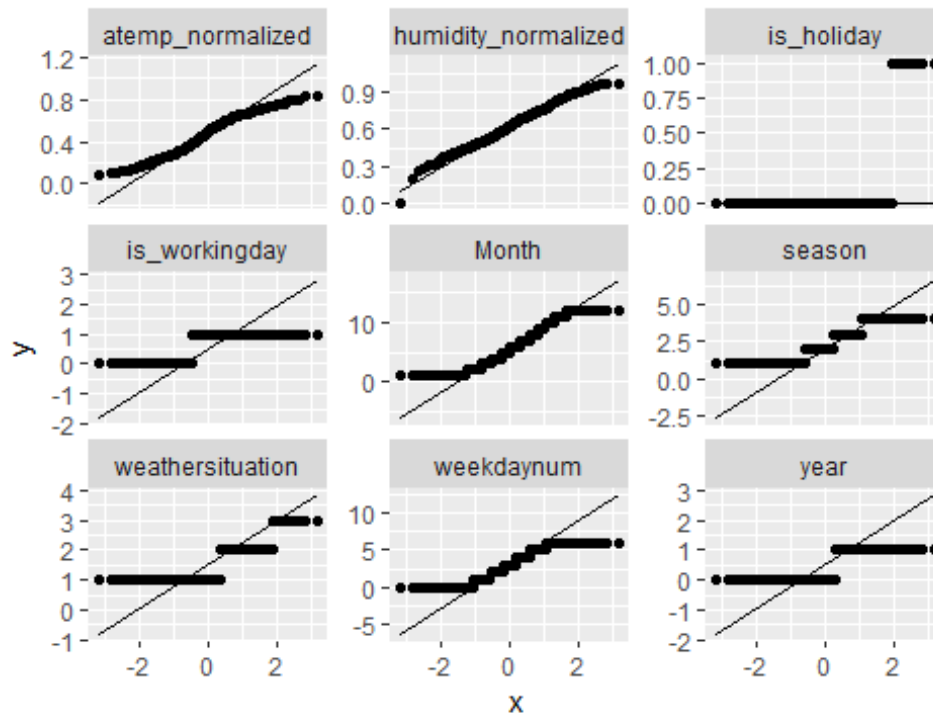
```
library(DataExplorer)
plot_bar(train)
```



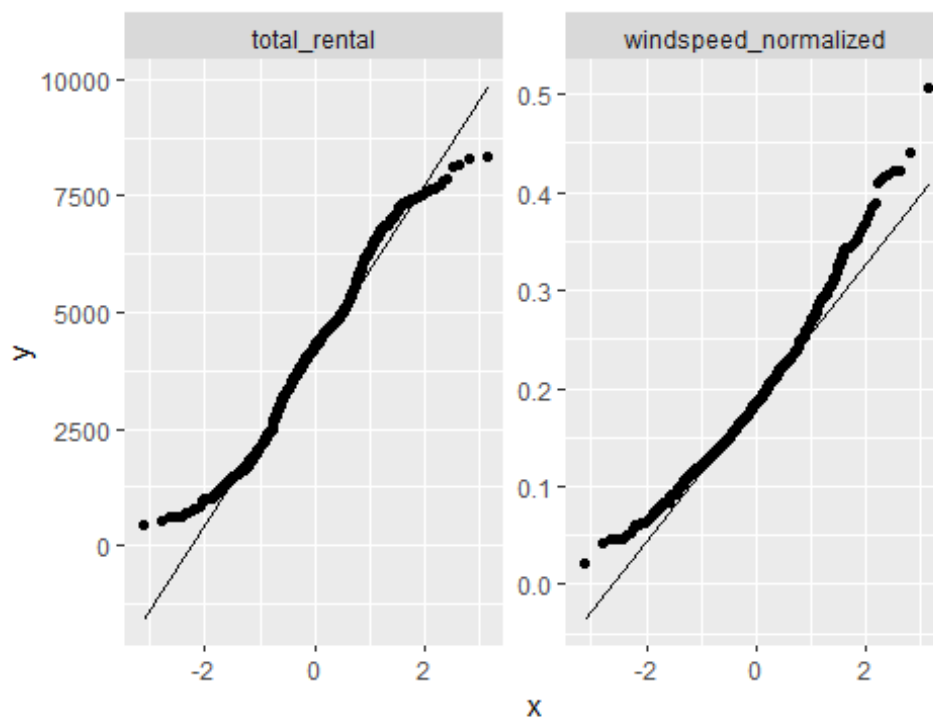
```
plot_density(train)
```



```
plot_qq(train)
```



Page 1



Page 2

```
pairs(train2, pch=20, cex=0.4, col="blue")
```


The dataset contains 5 categorical variables, 2 binary variables and four continuous variables with no missing observations. The majority of the observations is related to 2011, it wasn't a holiday but it was a working day. In addition, the majority of the observations was from January to July, with cloudy weather in spring and the most positive correlated variables were weather and humidity and month and season.

```
regression <- step(lm(total_rental~.+Month*season, data=train2), direction='both')

## Start: AIC=8006.87
## total_rental ~ season + year + Month + is_holiday + weekdaynum +
## is_workingday + weathersituation + atemp_normalized + humidity_normalized +
## windspeed_normalized + Month * season
##
##           Df Sum of Sq      RSS      AIC
## - is_workingday      1    1185120 368693883 8006.8
## <none>                      367508764 8006.9
## - is_holiday        1    1784748 369293511 8007.8
## - humidity_normalized  1    4674773 372183537 8012.4
## - weekdaynum         1    5528283 373037047 8013.8
## - windspeed_normalized 1   16590088 384098851 8031.3
## - season:Month        1   17226659 384735422 8032.3
## - weathersituation     1   31665457 399174221 8054.4
## - atemp_normalized    1   94956923 462465686 8142.5
## - year                1  493402107 860910870 8514.8
##
## Step: AIC=8006.8
## total_rental ~ season + year + Month + is_holiday + weekdaynum +
## weathersituation + atemp_normalized + humidity_normalized +
## windspeed_normalized + season:Month
##
##           Df Sum of Sq      RSS      AIC
## <none>                      368693883 8006.8
## + is_workingday      1    1185120 367508764 8006.9
## - is_holiday        1    2709972 371403855 8009.2
## - humidity_normalized  1    4813416 373507299 8012.6
## - weekdaynum         1    5557591 374251474 8013.8
## - windspeed_normalized 1   16565569 385259452 8031.1
## - season:Month        1   16945383 385639266 8031.7
## - weathersituation     1   30998548 399692431 8053.2
## - atemp_normalized    1   96737206 465431089 8144.4
## - year                1  492946978 861640861 8513.3

summary(regression)

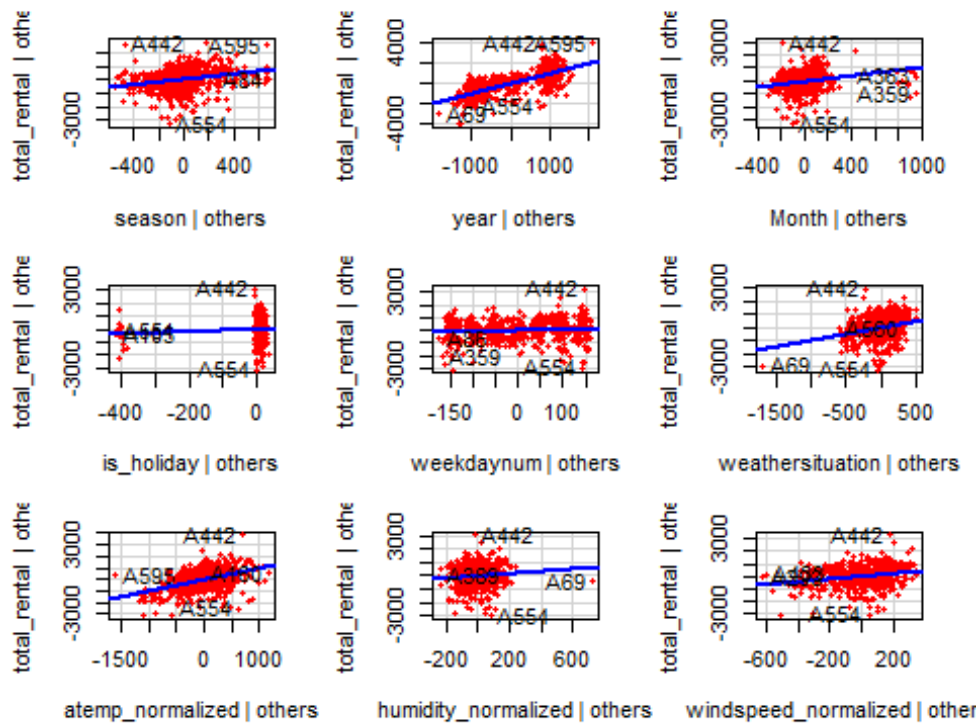
##
## Call:
## lm(formula = total_rental ~ season + year + Month + is_holiday +
## weekdaynum + weathersituation + atemp_normalized + humidity_normalized +
## windspeed_normalized + season:Month, data = train2)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
```



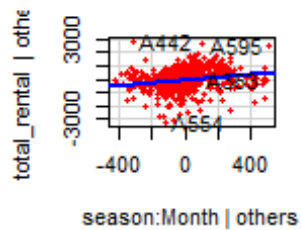
```
## -3123.36 -443.86 55.08 487.27 3106.38
##
## Coefficients:
## Estimate Std. Error t value Pr(>|t|)
## (Intercept) 931.10 252.40 3.689 0.000246 ***
## season 1052.74 158.27 6.652 6.64e-11 ***
## year 2061.89 73.54 28.039 < 2e-16 ***
## Month 164.80 33.17 4.969 8.83e-07 ***
## is_holiday -420.34 202.19 -2.079 0.038058 *
## weekdaynum 48.61 16.33 2.977 0.003029 **
## weathersituation -548.04 77.94 -7.031 5.71e-12 ***
## atemp_normalized 4227.25 340.33 12.421 < 2e-16 ***
## humidity_normalized -843.69 304.51 -2.771 0.005771 **
## windspeed_normalized -2373.48 461.77 -5.140 3.75e-07 ***
## season:Month -80.21 15.43 -5.199 2.78e-07 ***
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 791.9 on 588 degrees of freedom
## Multiple R-squared: 0.8138, Adjusted R-squared: 0.8106
## F-statistic: 257 on 10 and 588 DF, p-value: < 2.2e-16

library(car)

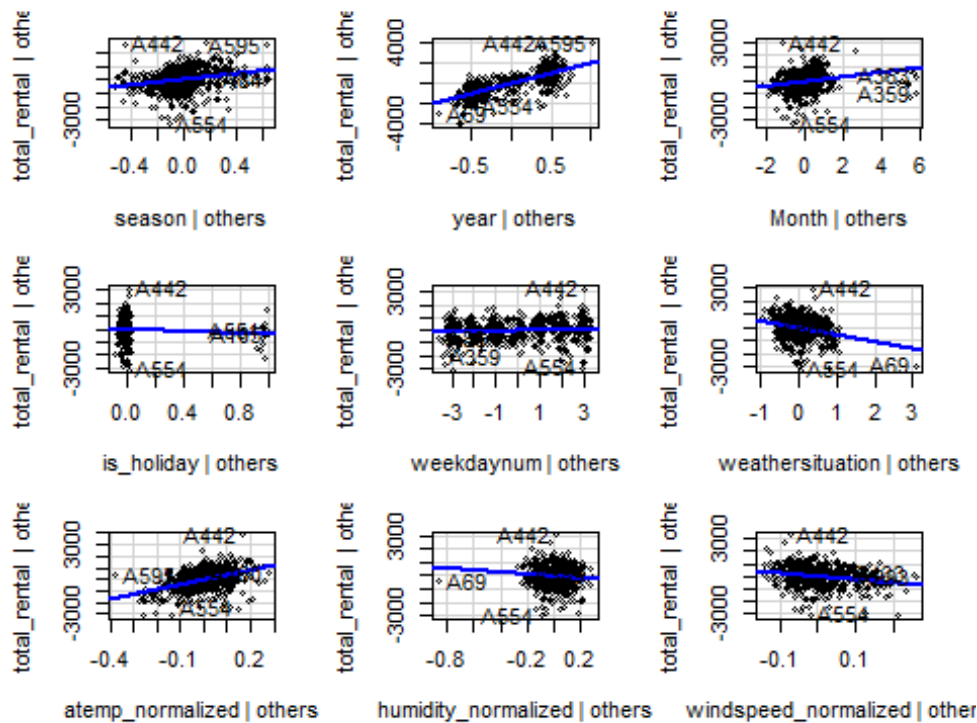
leveragePlots(regression, pch=20, col='red')
```



