MVA_Project5.R

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```
###### Applying Multiple Regression Analysis ######

#Getting working directory
getwd()
```

```
## [1] "/Users/thindprateek/Desktop/Multivariate Analysis"
```

```
#Setting directory to load data set
setwd("/Users/thindprateek/Desktop/Multivariate Analysis")

#Reading the data into a data frame
#df <- read.csv(file = 'US_Acc_June20.csv')
num <- read.csv(file = 'num.csv')
# Performing clustering on the first 500 records for now to achieve easy and quick results and test the
attach(num)
# Printing first few columns of data set for inference
#head(df)

## Setting random seed to shuffle data before splitting
set.seed(23)

#Checking number of rows
#rows<-sample(nrow(df))

#Shuffling the data
#mva<-df[rows,]

#Taking the required number of instances from the shuffled data to reduce any biases
#mva<-mva[950000:1000000,]

#Checking the structure of the data set
#str(mva)

# Checking the number of rows and columns in the current uncleaned dataset
#ncol(mva)
#nrow(mva)

# Printing all the column names to find and filter the relevant and irrelevant attributes
#names<-names(mva)
#names
```

```
## DATA CLEANING ##

#Dropping the surplus attributes which do not contribute to the analysis
#mva <- mva[-c(1:3,7:10,13,14,19,21:23,33,47:49)]

#Checking for any null values in the present data set
# is.na(mva[,])

#Checking which rows have all the values filled and complete
# complete.cases(mva)

#Making a new dataframe with only the rows that have complete information and all values filled
#Mva<-na.omit(mva)
#Mva<-Mva[!(is.na(Mva$Sunrise_Sunset) | Mva$Sunrise_Sunset==""), ]
#Mva<- Mva[complete.cases(Mva),]
#Verifying for missing values in the new dataframe
#complete.cases(Mva)
#unique(Mva$Sunrise_Sunset)

# Creating new dataframe with only the numerical attributes to perform statistical functions
#num<-Mva[,c(1,4,11:15,17,18)]
#write.csv(num,"/Users/mihikagupta/Desktop/SEM_2/MVA/num.csv", row.names = FALSE)

# Scaling the new data set for better accuracies
# num<-scale(num)

# Checking the dimensions of the data
nrow(num)
```

```
## [1] 18250
```

```
ncol(num)
```

```
## [1] 9
```

```
names(num)
```

```
## [1] "Severity"          "Distance.mi."      "Temperature.F."
## [4] "Wind_Chill.F."     "Humidity..."       "Pressure.in."
## [7] "Visibility.mi."    "Wind_Speed.mph."   "Precipitation.in."
```

```
names(num)[names(num) == "Distance.mi."] <- "dist"
names(num)[names(num) == "Temperature.F."] <- "temp"
names(num)[names(num) == "Wind_Chill.F."] <- "windchill"
names(num)[names(num) == "Humidity..."] <- "humidity"
names(num)[names(num) == "Pressure.in."] <- "pressure"
names(num)[names(num) == "Visibility.mi."] <- "visibility"
names(num)[names(num) == "Wind_Speed.mph."] <- "windspeed"
names(num)[names(num) == "Precipitation.in."] <- "precip"
names(num)
```

```
## [1] "Severity"   "dist"       "temp"       "windchill"  "humidity"
## [6] "pressure"   "visibility" "windspeed"  "precip"
```

```r
# finding covariance,Covariance measures the linear relationship between two variables. ... The correla
cov(num)
```

```
##                Severity          dist          temp     windchill     humidity
## Severity    0.310236580  0.1670840167   -0.35171651   -0.47620943    0.6439822
## dist        0.167084017  2.4204304155   -0.46482491   -0.64706455    0.5613710
## temp       -0.351716514 -0.4648249146  354.39442593  397.07844765 -185.2055863
## windchill  -0.476209435 -0.6470645543  397.07844765  450.54026468 -200.8257533
## humidity    0.643982246  0.5613709540 -185.20558632 -200.82575330  530.2655286
## pressure   -0.005748438 -0.0567534649    1.01969027    1.16018376    5.2382330
## visibility -0.049013351 -0.1056278936   16.89140979   19.68781198  -27.8803082
## windspeed   0.143762668  0.1759889303   -1.21123799   -7.64665928  -18.3282076
## precip      0.001178471  0.0004767836   -0.05005218   -0.05860904    0.1685233
##                pressure   visibility    windspeed        precip
## Severity   -0.005748438  -0.04901335   0.14376267  0.0011784711
## dist       -0.056753465  -0.10562789   0.17598893  0.0004767836
## temp        1.019690266  16.89140979  -1.21123799 -0.0500521830
## windchill   1.160183765  19.68781198  -7.64665928 -0.0586090372
## humidity    5.238233012 -27.88030819 -18.32820757  0.1685233120
## pressure    1.319215237  -0.28537521  -0.29431416  0.0015056899
## visibility -0.285375212   8.02960442  -0.42228979 -0.0303542240
## windspeed  -0.294314160  -0.42228979  29.19965932  0.0161919228
## precip      0.001505690  -0.03035422   0.01619192  0.0070357365
```

```r
# here we find that the highest covariances with severity in either directions, positive or negative ar

# Performing multiple regression on  dataset
fit<-lm(Severity~dist+temp+windchill+humidity,data = num)

# showing results
summary(fit)
```

```
##
## Call:
## lm(formula = Severity ~ dist + temp + windchill + humidity, data = num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.6912 -0.2745 -0.2413  0.5915  1.8145
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.0659506  0.0292263  70.688  < 2e-16 ***
## dist         0.0679376  0.0025946  26.184  < 2e-16 ***
## temp         0.0160049  0.0019505   8.205 2.45e-16 ***
## windchill   -0.0145144  0.0017157  -8.460  < 2e-16 ***
## humidity     0.0012356  0.0001955   6.319 2.70e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5449 on 18245 degrees of freedom
## Multiple R-squared:  0.04329,    Adjusted R-squared:  0.04308
## F-statistic: 206.4 on 4 and 18245 DF,  p-value: < 2.2e-16
```

```r
coefficients(fit)
```

```
##  (Intercept)         dist         temp    windchill     humidity
##  2.065950617  0.067937558  0.016004929 -0.014514415  0.001235566
```

```r
# plotting the scatterplot matrix
library(ggplot2)
require(GGally)
```

```
## Loading required package: GGally
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```r
# ggpairs(data=num,title = "US Accidents Data")