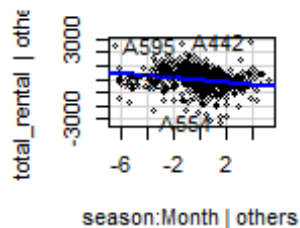
Leverage Plots



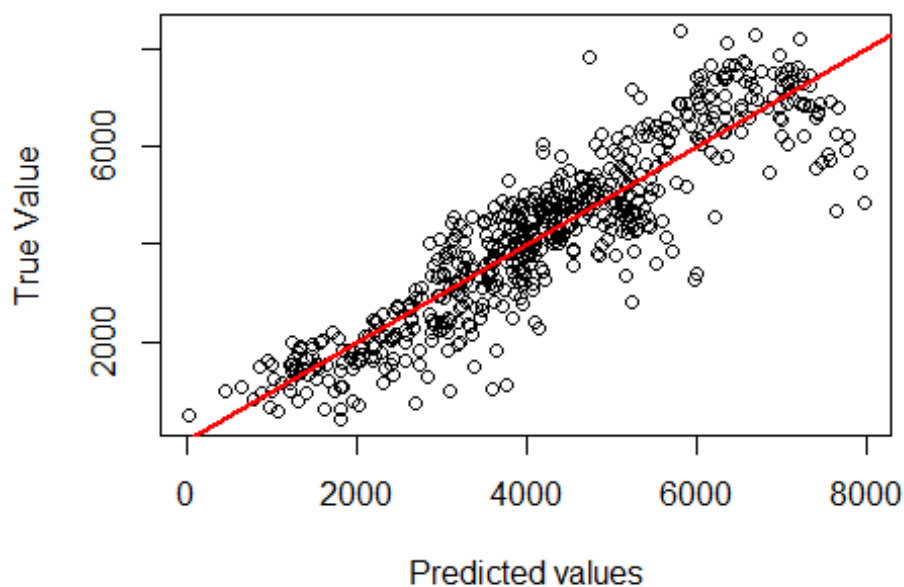
```
avPlots(regression)
```



Added-Variable Plots



```
predictregression <- predict(regression, data=train2 ,interval = "confidence")
plot(predictregression[,1], train2$total_rental, xlab='Predicted values',
ylab='True Value')
abline(a = 0, b = 1, col = "red", lwd = 2)
```

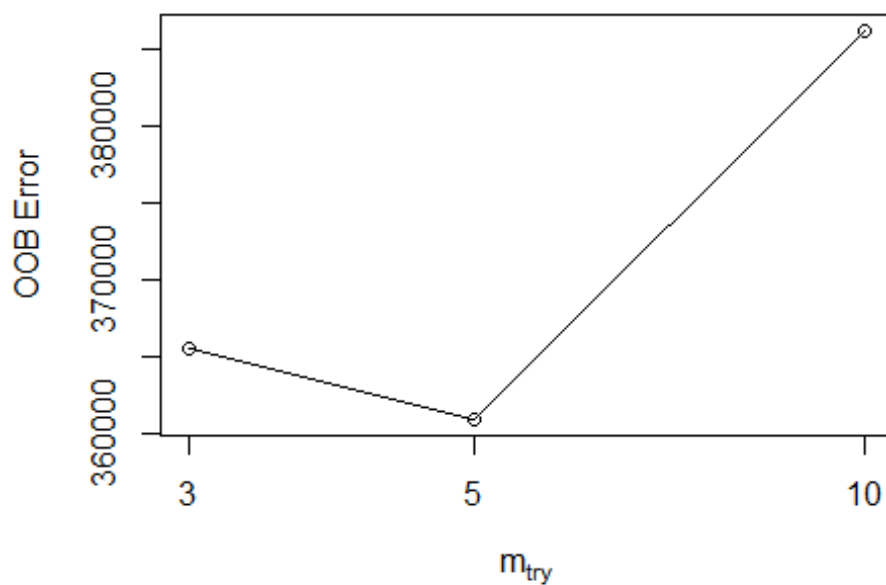


Thanks to a mixed variables selection approach I detected a multiple regression model with 10 variables and an adjusted R-squared index of 0.81. By analyzing the residual plots, I can see that A442 is a high leverage point and the predicted values are not so strictly linearly correlated with the true values, so I tried out the random forest model.

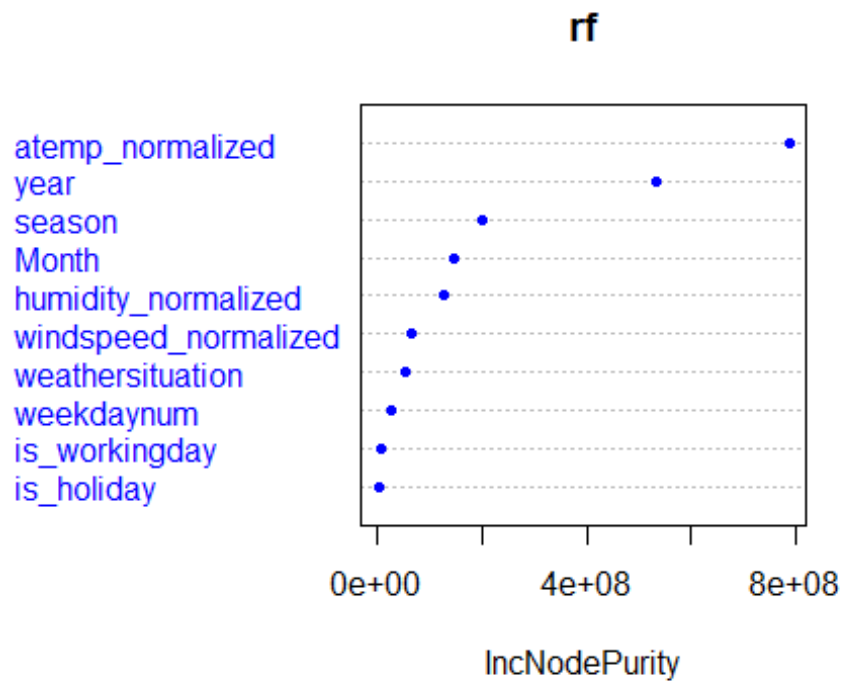
```
library(randomForest)

set.seed(1)
(rf <- tuneRF(x = subset(train2, select = -total_rental), y = train$total_rental,
ntreeTry = 500, plot = TRUE, mtryStart = 10, doBest = T))

## mtry = 10  OOB error = 386263.1
## Searching left ...
## mtry = 5    OOB error = 360996.2
## 0.06541379 0.05
## mtry = 3    OOB error = 365617.1
## -0.01280045 0.05
## Searching right ...
```



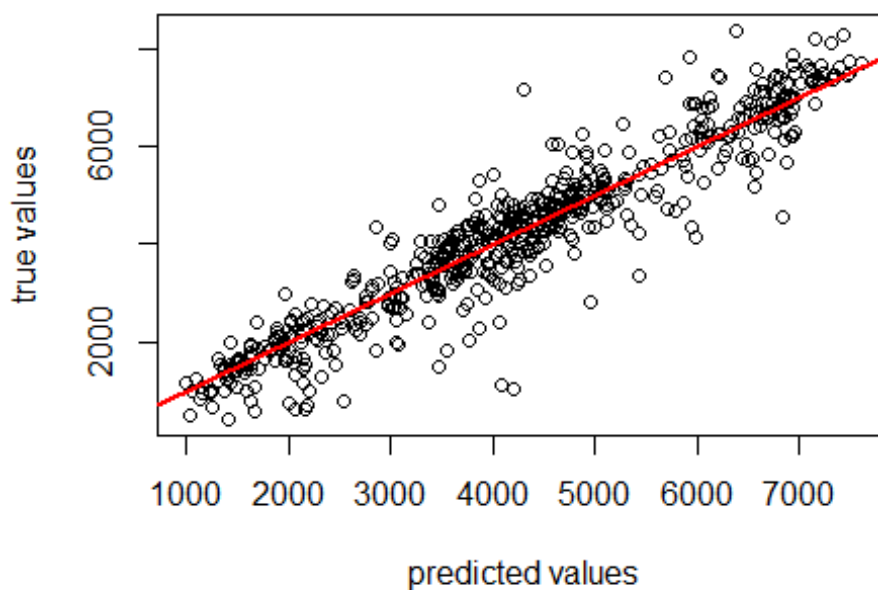
```
##  
## Call:  
## randomForest(x = x, y = y, mtry = res[which.min(res[, 2]), 1])  
##           Type of random forest: regression  
##           Number of trees: 500  
## No. of variables tried at each split: 5  
##  
##           Mean of squared residuals: 357079.1  
##           % Var explained: 89.2  
  
varImpPlot(rf, col="blue", pch=20)
```



```

predicttree <- predict(rf, data=train2)
plot(predicttree, train2$total_rental, xlab="predicted values", ylab="true
values")
abline(0, 1, col='red', lwd=2)

```



On performing the Random forest model with 500 decision tree and 10 variables, the lowest out-of-bound error was with 5 variables that are temperature, year, season, month and humidity. The predicted values appears to be better correlated to the true values. However, I tried out a xboosting approach.

```
library(xgboost)

library(caret)

set.seed(1)
parts = createDataPartition(train$total_rental, p = .8, list = F)
dtrain = train[parts, ]
dval = train[-parts, ]

trainx <- data.matrix(dtrain[,2:11])
trainy <- dtrain[,12]

valx <- data.matrix(dval[,2:11])
valy <- dval[,12]

xgb_train <- xgb.DMatrix(data = trainx, label = trainy)
xgb_val = xgb.DMatrix(data = valx, label = valy)

watchlist = list(train=xgb_train, test=xgb_val)
model = xgb.train(data = xgb_train, max.depth = 3, watchlist=watchlist, nrounds = 1000)

## [1] train-rmse:3277.441411 test-rmse:3329.171422
## [2] train-rmse:2369.285545 test-rmse:2407.019713
## [3] train-rmse:1748.973800 test-rmse:1783.337871
## [4] train-rmse:1330.722948 test-rmse:1369.903655
## [5] train-rmse:1050.826862 test-rmse:1093.075921
## [6] train-rmse:860.810336 test-rmse:902.889883
## [7] train-rmse:739.781082 test-rmse:783.383027
## [8] train-rmse:666.037170 test-rmse:713.964892
## [9] train-rmse:611.083939 test-rmse:668.093585
## [10] train-rmse:576.350617 test-rmse:644.766440
## [11] train-rmse:553.378189 test-rmse:627.588410
## [12] train-rmse:532.452962 test-rmse:615.343333
## [13] train-rmse:519.870470 test-rmse:602.004164
## [14] train-rmse:506.400856 test-rmse:603.462537
## [15] train-rmse:496.600521 test-rmse:610.956891
## [16] train-rmse:486.338402 test-rmse:607.356179
## [17] train-rmse:477.259697 test-rmse:601.315362
## [18] train-rmse:468.534068 test-rmse:603.736155
## [19] train-rmse:462.306788 test-rmse:602.064996
## [20] train-rmse:453.036487 test-rmse:608.112655
## [21] train-rmse:448.744357 test-rmse:607.080090
## [22] train-rmse:446.253321 test-rmse:609.972597
## [23] train-rmse:441.375431 test-rmse:611.256720
## [24] train-rmse:435.209042 test-rmse:604.496118
```

## [25]	train-rmse:433.166126	test-rmse:603.430653
## [26]	train-rmse:430.003636	test-rmse:606.187653
## [27]	train-rmse:426.360104	test-rmse:606.696160
## [28]	train-rmse:422.223835	test-rmse:603.349047
## [29]	train-rmse:420.501511	test-rmse:602.768278
## [30]	train-rmse:419.580312	test-rmse:603.857396
## [31]	train-rmse:411.665150	test-rmse:603.262044
## [32]	train-rmse:400.681074	test-rmse:596.005863
## [33]	train-rmse:392.714331	test-rmse:600.051284
## [34]	train-rmse:385.992769	test-rmse:598.368226
## [35]	train-rmse:382.585996	test-rmse:598.003450
## [36]	train-rmse:380.837483	test-rmse:599.914533
## [37]	train-rmse:379.912872	test-rmse:599.147234
## [38]	train-rmse:375.580778	test-rmse:596.077874
## [39]	train-rmse:372.475307	test-rmse:595.814966
## [40]	train-rmse:370.853049	test-rmse:595.311334
## [41]	train-rmse:366.336626	test-rmse:594.580783
## [42]	train-rmse:359.864605	test-rmse:597.145588
## [43]	train-rmse:357.205530	test-rmse:602.432910
## [44]	train-rmse:352.631053	test-rmse:603.224914
## [45]	train-rmse:349.209175	test-rmse:602.394038
## [46]	train-rmse:346.646125	test-rmse:602.217108
## [47]	train-rmse:344.663097	test-rmse:608.215642
## [48]	train-rmse:337.610449	test-rmse:613.384211
## [49]	train-rmse:333.269389	test-rmse:613.088160
## [50]	train-rmse:330.045873	test-rmse:612.634779
## [51]	train-rmse:328.493371	test-rmse:613.958725
## [52]	train-rmse:326.644141	test-rmse:612.870341
## [53]	train-rmse:322.044929	test-rmse:617.400230
## [54]	train-rmse:320.207719	test-rmse:613.348647
## [55]	train-rmse:319.804592	test-rmse:612.928276
## [56]	train-rmse:316.057822	test-rmse:610.453972
## [57]	train-rmse:314.068998	test-rmse:610.583511
## [58]	train-rmse:312.767757	test-rmse:611.574831
## [59]	train-rmse:309.471670	test-rmse:609.160567
## [60]	train-rmse:305.666830	test-rmse:613.580512
## [61]	train-rmse:303.507675	test-rmse:615.620142
## [62]	train-rmse:299.941514	test-rmse:615.126427
## [63]	train-rmse:297.141902	test-rmse:615.598784
## [64]	train-rmse:295.423624	test-rmse:616.356244
## [65]	train-rmse:292.353481	test-rmse:619.804110
## [66]	train-rmse:292.064461	test-rmse:620.669052
## [67]	train-rmse:290.801069	test-rmse:621.204508
## [68]	train-rmse:289.574608	test-rmse:620.152032
## [69]	train-rmse:287.812788	test-rmse:619.791246
## [70]	train-rmse:285.375026	test-rmse:618.297869
## [71]	train-rmse:284.851850	test-rmse:618.158073
## [72]	train-rmse:283.411139	test-rmse:616.655765
## [73]	train-rmse:283.104640	test-rmse:616.844095
## [74]	train-rmse:280.626281	test-rmse:620.044579
## [75]	train-rmse:278.250184	test-rmse:620.661515

## [76]	train-rmse:275.845591	test-rmse:622.184865
## [77]	train-rmse:273.365020	test-rmse:621.695789
## [78]	train-rmse:272.063584	test-rmse:621.992403
## [79]	train-rmse:269.092221	test-rmse:622.441445
## [80]	train-rmse:266.317701	test-rmse:624.156772
## [81]	train-rmse:264.138347	test-rmse:625.415300
## [82]	train-rmse:262.356470	test-rmse:628.667722
## [83]	train-rmse:259.965988	test-rmse:629.326279
## [84]	train-rmse:257.354537	test-rmse:633.396880
## [85]	train-rmse:254.993042	test-rmse:632.047542
## [86]	train-rmse:254.076600	test-rmse:631.250265
## [87]	train-rmse:251.398202	test-rmse:630.827862
## [88]	train-rmse:247.965686	test-rmse:631.739351
## [89]	train-rmse:245.801643	test-rmse:631.932526
## [90]	train-rmse:244.749305	test-rmse:631.071203
## [91]	train-rmse:242.716086	test-rmse:631.734038
## [92]	train-rmse:241.968479	test-rmse:633.395039
## [93]	train-rmse:240.950445	test-rmse:632.954881
## [94]	train-rmse:239.222632	test-rmse:634.810381
## [95]	train-rmse:238.616848	test-rmse:635.924840
## [96]	train-rmse:236.828863	test-rmse:636.198689
## [97]	train-rmse:235.976937	test-rmse:633.612597
## [98]	train-rmse:234.408008	test-rmse:635.044525
## [99]	train-rmse:233.605377	test-rmse:634.926206
## [100]	train-rmse:232.657022	test-rmse:634.921731
## [101]	train-rmse:231.439259	test-rmse:633.823510
## [102]	train-rmse:231.278492	test-rmse:633.724209
## [103]	train-rmse:228.626026	test-rmse:632.670360
## [104]	train-rmse:226.578848	test-rmse:633.948948
## [105]	train-rmse:224.596544	test-rmse:634.099186
## [106]	train-rmse:222.664676	test-rmse:635.515277
## [107]	train-rmse:221.358992	test-rmse:635.695031
## [108]	train-rmse:219.480178	test-rmse:635.813208
## [109]	train-rmse:217.686429	test-rmse:636.455777
## [110]	train-rmse:217.155540	test-rmse:635.975725
## [111]	train-rmse:215.697360	test-rmse:637.418479
## [112]	train-rmse:213.870466	test-rmse:637.540479
## [113]	train-rmse:212.086803	test-rmse:635.032821
## [114]	train-rmse:211.340698	test-rmse:634.331322
## [115]	train-rmse:209.484430	test-rmse:634.522993
## [116]	train-rmse:208.521738	test-rmse:634.337899
## [117]	train-rmse:207.763861	test-rmse:634.955768
## [118]	train-rmse:206.157710	test-rmse:634.012127
## [119]	train-rmse:204.524569	test-rmse:635.198503
## [120]	train-rmse:203.476599	test-rmse:636.135505
## [121]	train-rmse:202.760454	test-rmse:636.044870
## [122]	train-rmse:199.911883	test-rmse:634.753406
## [123]	train-rmse:198.152764	test-rmse:636.009500
## [124]	train-rmse:195.858831	test-rmse:635.629458
## [125]	train-rmse:194.665444	test-rmse:638.032696
## [126]	train-rmse:193.778854	test-rmse:639.649143

## [127]	train-rmse:193.427746	test-rmse:638.438558
## [128]	train-rmse:193.128911	test-rmse:639.239778
## [129]	train-rmse:192.128792	test-rmse:639.457598
## [130]	train-rmse:190.359355	test-rmse:639.861526
## [131]	train-rmse:188.924933	test-rmse:641.378476
## [132]	train-rmse:187.165007	test-rmse:641.127703
## [133]	train-rmse:186.214333	test-rmse:641.160198
## [134]	train-rmse:184.946398	test-rmse:640.775781
## [135]	train-rmse:183.927173	test-rmse:642.351354
## [136]	train-rmse:182.456619	test-rmse:643.504503
## [137]	train-rmse:181.170223	test-rmse:644.585505
## [138]	train-rmse:179.536565	test-rmse:643.778801
## [139]	train-rmse:177.637515	test-rmse:643.759754
## [140]	train-rmse:176.286118	test-rmse:643.363280
## [141]	train-rmse:174.999646	test-rmse:643.217677
## [142]	train-rmse:172.921436	test-rmse:643.815879
## [143]	train-rmse:171.466662	test-rmse:645.067299
## [144]	train-rmse:170.939196	test-rmse:645.052736
## [145]	train-rmse:170.467670	test-rmse:643.306471
## [146]	train-rmse:169.331965	test-rmse:644.477864
## [147]	train-rmse:167.698328	test-rmse:643.886843
## [148]	train-rmse:166.193392	test-rmse:643.908816
## [149]	train-rmse:164.742735	test-rmse:644.120508
## [150]	train-rmse:163.791605	test-rmse:643.755583
## [151]	train-rmse:163.368867	test-rmse:643.669868
## [152]	train-rmse:163.179477	test-rmse:644.369212
## [153]	train-rmse:162.003235	test-rmse:645.695155
## [154]	train-rmse:160.871698	test-rmse:646.428286
## [155]	train-rmse:160.641240	test-rmse:645.510576
## [156]	train-rmse:159.757164	test-rmse:646.781902
## [157]	train-rmse:158.072930	test-rmse:646.005587
## [158]	train-rmse:157.145642	test-rmse:646.186928
## [159]	train-rmse:156.524291	test-rmse:645.101782
## [160]	train-rmse:154.820493	test-rmse:645.586466
## [161]	train-rmse:154.393292	test-rmse:643.814139
## [162]	train-rmse:152.644784	test-rmse:643.701703
## [163]	train-rmse:151.801898	test-rmse:645.119127
## [164]	train-rmse:150.754764	test-rmse:645.576702
## [165]	train-rmse:149.996882	test-rmse:646.298164
## [166]	train-rmse:149.089433	test-rmse:647.552461
## [167]	train-rmse:147.180871	test-rmse:647.679584
## [168]	train-rmse:146.640727	test-rmse:648.082009
## [169]	train-rmse:144.728285	test-rmse:647.296462
## [170]	train-rmse:142.892646	test-rmse:648.567194
## [171]	train-rmse:141.516430	test-rmse:648.390399
## [172]	train-rmse:140.056760	test-rmse:648.043495
## [173]	train-rmse:138.946172	test-rmse:648.330563
## [174]	train-rmse:138.372568	test-rmse:649.446826
## [175]	train-rmse:137.906819	test-rmse:650.241592
## [176]	train-rmse:136.865724	test-rmse:650.878697
## [177]	train-rmse:136.509073	test-rmse:650.811744