# confidence levels
confint(fit,level=0.95)
```

```
##                    2.5 %       97.5 %
## (Intercept)  2.008664227  2.123237007
## dist         0.062851860  0.073023256
## temp         0.012181739  0.019828119
## windchill   -0.017877309 -0.011151520
## humidity     0.000852287  0.001618845
```

```r
# Predicted Values
fit_values<-fitted(fit)
res<-residuals(fit)

# ANOVA Table
anova(fit)
```

```
## Analysis of Variance Table
##
## Response: Severity
##              Df Sum Sq Mean Sq F value    Pr(>F)
## dist          1  210.5 210.483 709.001 < 2.2e-16 ***
## temp          1    5.3   5.262  17.725 2.565e-05 ***
## windchill     1   17.5  17.480  58.882 1.758e-14 ***
## humidity      1   11.9  11.853  39.926 2.699e-10 ***
## Residuals 18245 5416.4   0.297
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
vcov(fit)
```

```
##                (Intercept)          dist          temp     windchill
## (Intercept)  8.541794e-04 -3.435445e-07 -3.888329e-05  3.028434e-05
```

```
## dist        -3.435445e-07  6.732050e-06 -1.738325e-07  1.595721e-07
## temp        -3.888329e-05 -1.738325e-07  3.804504e-06 -3.321667e-06
## windchill    3.028434e-05  1.595721e-07 -3.321667e-06  2.943559e-06
## humidity    -4.117036e-06 -7.407106e-09  7.097681e-08 -4.552161e-08
##                  humidity
## (Intercept) -4.117036e-06
## dist        -7.407106e-09
## temp         7.097681e-08
## windchill   -4.552161e-08
## humidity     3.823631e-08
```

```
cov2cor(vcov(fit))
```

```
##              (Intercept)         dist        temp   windchill    humidity
## (Intercept)  1.000000000 -0.004530382 -0.68208648  0.60395855 -0.72039741
## dist        -0.004530382  1.000000000 -0.03434854  0.03584652 -0.01459946
## temp        -0.682086482 -0.034348542  1.00000000 -0.99259204  0.18609276
## windchill    0.603958553  0.035846523 -0.99259204  1.00000000 -0.13568857
## humidity    -0.720397413 -0.014599464  0.18609276 -0.13568857  1.00000000
```

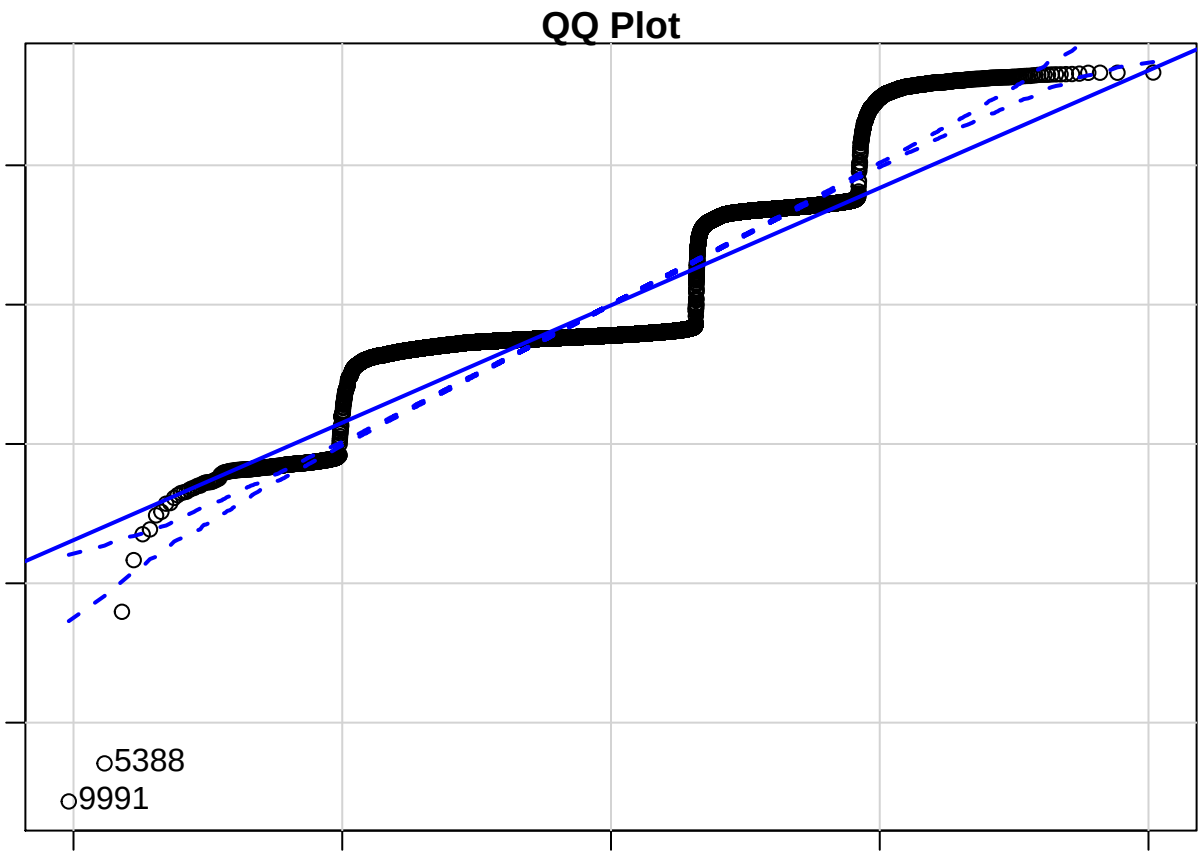
```
# Measure influence
temp <- influence.measures(fit)
# View(temp)