## [178]	train-rmse:135.728687	test-rmse:651.328819
## [179]	train-rmse:134.771892	test-rmse:652.712876
## [180]	train-rmse:134.072557	test-rmse:652.546935
## [181]	train-rmse:133.227403	test-rmse:653.615453
## [182]	train-rmse:131.436797	test-rmse:655.256746
## [183]	train-rmse:130.466192	test-rmse:653.883663
## [184]	train-rmse:129.549141	test-rmse:654.022007
## [185]	train-rmse:128.327520	test-rmse:653.137030
## [186]	train-rmse:127.964730	test-rmse:652.685427
## [187]	train-rmse:127.647808	test-rmse:652.279959
## [188]	train-rmse:127.508869	test-rmse:652.837405
## [189]	train-rmse:126.475003	test-rmse:653.515053
## [190]	train-rmse:125.224383	test-rmse:652.470072
## [191]	train-rmse:124.041494	test-rmse:653.622761
## [192]	train-rmse:123.503114	test-rmse:653.610927
## [193]	train-rmse:123.222922	test-rmse:652.543670
## [194]	train-rmse:122.319255	test-rmse:652.439315
## [195]	train-rmse:121.885290	test-rmse:652.571653
## [196]	train-rmse:121.283474	test-rmse:652.218345
## [197]	train-rmse:120.727339	test-rmse:652.031257
## [198]	train-rmse:119.975620	test-rmse:652.263717
## [199]	train-rmse:118.400368	test-rmse:652.027211
## [200]	train-rmse:116.954050	test-rmse:652.568213
## [201]	train-rmse:116.077566	test-rmse:652.573563
## [202]	train-rmse:115.972743	test-rmse:652.913920
## [203]	train-rmse:114.853925	test-rmse:652.796593
## [204]	train-rmse:113.842745	test-rmse:652.773977
## [205]	train-rmse:113.185397	test-rmse:653.666834
## [206]	train-rmse:113.035926	test-rmse:653.988430
## [207]	train-rmse:112.471324	test-rmse:654.536201
## [208]	train-rmse:111.586665	test-rmse:655.032058
## [209]	train-rmse:110.928390	test-rmse:655.261375
## [210]	train-rmse:110.245378	test-rmse:654.907969
## [211]	train-rmse:109.436850	test-rmse:655.074519
## [212]	train-rmse:108.565159	test-rmse:655.357693
## [213]	train-rmse:107.474184	test-rmse:656.058441
## [214]	train-rmse:106.993202	test-rmse:656.118114
## [215]	train-rmse:106.566926	test-rmse:656.886522
## [216]	train-rmse:105.923414	test-rmse:656.896237
## [217]	train-rmse:105.332779	test-rmse:657.019660
## [218]	train-rmse:104.366328	test-rmse:656.836726
## [219]	train-rmse:104.114265	test-rmse:656.799291
## [220]	train-rmse:104.030527	test-rmse:656.966956
## [221]	train-rmse:103.376463	test-rmse:657.865338
## [222]	train-rmse:102.428760	test-rmse:657.716481
## [223]	train-rmse:101.867909	test-rmse:657.732848
## [224]	train-rmse:101.465201	test-rmse:657.588022
## [225]	train-rmse:100.496152	test-rmse:657.938516
## [226]	train-rmse:100.272240	test-rmse:658.437971
## [227]	train-rmse:100.198272	test-rmse:658.366080
## [228]	train-rmse:99.726920	test-rmse:658.451023

## [229]	train-rmse:99.553082	test-rmse:658.441957
## [230]	train-rmse:99.472760	test-rmse:658.791916
## [231]	train-rmse:99.250023	test-rmse:658.917216
## [232]	train-rmse:98.630287	test-rmse:659.291244
## [233]	train-rmse:98.006986	test-rmse:659.728049
## [234]	train-rmse:97.077659	test-rmse:658.755766
## [235]	train-rmse:96.184780	test-rmse:658.762185
## [236]	train-rmse:95.558371	test-rmse:658.606316
## [237]	train-rmse:94.089799	test-rmse:658.463844
## [238]	train-rmse:93.713646	test-rmse:658.179245
## [239]	train-rmse:93.071582	test-rmse:658.279354
## [240]	train-rmse:92.658651	test-rmse:658.675558
## [241]	train-rmse:92.503558	test-rmse:658.681236
## [242]	train-rmse:92.333257	test-rmse:658.862736
## [243]	train-rmse:92.221516	test-rmse:658.638971
## [244]	train-rmse:91.744481	test-rmse:659.382516
## [245]	train-rmse:90.710498	test-rmse:659.341597
## [246]	train-rmse:90.630611	test-rmse:659.701713
## [247]	train-rmse:90.091772	test-rmse:659.505312
## [248]	train-rmse:89.817816	test-rmse:660.251723
## [249]	train-rmse:89.519389	test-rmse:660.537411
## [250]	train-rmse:88.648528	test-rmse:660.995902
## [251]	train-rmse:88.051032	test-rmse:660.277516
## [252]	train-rmse:87.442499	test-rmse:660.259140
## [253]	train-rmse:86.875981	test-rmse:659.901003
## [254]	train-rmse:86.680558	test-rmse:659.990866
## [255]	train-rmse:85.884670	test-rmse:660.012215
## [256]	train-rmse:85.495418	test-rmse:659.894492
## [257]	train-rmse:85.150285	test-rmse:660.514399
## [258]	train-rmse:84.691481	test-rmse:660.415206
## [259]	train-rmse:84.304061	test-rmse:660.435646
## [260]	train-rmse:84.244175	test-rmse:660.441224
## [261]	train-rmse:83.496657	test-rmse:660.206570
## [262]	train-rmse:82.731825	test-rmse:660.044494
## [263]	train-rmse:82.691610	test-rmse:660.232698
## [264]	train-rmse:82.148364	test-rmse:659.527501
## [265]	train-rmse:81.871713	test-rmse:659.789542
## [266]	train-rmse:81.322858	test-rmse:659.138462
## [267]	train-rmse:81.010736	test-rmse:658.964484
## [268]	train-rmse:80.426117	test-rmse:659.197265
## [269]	train-rmse:80.071417	test-rmse:659.297887
## [270]	train-rmse:79.325163	test-rmse:659.721288
## [271]	train-rmse:78.702319	test-rmse:659.990281
## [272]	train-rmse:77.798634	test-rmse:660.036897
## [273]	train-rmse:77.424689	test-rmse:660.050503
## [274]	train-rmse:77.055042	test-rmse:660.280648
## [275]	train-rmse:76.448293	test-rmse:660.654753
## [276]	train-rmse:75.895903	test-rmse:660.508745
## [277]	train-rmse:75.583404	test-rmse:660.618204
## [278]	train-rmse:75.091451	test-rmse:660.421395
## [279]	train-rmse:74.480396	test-rmse:661.244692

## [280]	train-rmse:74.025760	test-rmse:661.549229
## [281]	train-rmse:73.632376	test-rmse:661.383953
## [282]	train-rmse:73.451502	test-rmse:661.377057
## [283]	train-rmse:72.961020	test-rmse:661.010013
## [284]	train-rmse:72.583300	test-rmse:660.792678
## [285]	train-rmse:72.163522	test-rmse:660.876167
## [286]	train-rmse:71.831473	test-rmse:661.009862
## [287]	train-rmse:71.269099	test-rmse:661.092330
## [288]	train-rmse:70.804949	test-rmse:661.263855
## [289]	train-rmse:70.287432	test-rmse:660.968294
## [290]	train-rmse:69.469728	test-rmse:661.227828
## [291]	train-rmse:69.250326	test-rmse:661.538455
## [292]	train-rmse:68.989831	test-rmse:661.922511
## [293]	train-rmse:68.809915	test-rmse:661.697870
## [294]	train-rmse:68.684316	test-rmse:661.377768
## [295]	train-rmse:68.315712	test-rmse:661.570026
## [296]	train-rmse:68.042866	test-rmse:661.825369
## [297]	train-rmse:67.542078	test-rmse:661.785537
## [298]	train-rmse:67.118500	test-rmse:661.819318
## [299]	train-rmse:67.076481	test-rmse:661.819788
## [300]	train-rmse:66.655116	test-rmse:661.838373
## [301]	train-rmse:66.223293	test-rmse:662.168698
## [302]	train-rmse:65.822926	test-rmse:662.398108
## [303]	train-rmse:65.405808	test-rmse:662.379586
## [304]	train-rmse:65.195767	test-rmse:662.560096
## [305]	train-rmse:64.778635	test-rmse:662.393657
## [306]	train-rmse:64.580333	test-rmse:662.394016
## [307]	train-rmse:64.486404	test-rmse:662.310756
## [308]	train-rmse:64.301376	test-rmse:663.029266
## [309]	train-rmse:63.756626	test-rmse:663.384903
## [310]	train-rmse:63.522113	test-rmse:663.307282
## [311]	train-rmse:63.159555	test-rmse:663.609732
## [312]	train-rmse:62.854421	test-rmse:663.939709
## [313]	train-rmse:62.319704	test-rmse:664.155891
## [314]	train-rmse:62.009233	test-rmse:664.053198
## [315]	train-rmse:61.893317	test-rmse:664.136341
## [316]	train-rmse:61.540296	test-rmse:664.222167
## [317]	train-rmse:61.037795	test-rmse:664.334724
## [318]	train-rmse:60.496964	test-rmse:664.281130
## [319]	train-rmse:60.165547	test-rmse:664.597230
## [320]	train-rmse:59.656283	test-rmse:664.508281
## [321]	train-rmse:59.490553	test-rmse:664.804641
## [322]	train-rmse:59.137338	test-rmse:664.922315
## [323]	train-rmse:58.635907	test-rmse:664.857976
## [324]	train-rmse:58.140954	test-rmse:665.230082
## [325]	train-rmse:57.722428	test-rmse:665.308085
## [326]	train-rmse:57.404190	test-rmse:665.464920
## [327]	train-rmse:57.209873	test-rmse:665.620068
## [328]	train-rmse:56.946373	test-rmse:665.482100
## [329]	train-rmse:56.726432	test-rmse:665.444824
## [330]	train-rmse:56.630643	test-rmse:665.241916

## [331]	train-rmse:56.518079	test-rmse:665.477529
## [332]	train-rmse:56.425233	test-rmse:665.335487
## [333]	train-rmse:56.178142	test-rmse:665.320863
## [334]	train-rmse:55.791126	test-rmse:665.550317
## [335]	train-rmse:55.468122	test-rmse:665.430811
## [336]	train-rmse:55.202598	test-rmse:665.596981
## [337]	train-rmse:54.725018	test-rmse:665.385718
## [338]	train-rmse:54.399090	test-rmse:665.526299
## [339]	train-rmse:53.983915	test-rmse:665.734700
## [340]	train-rmse:53.538247	test-rmse:665.567825
## [341]	train-rmse:53.288396	test-rmse:665.493724
## [342]	train-rmse:53.008258	test-rmse:665.572261
## [343]	train-rmse:52.568078	test-rmse:665.718705
## [344]	train-rmse:52.130690	test-rmse:666.213845
## [345]	train-rmse:51.694838	test-rmse:666.109860
## [346]	train-rmse:51.296447	test-rmse:665.884505
## [347]	train-rmse:51.052022	test-rmse:665.995908
## [348]	train-rmse:50.592281	test-rmse:666.174697
## [349]	train-rmse:50.405726	test-rmse:666.090291
## [350]	train-rmse:50.068923	test-rmse:666.115324
## [351]	train-rmse:49.755457	test-rmse:666.407156
## [352]	train-rmse:49.515293	test-rmse:666.436483
## [353]	train-rmse:49.307570	test-rmse:666.464860
## [354]	train-rmse:49.010415	test-rmse:666.560809
## [355]	train-rmse:48.816125	test-rmse:666.463746
## [356]	train-rmse:48.654510	test-rmse:666.440028
## [357]	train-rmse:48.315590	test-rmse:666.655158
## [358]	train-rmse:47.986702	test-rmse:666.823012
## [359]	train-rmse:47.914425	test-rmse:667.117574
## [360]	train-rmse:47.869627	test-rmse:667.355934
## [361]	train-rmse:47.771707	test-rmse:667.360732
## [362]	train-rmse:47.543596	test-rmse:667.325924
## [363]	train-rmse:47.390426	test-rmse:667.262615
## [364]	train-rmse:47.177577	test-rmse:667.298930
## [365]	train-rmse:46.954176	test-rmse:667.459032
## [366]	train-rmse:46.703314	test-rmse:667.326237
## [367]	train-rmse:46.085122	test-rmse:667.249412
## [368]	train-rmse:45.570196	test-rmse:667.441036
## [369]	train-rmse:45.488608	test-rmse:667.512532
## [370]	train-rmse:45.263266	test-rmse:667.393253
## [371]	train-rmse:45.029015	test-rmse:667.714820
## [372]	train-rmse:44.764668	test-rmse:667.818960
## [373]	train-rmse:44.459602	test-rmse:667.783320
## [374]	train-rmse:44.301142	test-rmse:667.943588
## [375]	train-rmse:44.239438	test-rmse:667.958124
## [376]	train-rmse:43.977809	test-rmse:667.998923
## [377]	train-rmse:43.786014	test-rmse:667.989240
## [378]	train-rmse:43.423567	test-rmse:668.120215
## [379]	train-rmse:43.068056	test-rmse:668.209494
## [380]	train-rmse:42.920845	test-rmse:668.486436
## [381]	train-rmse:42.805186	test-rmse:668.403734

## [382]	train-rmse:42.529155	test-rmse:668.427233
## [383]	train-rmse:42.499258	test-rmse:668.529379
## [384]	train-rmse:42.435237	test-rmse:668.530340
## [385]	train-rmse:42.313546	test-rmse:668.482839
## [386]	train-rmse:42.160914	test-rmse:668.660943
## [387]	train-rmse:41.881037	test-rmse:668.681967
## [388]	train-rmse:41.532648	test-rmse:668.645128
## [389]	train-rmse:41.366552	test-rmse:668.740983
## [390]	train-rmse:41.077655	test-rmse:668.609165
## [391]	train-rmse:40.836162	test-rmse:668.666520
## [392]	train-rmse:40.774405	test-rmse:668.810544
## [393]	train-rmse:40.521251	test-rmse:669.148001
## [394]	train-rmse:40.466822	test-rmse:669.004640
## [395]	train-rmse:40.447985	test-rmse:669.110602
## [396]	train-rmse:40.094735	test-rmse:669.144046
## [397]	train-rmse:39.739886	test-rmse:669.345665
## [398]	train-rmse:39.561959	test-rmse:669.536487
## [399]	train-rmse:39.473432	test-rmse:669.535403
## [400]	train-rmse:39.207120	test-rmse:669.561165
## [401]	train-rmse:39.031894	test-rmse:669.919962
## [402]	train-rmse:38.758846	test-rmse:669.878792
## [403]	train-rmse:38.712835	test-rmse:669.843612
## [404]	train-rmse:38.508472	test-rmse:669.800048
## [405]	train-rmse:38.161052	test-rmse:669.883328
## [406]	train-rmse:37.974290	test-rmse:670.034845
## [407]	train-rmse:37.800869	test-rmse:670.007365
## [408]	train-rmse:37.681847	test-rmse:670.220175
## [409]	train-rmse:37.495839	test-rmse:670.444901
## [410]	train-rmse:37.404288	test-rmse:670.405848
## [411]	train-rmse:37.318419	test-rmse:670.347137
## [412]	train-rmse:37.136531	test-rmse:670.307443
## [413]	train-rmse:36.899626	test-rmse:670.217944
## [414]	train-rmse:36.700078	test-rmse:670.247127
## [415]	train-rmse:36.625191	test-rmse:670.192436
## [416]	train-rmse:36.321818	test-rmse:669.979275
## [417]	train-rmse:36.027914	test-rmse:669.812927
## [418]	train-rmse:35.986809	test-rmse:669.746244
## [419]	train-rmse:35.829594	test-rmse:669.868704
## [420]	train-rmse:35.593333	test-rmse:669.987430
## [421]	train-rmse:35.299254	test-rmse:670.046561
## [422]	train-rmse:35.135714	test-rmse:670.088254
## [423]	train-rmse:35.011531	test-rmse:670.166949
## [424]	train-rmse:34.988628	test-rmse:670.055279
## [425]	train-rmse:34.790750	test-rmse:670.192899
## [426]	train-rmse:34.566104	test-rmse:669.832821
## [427]	train-rmse:34.196020	test-rmse:669.627500
## [428]	train-rmse:34.058889	test-rmse:669.798826
## [429]	train-rmse:33.935340	test-rmse:669.744542
## [430]	train-rmse:33.820744	test-rmse:669.827237
## [431]	train-rmse:33.731230	test-rmse:669.981368
## [432]	train-rmse:33.688801	test-rmse:669.979654

## [433]	train-rmse:33.619706	test-rmse:669.740084
## [434]	train-rmse:33.372863	test-rmse:669.619905
## [435]	train-rmse:33.250025	test-rmse:669.553591
## [436]	train-rmse:33.042750	test-rmse:669.723024
## [437]	train-rmse:32.819893	test-rmse:669.830563
## [438]	train-rmse:32.554597	test-rmse:669.852866
## [439]	train-rmse:32.301741	test-rmse:669.809917
## [440]	train-rmse:32.234375	test-rmse:669.879903
## [441]	train-rmse:32.056764	test-rmse:669.801183
## [442]	train-rmse:31.771767	test-rmse:669.817351
## [443]	train-rmse:31.577429	test-rmse:669.740266
## [444]	train-rmse:31.330913	test-rmse:669.823830
## [445]	train-rmse:31.157898	test-rmse:669.835549
## [446]	train-rmse:31.029836	test-rmse:669.829415
## [447]	train-rmse:30.710111	test-rmse:669.886555
## [448]	train-rmse:30.366185	test-rmse:669.900181
## [449]	train-rmse:30.294759	test-rmse:669.780357
## [450]	train-rmse:30.037439	test-rmse:669.757228
## [451]	train-rmse:29.977871	test-rmse:669.880076
## [452]	train-rmse:29.945741	test-rmse:669.873216
## [453]	train-rmse:29.864789	test-rmse:670.015296
## [454]	train-rmse:29.656274	test-rmse:670.002446
## [455]	train-rmse:29.544521	test-rmse:669.926866
## [456]	train-rmse:29.491975	test-rmse:669.938045
## [457]	train-rmse:29.181581	test-rmse:669.812515
## [458]	train-rmse:29.048211	test-rmse:669.673040
## [459]	train-rmse:28.939110	test-rmse:669.822194
## [460]	train-rmse:28.840868	test-rmse:669.736422
## [461]	train-rmse:28.657690	test-rmse:669.775635
## [462]	train-rmse:28.354066	test-rmse:669.752890
## [463]	train-rmse:28.290400	test-rmse:669.821666
## [464]	train-rmse:28.093488	test-rmse:669.870157
## [465]	train-rmse:28.057640	test-rmse:669.800576
## [466]	train-rmse:27.844035	test-rmse:669.757328
## [467]	train-rmse:27.676668	test-rmse:669.781090
## [468]	train-rmse:27.488360	test-rmse:669.691878
## [469]	train-rmse:27.214613	test-rmse:669.826282
## [470]	train-rmse:27.046572	test-rmse:669.852185
## [471]	train-rmse:26.865453	test-rmse:669.909290
## [472]	train-rmse:26.704285	test-rmse:669.941979
## [473]	train-rmse:26.627155	test-rmse:670.075106
## [474]	train-rmse:26.563030	test-rmse:670.058306
## [475]	train-rmse:26.515642	test-rmse:670.147790
## [476]	train-rmse:26.394152	test-rmse:670.066792
## [477]	train-rmse:26.345864	test-rmse:670.125509
## [478]	train-rmse:26.219099	test-rmse:670.066990
## [479]	train-rmse:26.001964	test-rmse:670.205590
## [480]	train-rmse:25.975760	test-rmse:670.109467
## [481]	train-rmse:25.618329	test-rmse:670.165971
## [482]	train-rmse:25.509944	test-rmse:670.132980
## [483]	train-rmse:25.296664	test-rmse:670.109975

## [484]	train-rmse:25.145114	test-rmse:669.951757
## [485]	train-rmse:24.936914	test-rmse:669.991191
## [486]	train-rmse:24.782234	test-rmse:670.096710
## [487]	train-rmse:24.661901	test-rmse:669.983208
## [488]	train-rmse:24.426359	test-rmse:670.219605
## [489]	train-rmse:24.279844	test-rmse:670.295770
## [490]	train-rmse:24.180421	test-rmse:670.484839
## [491]	train-rmse:24.089505	test-rmse:670.482060
## [492]	train-rmse:24.034593	test-rmse:670.504842
## [493]	train-rmse:23.875611	test-rmse:670.478544
## [494]	train-rmse:23.718880	test-rmse:670.436509
## [495]	train-rmse:23.606139	test-rmse:670.475773
## [496]	train-rmse:23.520099	test-rmse:670.468958
## [497]	train-rmse:23.429223	test-rmse:670.523266
## [498]	train-rmse:23.310126	test-rmse:670.443815
## [499]	train-rmse:23.249432	test-rmse:670.518968
## [500]	train-rmse:23.224702	test-rmse:670.554881
## [501]	train-rmse:23.045932	test-rmse:670.602792
## [502]	train-rmse:22.841228	test-rmse:670.665934
## [503]	train-rmse:22.612054	test-rmse:670.652509
## [504]	train-rmse:22.514777	test-rmse:670.710684
## [505]	train-rmse:22.297454	test-rmse:670.726113
## [506]	train-rmse:22.223177	test-rmse:670.893693
## [507]	train-rmse:22.154994	test-rmse:670.886773
## [508]	train-rmse:22.027152	test-rmse:670.934246
## [509]	train-rmse:21.926764	test-rmse:670.932874
## [510]	train-rmse:21.900804	test-rmse:670.929499
## [511]	train-rmse:21.713001	test-rmse:670.870651
## [512]	train-rmse:21.635027	test-rmse:670.850576
## [513]	train-rmse:21.525805	test-rmse:670.890934
## [514]	train-rmse:21.365242	test-rmse:670.952213
## [515]	train-rmse:21.239660	test-rmse:671.126228
## [516]	train-rmse:21.185533	test-rmse:671.125354
## [517]	train-rmse:21.021586	test-rmse:671.092146
## [518]	train-rmse:20.998874	test-rmse:671.020197
## [519]	train-rmse:20.786902	test-rmse:671.099057
## [520]	train-rmse:20.741744	test-rmse:671.191724
## [521]	train-rmse:20.684967	test-rmse:671.178677
## [522]	train-rmse:20.575640	test-rmse:671.312097
## [523]	train-rmse:20.402292	test-rmse:671.278805
## [524]	train-rmse:20.349210	test-rmse:671.283378
## [525]	train-rmse:20.210461	test-rmse:671.293336
## [526]	train-rmse:20.194128	test-rmse:671.349729
## [527]	train-rmse:20.052745	test-rmse:671.405893
## [528]	train-rmse:19.887808	test-rmse:671.346091
## [529]	train-rmse:19.786627	test-rmse:671.379397
## [530]	train-rmse:19.710027	test-rmse:671.502881
## [531]	train-rmse:19.575724	test-rmse:671.645794
## [532]	train-rmse:19.443250	test-rmse:671.638241
## [533]	train-rmse:19.336568	test-rmse:671.599127
## [534]	train-rmse:19.310201	test-rmse:671.656840