# Assessing Outliers
library(car)
```

```
## Loading required package: carData
```

```
outlierTest(fit)
```

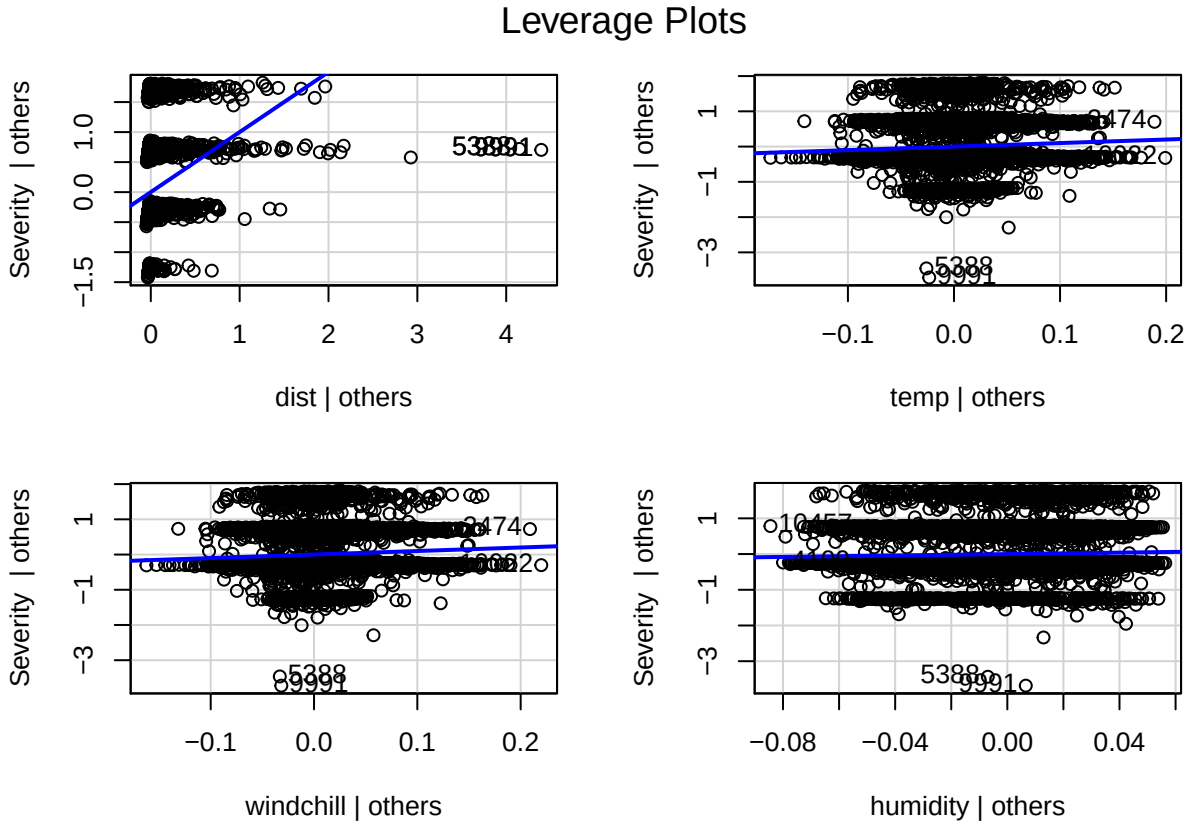
```
##       rstudent unadjusted p-value Bonferroni p
## 9991 -7.131187         1.0323e-12   1.8840e-08
## 5388 -6.585259         4.6648e-11   8.5132e-07
```

```
par(mar=c(1,1,1,1))
qqPlot(fit, main="QQ Plot")
```

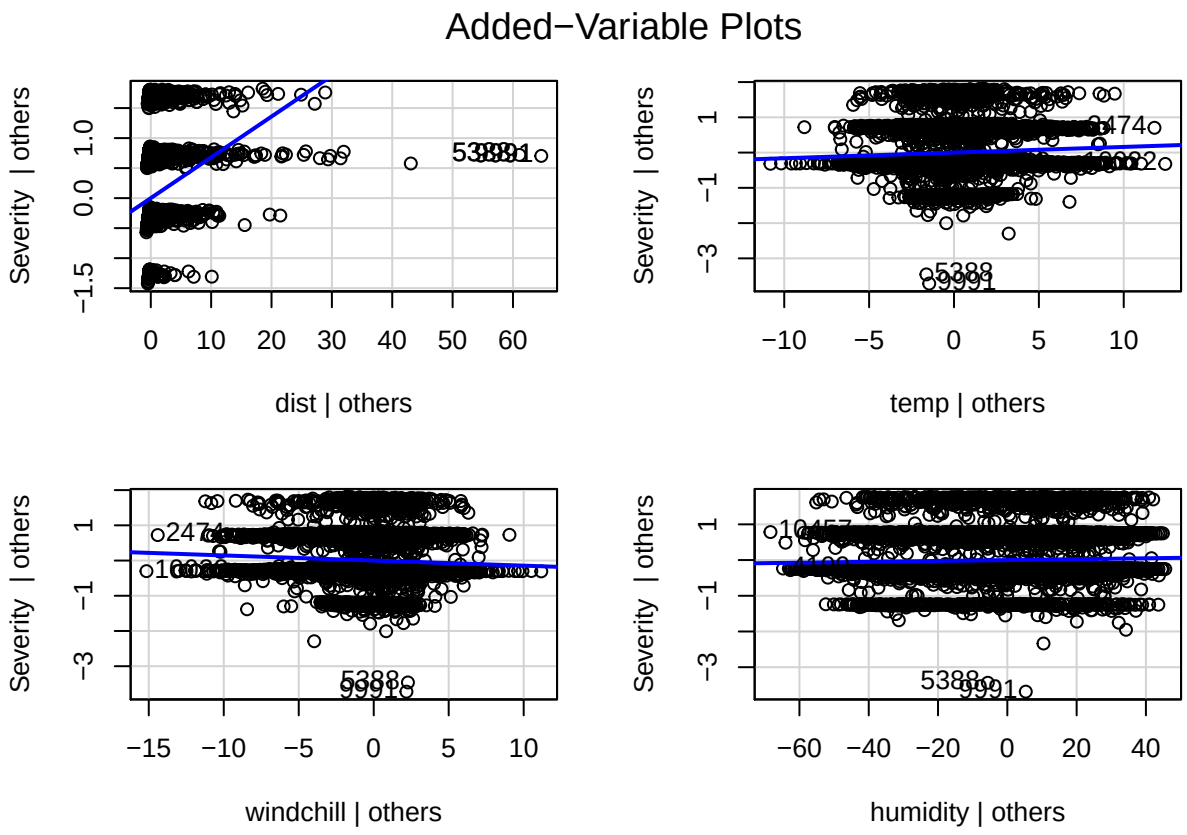



```
## [1] 5388 9991
```

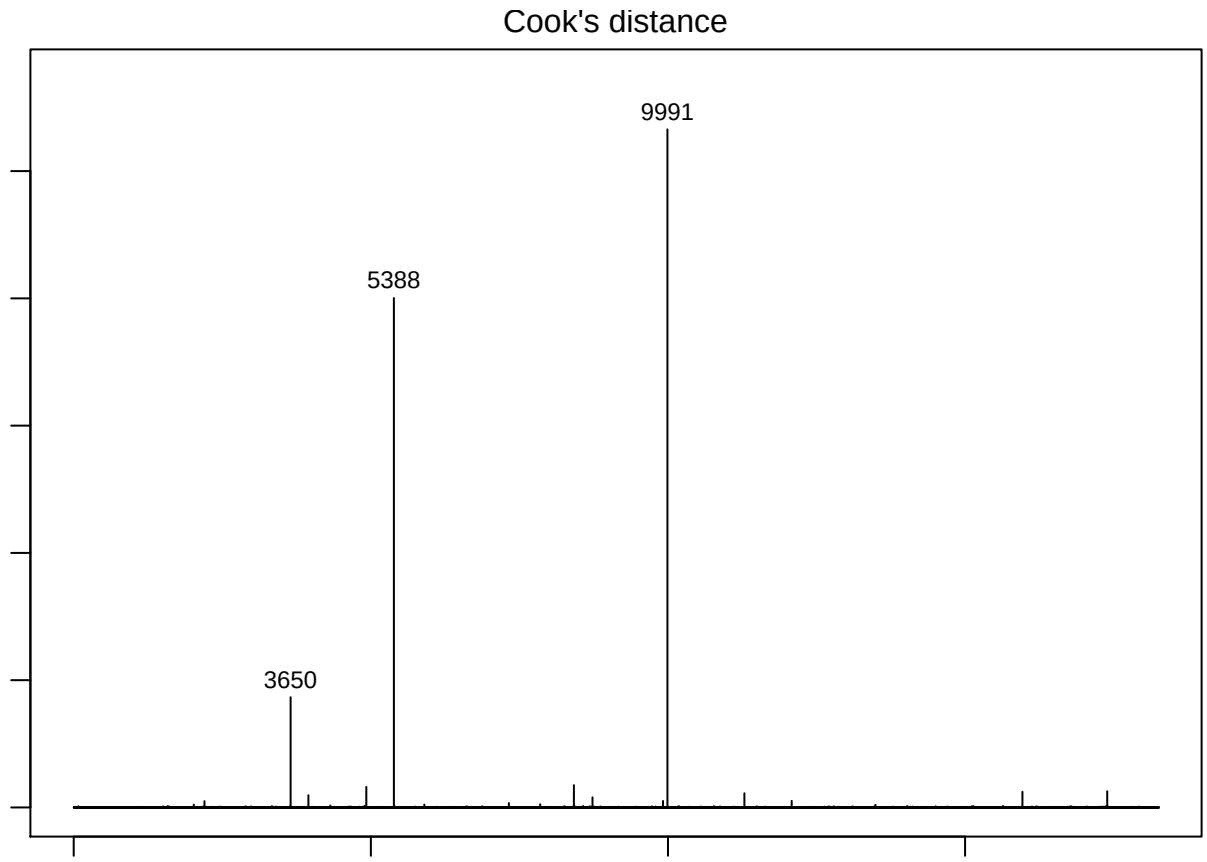
```
leveragePlots(fit) # leverage plots
```




```
# Influential Observations
# added variable plots
avPlots(fit)
```

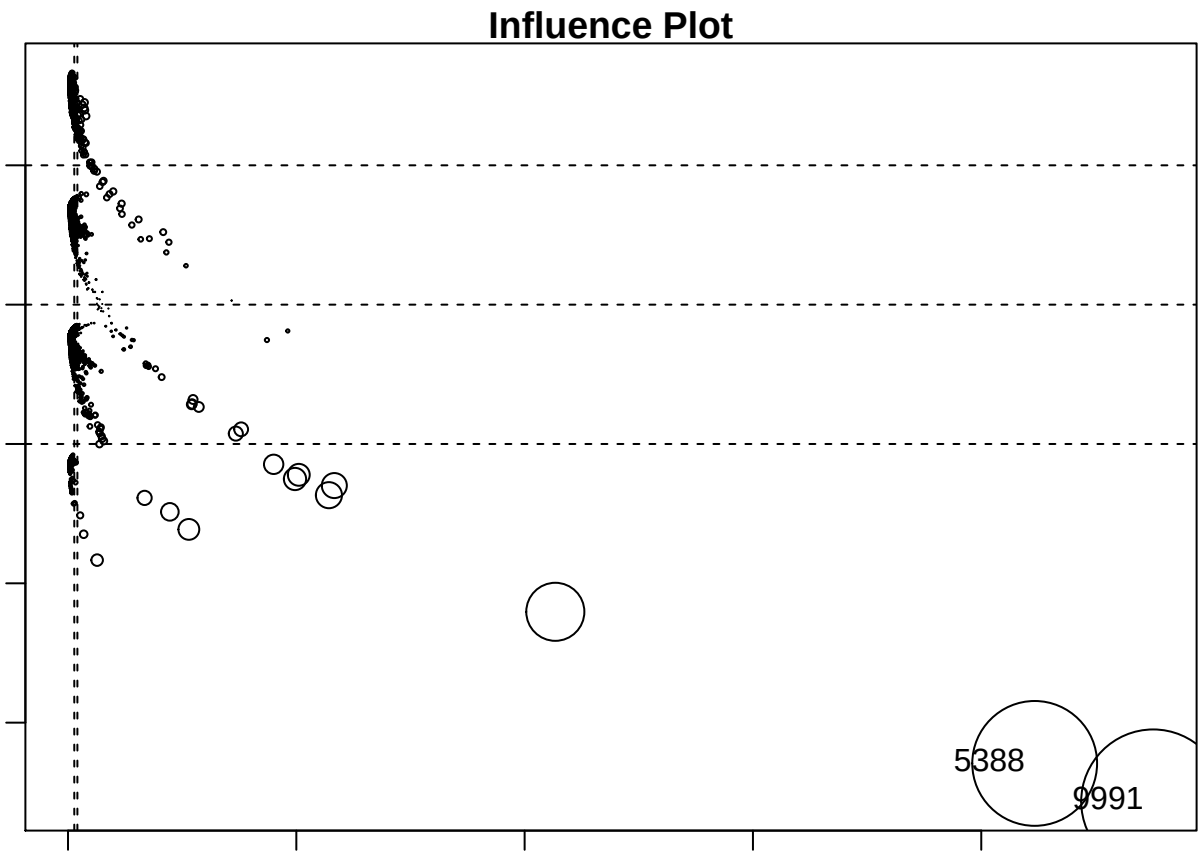