## [535]	train-rmse:19.289862	test-rmse:671.646419
## [536]	train-rmse:19.180682	test-rmse:671.717091
## [537]	train-rmse:19.108640	test-rmse:671.663435
## [538]	train-rmse:19.015804	test-rmse:671.785406
## [539]	train-rmse:18.918535	test-rmse:671.868299
## [540]	train-rmse:18.814605	test-rmse:671.783560
## [541]	train-rmse:18.644701	test-rmse:671.837461
## [542]	train-rmse:18.557099	test-rmse:671.935006
## [543]	train-rmse:18.477206	test-rmse:671.896103
## [544]	train-rmse:18.447311	test-rmse:671.960675
## [545]	train-rmse:18.426190	test-rmse:671.960148
## [546]	train-rmse:18.290161	test-rmse:671.878101
## [547]	train-rmse:18.261009	test-rmse:671.968702
## [548]	train-rmse:18.243791	test-rmse:671.922926
## [549]	train-rmse:18.186151	test-rmse:671.925799
## [550]	train-rmse:18.101959	test-rmse:671.896617
## [551]	train-rmse:18.087477	test-rmse:671.887256
## [552]	train-rmse:18.047829	test-rmse:671.841538
## [553]	train-rmse:17.904412	test-rmse:671.813492
## [554]	train-rmse:17.780054	test-rmse:671.846999
## [555]	train-rmse:17.689150	test-rmse:671.798692
## [556]	train-rmse:17.536863	test-rmse:671.857248
## [557]	train-rmse:17.469211	test-rmse:671.913607
## [558]	train-rmse:17.363516	test-rmse:671.892487
## [559]	train-rmse:17.277765	test-rmse:671.838016
## [560]	train-rmse:17.247083	test-rmse:671.841698
## [561]	train-rmse:17.228552	test-rmse:671.919983
## [562]	train-rmse:17.145086	test-rmse:671.935547
## [563]	train-rmse:17.074773	test-rmse:671.955618
## [564]	train-rmse:16.981820	test-rmse:671.984373
## [565]	train-rmse:16.922937	test-rmse:671.962625
## [566]	train-rmse:16.816594	test-rmse:672.057538
## [567]	train-rmse:16.681129	test-rmse:672.056910
## [568]	train-rmse:16.668855	test-rmse:672.004107
## [569]	train-rmse:16.553897	test-rmse:672.043190
## [570]	train-rmse:16.496332	test-rmse:671.976971
## [571]	train-rmse:16.389265	test-rmse:672.034774
## [572]	train-rmse:16.288666	test-rmse:672.009217
## [573]	train-rmse:16.237247	test-rmse:672.126405
## [574]	train-rmse:16.206025	test-rmse:672.095958
## [575]	train-rmse:16.132810	test-rmse:672.105827
## [576]	train-rmse:16.061641	test-rmse:672.122010
## [577]	train-rmse:15.993978	test-rmse:672.151209
## [578]	train-rmse:15.974794	test-rmse:672.121198
## [579]	train-rmse:15.848611	test-rmse:671.953711
## [580]	train-rmse:15.768494	test-rmse:671.947067
## [581]	train-rmse:15.712759	test-rmse:672.116169
## [582]	train-rmse:15.654904	test-rmse:672.113466
## [583]	train-rmse:15.544449	test-rmse:672.126110
## [584]	train-rmse:15.466594	test-rmse:672.086901
## [585]	train-rmse:15.394812	test-rmse:672.127641

## [586]	train-rmse:15.372683	test-rmse:672.052276
## [587]	train-rmse:15.296237	test-rmse:672.077859
## [588]	train-rmse:15.284245	test-rmse:672.070708
## [589]	train-rmse:15.163599	test-rmse:672.127361
## [590]	train-rmse:15.111695	test-rmse:672.122778
## [591]	train-rmse:14.940122	test-rmse:672.180264
## [592]	train-rmse:14.876189	test-rmse:672.276039
## [593]	train-rmse:14.819954	test-rmse:672.244214
## [594]	train-rmse:14.760853	test-rmse:672.218434
## [595]	train-rmse:14.719519	test-rmse:672.239770
## [596]	train-rmse:14.678131	test-rmse:672.201688
## [597]	train-rmse:14.667967	test-rmse:672.155188
## [598]	train-rmse:14.576485	test-rmse:672.190636
## [599]	train-rmse:14.510453	test-rmse:672.209504
## [600]	train-rmse:14.401648	test-rmse:672.180170
## [601]	train-rmse:14.314059	test-rmse:672.124093
## [602]	train-rmse:14.275576	test-rmse:672.158450
## [603]	train-rmse:14.204357	test-rmse:672.239974
## [604]	train-rmse:14.156299	test-rmse:672.184120
## [605]	train-rmse:13.997729	test-rmse:672.201137
## [606]	train-rmse:13.970966	test-rmse:672.197536
## [607]	train-rmse:13.942315	test-rmse:672.179487
## [608]	train-rmse:13.925737	test-rmse:672.182243
## [609]	train-rmse:13.856748	test-rmse:672.207168
## [610]	train-rmse:13.825416	test-rmse:672.245976
## [611]	train-rmse:13.757152	test-rmse:672.279264
## [612]	train-rmse:13.694888	test-rmse:672.346470
## [613]	train-rmse:13.676003	test-rmse:672.385443
## [614]	train-rmse:13.577709	test-rmse:672.424155
## [615]	train-rmse:13.497963	test-rmse:672.450359
## [616]	train-rmse:13.481423	test-rmse:672.420191
## [617]	train-rmse:13.442473	test-rmse:672.374700
## [618]	train-rmse:13.365657	test-rmse:672.406207
## [619]	train-rmse:13.260201	test-rmse:672.421481
## [620]	train-rmse:13.186279	test-rmse:672.428007
## [621]	train-rmse:13.118195	test-rmse:672.338196
## [622]	train-rmse:13.072182	test-rmse:672.365356
## [623]	train-rmse:12.996049	test-rmse:672.347896
## [624]	train-rmse:12.923483	test-rmse:672.384307
## [625]	train-rmse:12.913490	test-rmse:672.411181
## [626]	train-rmse:12.873500	test-rmse:672.417261
## [627]	train-rmse:12.812708	test-rmse:672.432020
## [628]	train-rmse:12.690395	test-rmse:672.392306
## [629]	train-rmse:12.676534	test-rmse:672.370400
## [630]	train-rmse:12.653551	test-rmse:672.345846
## [631]	train-rmse:12.623156	test-rmse:672.339040
## [632]	train-rmse:12.534178	test-rmse:672.291472
## [633]	train-rmse:12.449863	test-rmse:672.300258
## [634]	train-rmse:12.388550	test-rmse:672.322189
## [635]	train-rmse:12.275564	test-rmse:672.274878
## [636]	train-rmse:12.246738	test-rmse:672.248252