```
# Cook's D plot
# identify D values > 4/(n-k-1)
cutoff <- 4/((nrow(num)-length(fit$coefficients)-2))
plot(fit, which=4, cook.levels=cutoff)
```



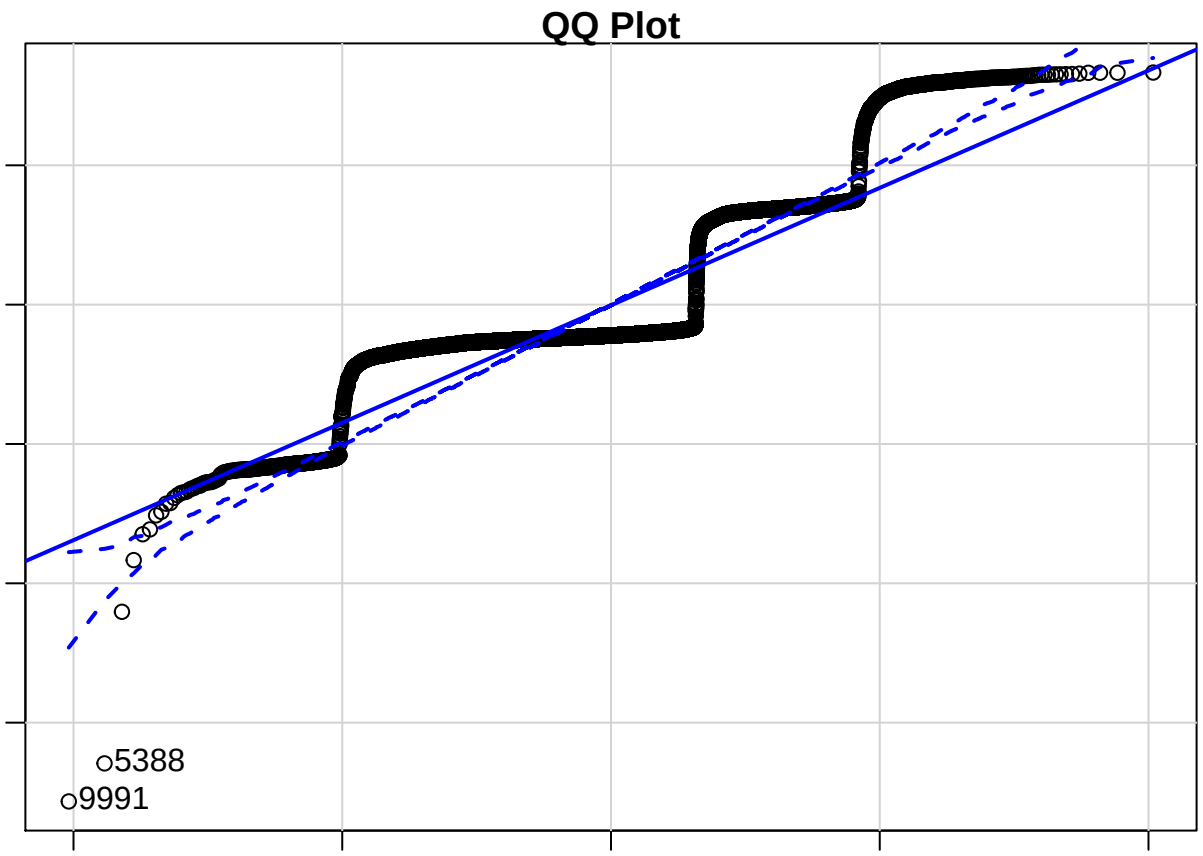

```
# Influence Plot
influencePlot(fit, id.method="identify", main="Influence Plot", sub="Circle size is proportial to Cook's
```

```
## Warning in plot.window(...): "id.method" is not a graphical parameter

## Warning in plot.xy(xy, type, ...): "id.method" is not a graphical parameter

## Warning in axis(side = side, at = at, labels = labels, ...): "id.method" is not
## a graphical parameter

## Warning in axis(side = side, at = at, labels = labels, ...): "id.method" is not
## a graphical parameter

## Warning in box(...): "id.method" is not a graphical parameter

## Warning in title(...): "id.method" is not a graphical parameter

## Warning in plot.xy(xy.coords(x, y), type = type, ...): "id.method" is not a
## graphical parameter
```



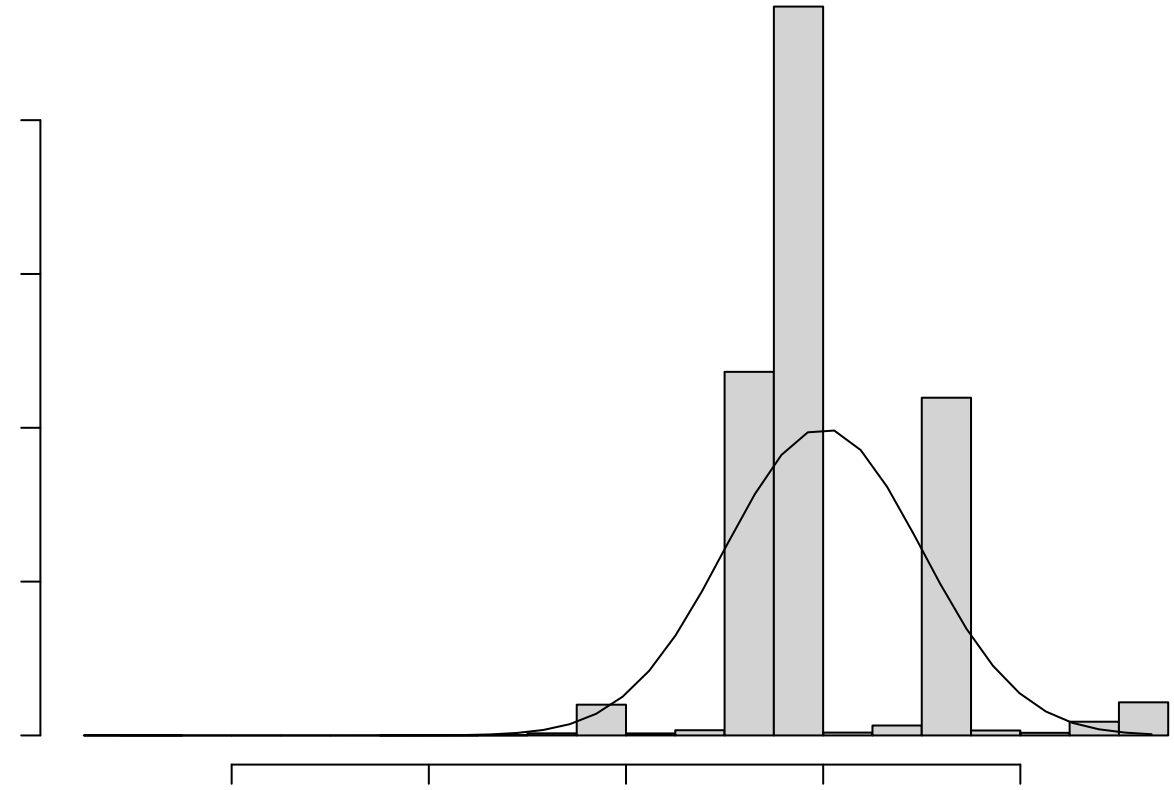

```
##        StudRes        Hat     CookD
## 5388 -6.585259 0.08468002 0.8005278
## 9991 -7.131187 0.09506396 1.0655322
```

```
# Normality of Residuals
# qq plot for studentized resid
qqPlot(fit, main="QQ Plot")
```




```
## [1] 5388 9991
```

```
# distribution of studentized residuals
library(MASS)
sresid <- studres(fit)
hist(sresid, freq=FALSE,
     main="Distribution of Studentized Residuals")
xfit<-seq(min(sresid),max(sresid),length=40)
yfit<-dnorm(xfit)
lines(xfit, yfit)
```

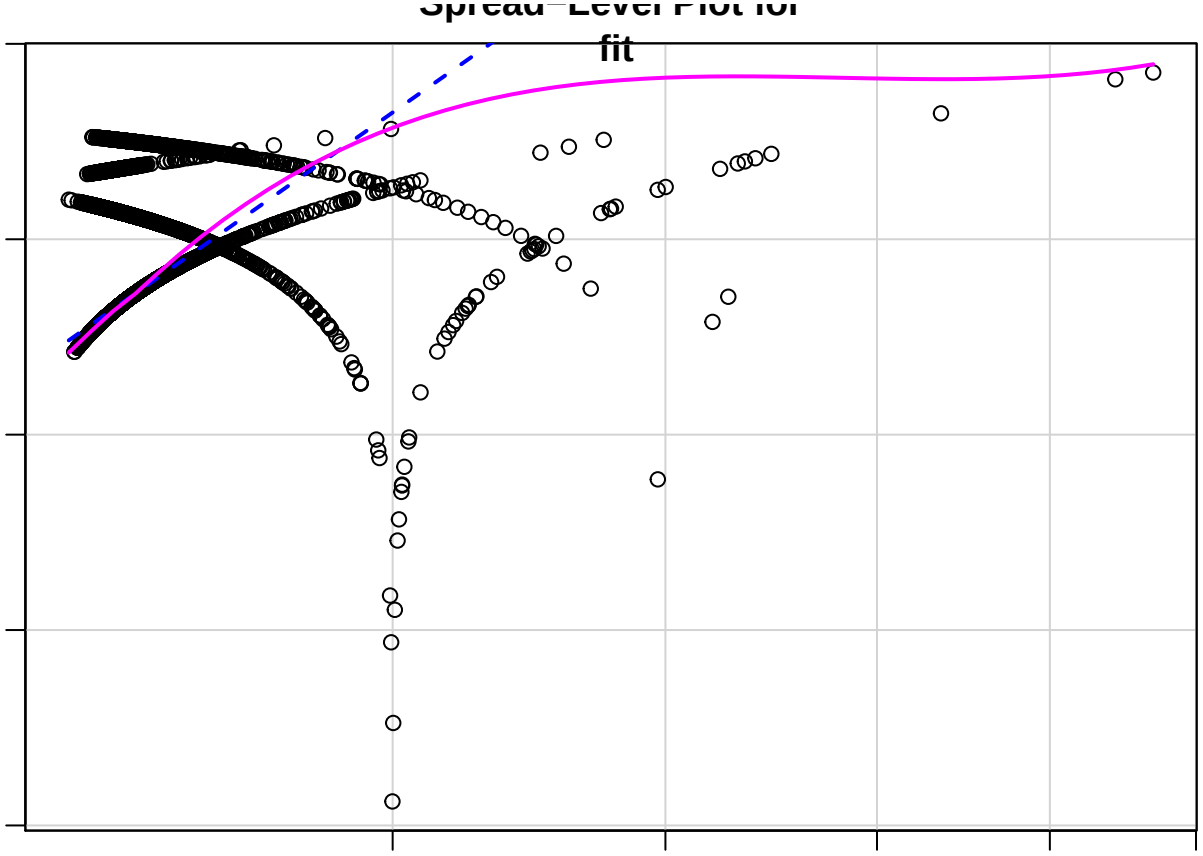



```
#Non-constant Error Variance
# Evaluate homoscedasticity
# non-constant error variance test
ncvTest(fit)
```

```
## Non-constant Variance Score Test
## Variance formula: ~ fitted.values
## Chisquare = 1688.63, Df = 1, p = < 2.22e-16
```

```
# plot studentized residuals vs. fitted values
spreadLevelPlot(fit)
```

```
## Warning in rlm.default(x, y, weights, method = method, wt.method = wt.method, :
## 'rlm' failed to converge in 20 steps
```




```
##
## Suggested power transformation:  -6.861469
```

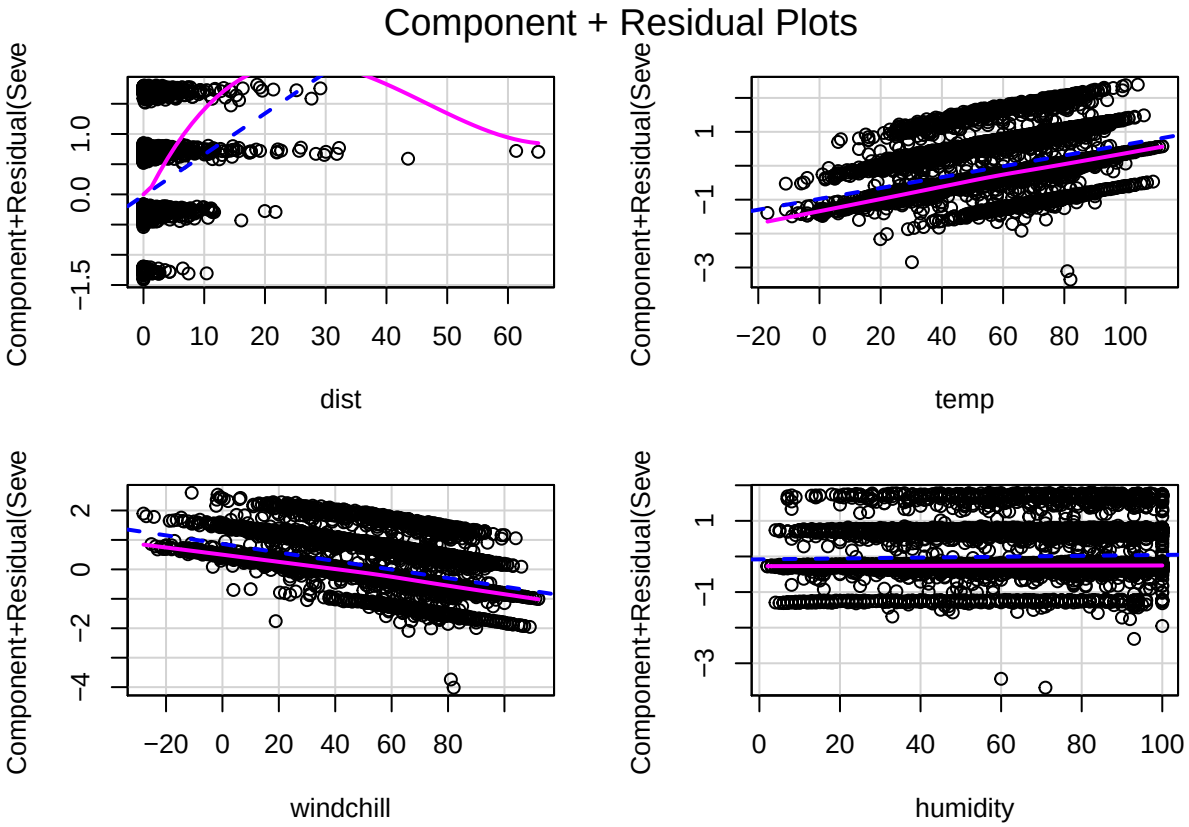
```
#Multi-collinearity
# Evaluate Collinearity
vif(fit) # variance inflation factors
```