## [637]	train-rmse:12.175120	test-rmse:672.210292
## [638]	train-rmse:12.127774	test-rmse:672.228234
## [639]	train-rmse:12.074880	test-rmse:672.199690
## [640]	train-rmse:12.060973	test-rmse:672.205833
## [641]	train-rmse:12.052121	test-rmse:672.185310
## [642]	train-rmse:11.992958	test-rmse:672.291522
## [643]	train-rmse:11.983122	test-rmse:672.322094
## [644]	train-rmse:11.935313	test-rmse:672.321027
## [645]	train-rmse:11.857432	test-rmse:672.356343
## [646]	train-rmse:11.814610	test-rmse:672.348200
## [647]	train-rmse:11.717490	test-rmse:672.358420
## [648]	train-rmse:11.648241	test-rmse:672.358699
## [649]	train-rmse:11.560696	test-rmse:672.348630
## [650]	train-rmse:11.473984	test-rmse:672.369710
## [651]	train-rmse:11.412869	test-rmse:672.282369
## [652]	train-rmse:11.403084	test-rmse:672.305151
## [653]	train-rmse:11.338554	test-rmse:672.297409
## [654]	train-rmse:11.296393	test-rmse:672.263422
## [655]	train-rmse:11.229632	test-rmse:672.254459
## [656]	train-rmse:11.165284	test-rmse:672.277199
## [657]	train-rmse:11.096900	test-rmse:672.296714
## [658]	train-rmse:11.054671	test-rmse:672.319787
## [659]	train-rmse:11.030208	test-rmse:672.338271
## [660]	train-rmse:11.008733	test-rmse:672.347942
## [661]	train-rmse:10.969331	test-rmse:672.350153
## [662]	train-rmse:10.933764	test-rmse:672.336912
## [663]	train-rmse:10.904043	test-rmse:672.348898
## [664]	train-rmse:10.859699	test-rmse:672.347101
## [665]	train-rmse:10.799512	test-rmse:672.346663
## [666]	train-rmse:10.747382	test-rmse:672.324925
## [667]	train-rmse:10.670998	test-rmse:672.339315
## [668]	train-rmse:10.630781	test-rmse:672.391990
## [669]	train-rmse:10.598733	test-rmse:672.385618
## [670]	train-rmse:10.515477	test-rmse:672.418315
## [671]	train-rmse:10.486408	test-rmse:672.423082
## [672]	train-rmse:10.454477	test-rmse:672.445332
## [673]	train-rmse:10.367179	test-rmse:672.455891
## [674]	train-rmse:10.343716	test-rmse:672.466618
## [675]	train-rmse:10.294941	test-rmse:672.480982
## [676]	train-rmse:10.217547	test-rmse:672.521484
## [677]	train-rmse:10.203380	test-rmse:672.505003
## [678]	train-rmse:10.187404	test-rmse:672.485647
## [679]	train-rmse:10.111570	test-rmse:672.469210
## [680]	train-rmse:10.051574	test-rmse:672.466983
## [681]	train-rmse:10.004376	test-rmse:672.475892
## [682]	train-rmse:9.942250	test-rmse:672.568068
## [683]	train-rmse:9.901547	test-rmse:672.600737
## [684]	train-rmse:9.843817	test-rmse:672.571121
## [685]	train-rmse:9.785238	test-rmse:672.584942
## [686]	train-rmse:9.745349	test-rmse:672.572520
## [687]	train-rmse:9.664001	test-rmse:672.559404

```
## [688] train-rmse:9.621716 test-rmse:672.556454
## [689] train-rmse:9.561403 test-rmse:672.507139
## [690] train-rmse:9.548902 test-rmse:672.506909
## [691] train-rmse:9.470656 test-rmse:672.566182
## [692] train-rmse:9.462350 test-rmse:672.591255
## [693] train-rmse:9.437164 test-rmse:672.627538
## [694] train-rmse:9.414754 test-rmse:672.680687
## [695] train-rmse:9.404045 test-rmse:672.682423
## [696] train-rmse:9.371163 test-rmse:672.690756
## [697] train-rmse:9.300704 test-rmse:672.705344
## [698] train-rmse:9.290457 test-rmse:672.721666
## [699] train-rmse:9.275716 test-rmse:672.739874
## [700] train-rmse:9.233687 test-rmse:672.703482
## [701] train-rmse:9.227287 test-rmse:672.710286
## [702] train-rmse:9.185283 test-rmse:672.728439
## [703] train-rmse:9.153424 test-rmse:672.729607
## [704] train-rmse:9.092241 test-rmse:672.723148
## [705] train-rmse:8.998999 test-rmse:672.716351
## [706] train-rmse:8.925517 test-rmse:672.768227
## [707] train-rmse:8.890681 test-rmse:672.783205
## [708] train-rmse:8.861609 test-rmse:672.753947
## [709] train-rmse:8.853153 test-rmse:672.778679
## [710] train-rmse:8.794157 test-rmse:672.778680
## [711] train-rmse:8.764989 test-rmse:672.764854
## [712] train-rmse:8.748997 test-rmse:672.760780
## [713] train-rmse:8.727553 test-rmse:672.770299
## [714] train-rmse:8.671256 test-rmse:672.824077
## [715] train-rmse:8.647460 test-rmse:672.843486
## [716] train-rmse:8.597930 test-rmse:672.865719
## [717] train-rmse:8.579651 test-rmse:672.907778
## [718] train-rmse:8.538566 test-rmse:672.919426
## [719] train-rmse:8.453573 test-rmse:672.973702
## [720] train-rmse:8.396686 test-rmse:672.936648
## [721] train-rmse:8.364175 test-rmse:672.932365
## [722] train-rmse:8.313720 test-rmse:672.931334
## [723] train-rmse:8.282446 test-rmse:672.951189
## [724] train-rmse:8.230235 test-rmse:672.957477
## [725] train-rmse:8.185985 test-rmse:672.984320
## [726] train-rmse:8.113691 test-rmse:672.986649
## [727] train-rmse:8.034310 test-rmse:672.991145
## [728] train-rmse:8.028512 test-rmse:673.003483
## [729] train-rmse:8.015577 test-rmse:673.037840
## [730] train-rmse:7.964850 test-rmse:673.007121
## [731] train-rmse:7.904612 test-rmse:673.029530
## [732] train-rmse:7.872772 test-rmse:673.030199
## [733] train-rmse:7.842308 test-rmse:673.006638
## [734] train-rmse:7.822444 test-rmse:673.004199
## [735] train-rmse:7.811718 test-rmse:673.001303
## [736] train-rmse:7.753147 test-rmse:672.992178
## [737] train-rmse:7.710212 test-rmse:672.995923
## [738] train-rmse:7.672716 test-rmse:672.989842
```

```
## [739] train-rmse:7.652349 test-rmse:673.004755
## [740] train-rmse:7.630923 test-rmse:673.001590
## [741] train-rmse:7.603434 test-rmse:673.038578
## [742] train-rmse:7.564303 test-rmse:673.049325
## [743] train-rmse:7.492391 test-rmse:673.049394
## [744] train-rmse:7.443777 test-rmse:673.062568
## [745] train-rmse:7.401256 test-rmse:673.091419
## [746] train-rmse:7.387264 test-rmse:673.079161
## [747] train-rmse:7.367714 test-rmse:673.115637
## [748] train-rmse:7.326823 test-rmse:673.115865
## [749] train-rmse:7.289466 test-rmse:673.108877
## [750] train-rmse:7.248224 test-rmse:673.111431
## [751] train-rmse:7.207728 test-rmse:673.082328
## [752] train-rmse:7.164660 test-rmse:673.075295
## [753] train-rmse:7.134593 test-rmse:673.132817
## [754] train-rmse:7.089404 test-rmse:673.125014
## [755] train-rmse:7.077083 test-rmse:673.169514
## [756] train-rmse:7.061935 test-rmse:673.172542
## [757] train-rmse:7.014361 test-rmse:673.187266
## [758] train-rmse:6.972745 test-rmse:673.180970
## [759] train-rmse:6.922868 test-rmse:673.171524
## [760] train-rmse:6.886514 test-rmse:673.191664
## [761] train-rmse:6.843709 test-rmse:673.187481
## [762] train-rmse:6.834337 test-rmse:673.195260
## [763] train-rmse:6.792558 test-rmse:673.195572
## [764] train-rmse:6.757948 test-rmse:673.207112
## [765] train-rmse:6.693392 test-rmse:673.251154
## [766] train-rmse:6.678338 test-rmse:673.267565
## [767] train-rmse:6.629184 test-rmse:673.255190
## [768] train-rmse:6.602980 test-rmse:673.268353
## [769] train-rmse:6.591792 test-rmse:673.306064
## [770] train-rmse:6.545421 test-rmse:673.310223
## [771] train-rmse:6.523452 test-rmse:673.321044
## [772] train-rmse:6.483276 test-rmse:673.328509
## [773] train-rmse:6.469501 test-rmse:673.335786
## [774] train-rmse:6.444380 test-rmse:673.344422
## [775] train-rmse:6.399591 test-rmse:673.404054
## [776] train-rmse:6.328220 test-rmse:673.430746
## [777] train-rmse:6.289107 test-rmse:673.423215
## [778] train-rmse:6.258571 test-rmse:673.387850
## [779] train-rmse:6.247126 test-rmse:673.395652
## [780] train-rmse:6.226691 test-rmse:673.353401
## [781] train-rmse:6.175998 test-rmse:673.357413
## [782] train-rmse:6.172430 test-rmse:673.361567
## [783] train-rmse:6.115691 test-rmse:673.368994
## [784] train-rmse:6.084822 test-rmse:673.351104
## [785] train-rmse:6.057191 test-rmse:673.355159
## [786] train-rmse:6.037229 test-rmse:673.329079
## [787] train-rmse:6.032016 test-rmse:673.353500
## [788] train-rmse:6.008474 test-rmse:673.357762
## [789] train-rmse:5.963318 test-rmse:673.354100
```

```
## [790] train-rmse:5.954786 test-rmse:673.371269
## [791] train-rmse:5.935502 test-rmse:673.383047
## [792] train-rmse:5.907598 test-rmse:673.390092
## [793] train-rmse:5.881058 test-rmse:673.400666
## [794] train-rmse:5.875985 test-rmse:673.398211
## [795] train-rmse:5.843181 test-rmse:673.395098
## [796] train-rmse:5.826191 test-rmse:673.403008
## [797] train-rmse:5.816302 test-rmse:673.424374
## [798] train-rmse:5.800156 test-rmse:673.406492
## [799] train-rmse:5.786674 test-rmse:673.368807
## [800] train-rmse:5.752775 test-rmse:673.370472
## [801] train-rmse:5.736075 test-rmse:673.372778
## [802] train-rmse:5.707180 test-rmse:673.387942
## [803] train-rmse:5.674290 test-rmse:673.386928
## [804] train-rmse:5.663807 test-rmse:673.373831
## [805] train-rmse:5.640805 test-rmse:673.359501
## [806] train-rmse:5.634238 test-rmse:673.352484
## [807] train-rmse:5.625112 test-rmse:673.362401
## [808] train-rmse:5.613316 test-rmse:673.376651
## [809] train-rmse:5.600122 test-rmse:673.355842
## [810] train-rmse:5.586470 test-rmse:673.339073
## [811] train-rmse:5.561701 test-rmse:673.321597
## [812] train-rmse:5.549680 test-rmse:673.314563
## [813] train-rmse:5.529613 test-rmse:673.302626
## [814] train-rmse:5.522490 test-rmse:673.278548
## [815] train-rmse:5.484224 test-rmse:673.280977
## [816] train-rmse:5.465253 test-rmse:673.305355
## [817] train-rmse:5.442303 test-rmse:673.302387
## [818] train-rmse:5.405862 test-rmse:673.296085
## [819] train-rmse:5.387737 test-rmse:673.314116
## [820] train-rmse:5.356389 test-rmse:673.301272
## [821] train-rmse:5.322829 test-rmse:673.310600
## [822] train-rmse:5.294366 test-rmse:673.337070
## [823] train-rmse:5.279333 test-rmse:673.344394
## [824] train-rmse:5.243841 test-rmse:673.344538
## [825] train-rmse:5.239778 test-rmse:673.342266
## [826] train-rmse:5.221926 test-rmse:673.361354
## [827] train-rmse:5.208258 test-rmse:673.346101
## [828] train-rmse:5.202513 test-rmse:673.346440
## [829] train-rmse:5.172879 test-rmse:673.356453
## [830] train-rmse:5.128279 test-rmse:673.390313
## [831] train-rmse:5.097245 test-rmse:673.382593
## [832] train-rmse:5.079742 test-rmse:673.385408
## [833] train-rmse:5.060001 test-rmse:673.390157
## [834] train-rmse:5.038391 test-rmse:673.383898
## [835] train-rmse:5.001851 test-rmse:673.376575
## [836] train-rmse:4.998927 test-rmse:673.384809
## [837] train-rmse:4.991624 test-rmse:673.378145
## [838] train-rmse:4.958874 test-rmse:673.397204
## [839] train-rmse:4.957110 test-rmse:673.400695
## [840] train-rmse:4.953759 test-rmse:673.382514
```

```
## [841] train-rmse:4.938498 test-rmse:673.374982
## [842] train-rmse:4.918812 test-rmse:673.387967
## [843] train-rmse:4.895436 test-rmse:673.390728
## [844] train-rmse:4.853283 test-rmse:673.390948
## [845] train-rmse:4.822820 test-rmse:673.389128
## [846] train-rmse:4.808212 test-rmse:673.394969
## [847] train-rmse:4.784480 test-rmse:673.416080
## [848] train-rmse:4.779877 test-rmse:673.410085
## [849] train-rmse:4.761388 test-rmse:673.430349
## [850] train-rmse:4.739959 test-rmse:673.419054
## [851] train-rmse:4.723347 test-rmse:673.448673
## [852] train-rmse:4.712584 test-rmse:673.427938
## [853] train-rmse:4.706024 test-rmse:673.421145
## [854] train-rmse:4.692396 test-rmse:673.436895
## [855] train-rmse:4.668760 test-rmse:673.444817
## [856] train-rmse:4.621799 test-rmse:673.430040
## [857] train-rmse:4.594099 test-rmse:673.430612
## [858] train-rmse:4.585634 test-rmse:673.434259
## [859] train-rmse:4.567769 test-rmse:673.440983
## [860] train-rmse:4.557262 test-rmse:673.439778
## [861] train-rmse:4.534696 test-rmse:673.452811
## [862] train-rmse:4.523496 test-rmse:673.441666
## [863] train-rmse:4.516109 test-rmse:673.436967
## [864] train-rmse:4.502141 test-rmse:673.445036
## [865] train-rmse:4.456002 test-rmse:673.488184
## [866] train-rmse:4.394798 test-rmse:673.517843
## [867] train-rmse:4.366265 test-rmse:673.502597
## [868] train-rmse:4.338471 test-rmse:673.521219
## [869] train-rmse:4.313641 test-rmse:673.530155
## [870] train-rmse:4.266459 test-rmse:673.507758
## [871] train-rmse:4.241671 test-rmse:673.486104
## [872] train-rmse:4.212573 test-rmse:673.502766
## [873] train-rmse:4.205596 test-rmse:673.500472
## [874] train-rmse:4.175368 test-rmse:673.514043
## [875] train-rmse:4.165328 test-rmse:673.511739
## [876] train-rmse:4.153903 test-rmse:673.510447
## [877] train-rmse:4.125617 test-rmse:673.518617
## [878] train-rmse:4.088582 test-rmse:673.540591
## [879] train-rmse:4.063151 test-rmse:673.547616
## [880] train-rmse:4.047231 test-rmse:673.550139
## [881] train-rmse:4.029090 test-rmse:673.541855
## [882] train-rmse:4.006012 test-rmse:673.528869
## [883] train-rmse:3.982091 test-rmse:673.531203
## [884] train-rmse:3.976464 test-rmse:673.525710
## [885] train-rmse:3.953822 test-rmse:673.525033
## [886] train-rmse:3.932309 test-rmse:673.526847
## [887] train-rmse:3.923949 test-rmse:673.539865
## [888] train-rmse:3.904368 test-rmse:673.566171
## [889] train-rmse:3.872079 test-rmse:673.584463
## [890] train-rmse:3.856161 test-rmse:673.596205
## [891] train-rmse:3.850818 test-rmse:673.596121
```



```
## [892] train-rmse:3.829542 test-rmse:673.599377
## [893] train-rmse:3.810080 test-rmse:673.594033
## [894] train-rmse:3.784026 test-rmse:673.606097
## [895] train-rmse:3.771924 test-rmse:673.628931
## [896] train-rmse:3.746627 test-rmse:673.621494
## [897] train-rmse:3.732937 test-rmse:673.615549
## [898] train-rmse:3.709978 test-rmse:673.615305
## [899] train-rmse:3.689879 test-rmse:673.616993
## [900] train-rmse:3.679645 test-rmse:673.615553
## [901] train-rmse:3.677916 test-rmse:673.613724
## [902] train-rmse:3.653544 test-rmse:673.615627
## [903] train-rmse:3.632363 test-rmse:673.616022
## [904] train-rmse:3.614908 test-rmse:673.630389
## [905] train-rmse:3.605096 test-rmse:673.641403
## [906] train-rmse:3.586652 test-rmse:673.636383
## [907] train-rmse:3.556934 test-rmse:673.619227
## [908] train-rmse:3.535249 test-rmse:673.629800
## [909] train-rmse:3.529607 test-rmse:673.641896
## [910] train-rmse:3.525721 test-rmse:673.634779
## [911] train-rmse:3.500690 test-rmse:673.626033
## [912] train-rmse:3.470426 test-rmse:673.618377
## [913] train-rmse:3.465600 test-rmse:673.623692
## [914] train-rmse:3.454401 test-rmse:673.626470
## [915] train-rmse:3.438968 test-rmse:673.615464
## [916] train-rmse:3.420844 test-rmse:673.609810
## [917] train-rmse:3.396350 test-rmse:673.636507
## [918] train-rmse:3.374398 test-rmse:673.645021
## [919] train-rmse:3.355075 test-rmse:673.646690
## [920] train-rmse:3.344875 test-rmse:673.646489
## [921] train-rmse:3.336728 test-rmse:673.657234
## [922] train-rmse:3.317130 test-rmse:673.651271
## [923] train-rmse:3.287614 test-rmse:673.650353
## [924] train-rmse:3.272855 test-rmse:673.620155
## [925] train-rmse:3.270836 test-rmse:673.622121
## [926] train-rmse:3.253255 test-rmse:673.640492
## [927] train-rmse:3.251272 test-rmse:673.636794
## [928] train-rmse:3.249804 test-rmse:673.638233
## [929] train-rmse:3.242239 test-rmse:673.632571
## [930] train-rmse:3.224187 test-rmse:673.637018
## [931] train-rmse:3.209885 test-rmse:673.638887
## [932] train-rmse:3.173524 test-rmse:673.674633
## [933] train-rmse:3.157430 test-rmse:673.701304
## [934] train-rmse:3.119644 test-rmse:673.702118
## [935] train-rmse:3.101102 test-rmse:673.721174
## [936] train-rmse:3.089493 test-rmse:673.737808
## [937] train-rmse:3.061996 test-rmse:673.746312
## [938] train-rmse:3.054586 test-rmse:673.749230
## [939] train-rmse:3.036004 test-rmse:673.738880
## [940] train-rmse:3.017714 test-rmse:673.753111
## [941] train-rmse:3.003461 test-rmse:673.757747
## [942] train-rmse:2.992651 test-rmse:673.774215
```

```
## [943] train-rmse:2.982112 test-rmse:673.768770
## [944] train-rmse:2.968516 test-rmse:673.774495
## [945] train-rmse:2.961010 test-rmse:673.784546
## [946] train-rmse:2.946615 test-rmse:673.795135
## [947] train-rmse:2.931095 test-rmse:673.793938
## [948] train-rmse:2.921222 test-rmse:673.822788
## [949] train-rmse:2.915758 test-rmse:673.818642
## [950] train-rmse:2.897244 test-rmse:673.823774
## [951] train-rmse:2.887563 test-rmse:673.815421
## [952] train-rmse:2.872548 test-rmse:673.809098
## [953] train-rmse:2.855244 test-rmse:673.812587
## [954] train-rmse:2.825535 test-rmse:673.812593
## [955] train-rmse:2.805207 test-rmse:673.811016
## [956] train-rmse:2.789086 test-rmse:673.845056
## [957] train-rmse:2.775518 test-rmse:673.847146
## [958] train-rmse:2.762399 test-rmse:673.848803
## [959] train-rmse:2.744209 test-rmse:673.843728
## [960] train-rmse:2.733713 test-rmse:673.846038
## [961] train-rmse:2.711741 test-rmse:673.844228
## [962] train-rmse:2.701286 test-rmse:673.844108
## [963] train-rmse:2.692216 test-rmse:673.844357
## [964] train-rmse:2.682219 test-rmse:673.845211
## [965] train-rmse:2.673336 test-rmse:673.859889
## [966] train-rmse:2.655346 test-rmse:673.856586
## [967] train-rmse:2.642512 test-rmse:673.854996
## [968] train-rmse:2.620716 test-rmse:673.869005
## [969] train-rmse:2.617786 test-rmse:673.871376
## [970] train-rmse:2.616171 test-rmse:673.866794
## [971] train-rmse:2.596478 test-rmse:673.875766
## [972] train-rmse:2.584962 test-rmse:673.880339
## [973] train-rmse:2.574630 test-rmse:673.888960
## [974] train-rmse:2.567684 test-rmse:673.889667
## [975] train-rmse:2.566325 test-rmse:673.890107
## [976] train-rmse:2.556200 test-rmse:673.892981
## [977] train-rmse:2.535480 test-rmse:673.916273
## [978] train-rmse:2.525640 test-rmse:673.917590
## [979] train-rmse:2.518694 test-rmse:673.929335
## [980] train-rmse:2.506003 test-rmse:673.936370
## [981] train-rmse:2.496922 test-rmse:673.939695
## [982] train-rmse:2.479899 test-rmse:673.949020
## [983] train-rmse:2.472667 test-rmse:673.938812
## [984] train-rmse:2.465353 test-rmse:673.934797
## [985] train-rmse:2.453830 test-rmse:673.946359
## [986] train-rmse:2.445554 test-rmse:673.947327
## [987] train-rmse:2.441706 test-rmse:673.944572
## [988] train-rmse:2.438891 test-rmse:673.950740
## [989] train-rmse:2.428770 test-rmse:673.951231
## [990] train-rmse:2.410818 test-rmse:673.950054
## [991] train-rmse:2.394088 test-rmse:673.953171
## [992] train-rmse:2.379902 test-rmse:673.960288
## [993] train-rmse:2.364100 test-rmse:673.961768
```