```
##      dist      temp windchill  humidity
##  1.001636 82.880956 81.522254  1.246348
```

```
sqrt(vif(fit)) > 2 # problem?
```

```
##      dist      temp windchill  humidity
##     FALSE      TRUE      TRUE     FALSE
```

```
#Nonlinearity
# component + residual plot
crPlots(fit)
```




```
# Ceres plots
#ceresPlots(fit)

#Non-independence of Errors
# Test for Autocorrelated Errors
durbinWatsonTest(fit)
```

```
##  lag Autocorrelation D-W Statistic p-value
##    1     -0.01955319      2.039079   0.006
##  Alternative hypothesis: rho != 0
```

```
# Global test of model assumptions
library(gvlma)
gvmodel <- gvlma(fit)
summary(gvmodel)
```

```
##
## Call:
## lm(formula = Severity ~ dist + temp + windchill + humidity, data = num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.6912 -0.2745 -0.2413  0.5915  1.8145
##
## Coefficients:
```

```
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.0659506  0.0292263  70.688  < 2e-16 ***
## dist         0.0679376  0.0025946  26.184  < 2e-16 ***
## temp         0.0160049  0.0019505   8.205 2.45e-16 ***
## windchill   -0.0145144  0.0017157  -8.460  < 2e-16 ***
## humidity     0.0012356  0.0001955   6.319 2.70e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5449 on 18245 degrees of freedom
## Multiple R-squared:  0.04329,    Adjusted R-squared:  0.04308
## F-statistic: 206.4 on 4 and 18245 DF,  p-value: < 2.2e-16
##
##
## ASSESSMENT OF THE LINEAR MODEL ASSUMPTIONS
## USING THE GLOBAL TEST ON 4 DEGREES-OF-FREEDOM:
## Level of Significance =  0.05
##
## Call:
##  gvlma(x = fit)
##
##                       Value p-value                   Decision
## Global Stat        5090.7088   0.000 Assumptions NOT satisfied!
## Skewness           3260.7930   0.000 Assumptions NOT satisfied!
## Kurtosis           1512.2197   0.000 Assumptions NOT satisfied!
## Link Function       317.1380   0.000 Assumptions NOT satisfied!
## Heteroscedasticity    0.5581   0.455    Assumptions acceptable.
```

```
fit
```

```
##
## Call:
## lm(formula = Severity ~ dist + temp + windchill + humidity, data = num)
##
## Coefficients:
## (Intercept)         dist         temp    windchill     humidity
##    2.065951     0.067938     0.016005    -0.014514     0.001236
```

```
summary(fit)
```

```
##
## Call:
## lm(formula = Severity ~ dist + temp + windchill + humidity, data = num)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -3.6912 -0.2745 -0.2413  0.5915  1.8145
##
## Coefficients:
##               Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.0659506  0.0292263  70.688  < 2e-16 ***
## dist         0.0679376  0.0025946  26.184  < 2e-16 ***
## temp         0.0160049  0.0019505   8.205 2.45e-16 ***
```

```
## windchill   -0.0145144  0.0017157  -8.460  < 2e-16 ***
## humidity     0.0012356  0.0001955   6.319 2.70e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5449 on 18245 degrees of freedom
## Multiple R-squared:  0.04329,    Adjusted R-squared:  0.04308
## F-statistic: 206.4 on 4 and 18245 DF,  p-value: < 2.2e-16
```

```
fit1 <- fit
fit2 <- lm(Severity ~ dist+temp+windchill, data = num)

# compare models
anova(fit1, fit2)
```

```
## Analysis of Variance Table
##
## Model 1: Severity ~ dist + temp + windchill + humidity
## Model 2: Severity ~ dist + temp + windchill
##   Res.Df    RSS Df Sum of Sq      F    Pr(>F)
## 1  18245 5416.4
## 2  18246 5428.3 -1   -11.853 39.926 2.699e-10 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
step <- stepAIC(fit, direction="both")
```

```
## Start:  AIC=-22158.79
## Severity ~ dist + temp + windchill + humidity
##
##             Df Sum of Sq    RSS    AIC
## <none>                   5416.4 -22159
## - humidity   1    11.853 5428.3 -22121
## - temp       1    19.988 5436.4 -22094
## - windchill  1    21.247 5437.7 -22089
## - dist       1   203.536 5620.0 -21488
```

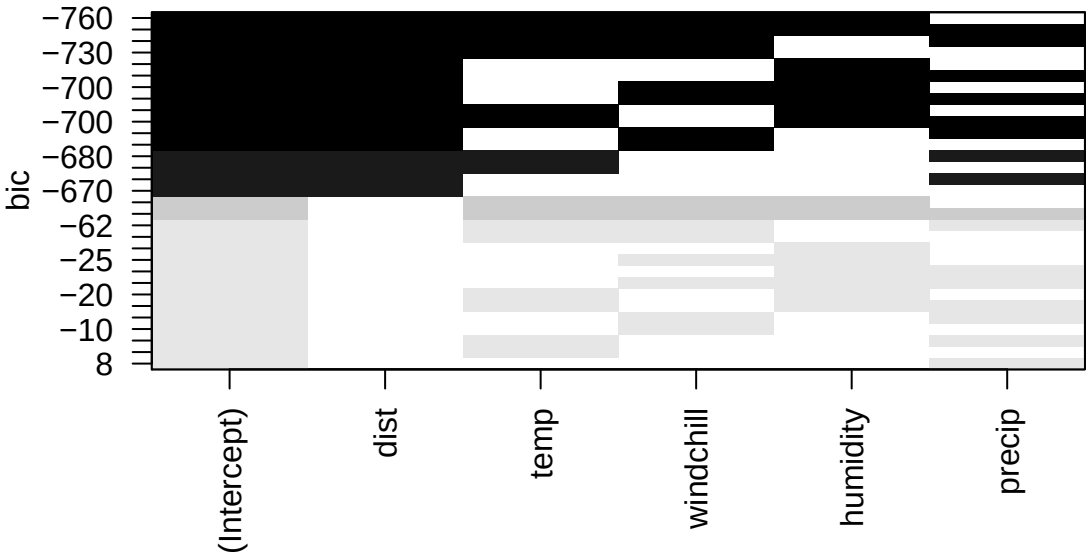
```
step$anova # display results
```

```
## Stepwise Model Path
## Analysis of Deviance Table
##
## Initial Model:
## Severity ~ dist + temp + windchill + humidity
##
## Final Model:
## Severity ~ dist + temp + windchill + humidity
##
##
##   Step Df Deviance Resid. Df Resid. Dev       AIC
## 1                     18245   5416.429 -22158.79
```

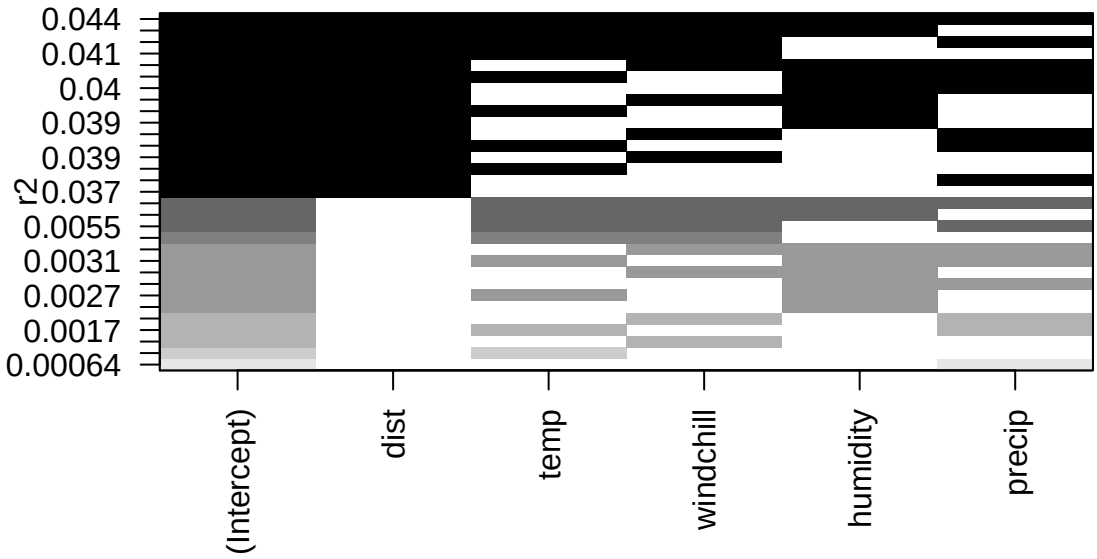
```r
library(leaps)
leaps<-regsubsets(Severity~dist+temp+windchill+humidity+precip,data=num,nbest=10)

# view results
summary(leaps)
```

```
## Subset selection object
## Call: regsubsets.formula(Severity ~ dist + temp + windchill + humidity +
##     precip, data = num, nbest = 10)
## 5 Variables  (and intercept)
##           Forced in Forced out
## dist          FALSE      FALSE
## temp          FALSE      FALSE
## windchill     FALSE      FALSE
## humidity      FALSE      FALSE
## precip        FALSE      FALSE
## 10 subsets of each size up to 5
## Selection Algorithm: exhaustive
##           dist temp windchill humidity precip
## 1  ( 1 )  "*"  " "  " "       " "      " "
## 1  ( 2 )  " "  " "  " "       "*"      " "
## 1  ( 3 )  " "  " "  "*"       " "      " "
## 1  ( 4 )  " "  "*"  " "       " "      " "
## 1  ( 5 )  " "  " "  " "       " "      "*"
## 2  ( 1 )  "*"  " "  " "       "*"      " "
## 2  ( 2 )  "*"  " "  "*"       " "      " "
## 2  ( 3 )  "*"  "*"  " "       " "      " "
## 2  ( 4 )  "*"  " "  " "       " "      "*"
## 2  ( 5 )  " "  "*"  "*"       " "      " "
## 2  ( 6 )  " "  " "  "*"       "*"      " "
## 2  ( 7 )  " "  " "  " "       "*"      "*"
## 2  ( 8 )  " "  "*"  " "       "*"      " "
## 2  ( 9 )  " "  " "  "*"       " "      "*"
## 2  ( 10 ) " "  "*"  " "       " "      "*"
## 3  ( 1 )  "*"  "*"  "*"       " "      " "
## 3  ( 2 )  "*"  " "  " "       "*"      "*"
## 3  ( 3 )  "*"  " "  "*"       "*"      " "
## 3  ( 4 )  "*"  "*"  " "       "*"      " "
## 3  ( 5 )  "*"  " "  "*"       " "      "*"
## 3  ( 6 )  "*"  "*"  " "       " "      "*"
## 3  ( 7 )  " "  "*"  "*"       "*"      " "
## 3  ( 8 )  " "  "*"  "*"       " "      "*"
## 3  ( 9 )  " "  " "  "*"       "*"      "*"
## 3  ( 10 ) " "  "*"  " "       "*"      "*"
## 4  ( 1 )  "*"  "*"  "*"       "*"      " "
## 4  ( 2 )  "*"  "*"  "*"       " "      "*"
## 4  ( 3 )  "*"  " "  "*"       "*"      "*"
## 4  ( 4 )  "*"  "*"  " "       "*"      "*"
## 4  ( 5 )  " "  "*"  "*"       "*"      "*"
## 5  ( 1 )  "*"  "*"  "*"       "*"      "*"
```

```
# plot a table of models showing variables in each model.
# models are ordered by the selection statistic.
plot(leaps)
```




```
plot(leaps,scale="r2")
```




```
# subsets(leaps, statistic="rsq")
```