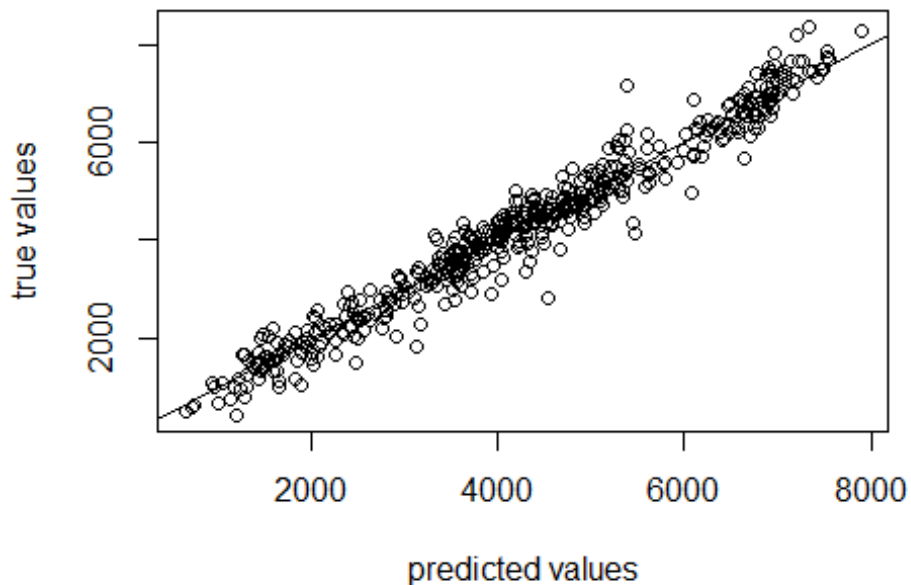
```
## [994]    train-rmse:2.353947 test-rmse:673.964916
## [995]    train-rmse:2.338375 test-rmse:673.971266
## [996]    train-rmse:2.332695 test-rmse:673.966899
## [997]    train-rmse:2.323624 test-rmse:673.969360
## [998]    train-rmse:2.316842 test-rmse:673.971371
## [999]    train-rmse:2.303906 test-rmse:673.962400
## [1000]   train-rmse:2.287694 test-rmse:673.963848
```

```
final = xgboost(data = xgb_train, max.depth = 3, nrounds = 41, verbose = 0)
```

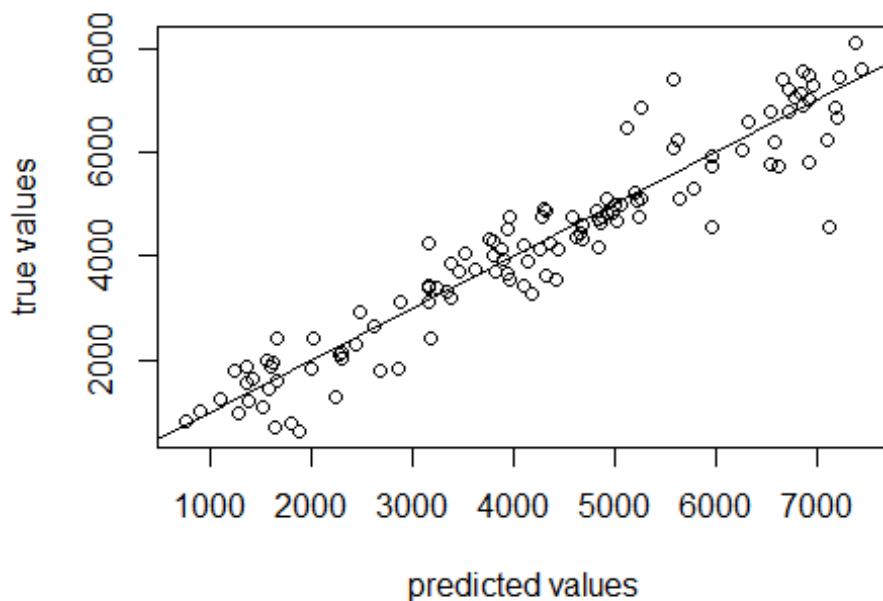
```
predictboosttrain <- predict(final, newdata=trainx)
```

```
predictboostval <- predict(final, newdata=valx)
```

```
plot(predictboosttrain, trainy, xlab="predicted values", ylab="true values")
abline(0,1)
```



```
plot(predictboostval, valy, xlab="predicted values", ylab="true values")
abline(0,1)
```



The iteration that leads to the lowest values of rmse was 41 and the predicted values appears well correlated to the true values in both train and validation set.

```
test <- read.csv(file.choose())
rownames(test) <- test$ID
test <- test[,2:12]
test2 <- test[2:11]
testx <- data.matrix(test2[,1:10])
test$total_rental <- predict(final, newdata=testx)

library(ggplot2)
train$dteday <- as.Date(train$dteday, format = "%d-%m-%y")
trainrental <- ggplot(train, aes(x=dteday, y=total_rental)) +geom_line()
test$dteday <- as.Date(test$dteday, format = "%d-%m-%y")
testrental <- ggplot(test, aes(x=dteday, y=total_rental)) +geom_line()
library(gridExtra)

grid.arrange(trainrental, testrental)
```

