Regression

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Regression:

What is Our Data?

This notebook explores song data from Kaggle (https://www.kaggle.com/datasets/budincsevity/szeged-weather). In particular, this is a Hungary dataset.

Exploring Our Data

Load the weatherHistory.csv file.

```
df <- read.csv("weatherHistory.csv")
#df_temp <- df
str(df)
```

```
## 'data.frame':    96453 obs. of  12 variables:
##  $ Formatted.Date          : chr  "2006-04-01 00:00:00.000 +0200" "2006-04-01 01:00:00.000 +0
200" "2006-04-01 02:00:00.000 +0200" "2006-04-01 03:00:00.000 +0200" ...
##  $ Summary                 : chr  "Partly Cloudy" "Partly Cloudy" "Mostly Cloudy" "Partly Clo
udy" ...
##  $ Precip.Type             : chr  "rain" "rain" "rain" "rain" ...
##  $ Temperature..C.         : num  9.47 9.36 9.38 8.29 8.76 ...
##  $ Apparent.Temperature..C.: num  7.39 7.23 9.38 5.94 6.98 ...
##  $ Humidity                : num  0.89 0.86 0.89 0.83 0.83 0.85 0.95 0.89 0.82 0.72 ...
##  $ Wind.Speed..km.h.       : num  14.12 14.26 3.93 14.1 11.04 ...
##  $ Wind.Bearing..degrees.  : num  251 259 204 269 259 258 259 260 259 279 ...
##  $ Visibility..km.         : num  15.8 15.8 15 15.8 15.8 ...
##  $ Loud.Cover              : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Pressure..millibars.    : num  1015 1016 1016 1016 1017 ...
##  $ Daily.Summary           : chr  "Partly cloudy throughout the day." "Partly cloudy througho
ut the day." "Partly cloudy throughout the day." "Partly cloudy throughout the day." ...
```

Calculate difference in Apparent Temperature and Temperature and add it as new data field.

```
df$Temperature.TempDiff <- df$Temperature..C. - df$Apparent.Temperature..C
str(df)
```

```
## 'data.frame':    96453 obs. of  13 variables:
##  $ Formatted.Date          : chr  "2006-04-01 00:00:00.000 +0200" "2006-04-01 01:00:00.000 +0
200" "2006-04-01 02:00:00.000 +0200" "2006-04-01 03:00:00.000 +0200" ...
##  $ Summary                 : chr  "Partly Cloudy" "Partly Cloudy" "Mostly Cloudy" "Partly Clo
udy" ...
##  $ Precip.Type             : chr  "rain" "rain" "rain" "rain" ...
##  $ Temperature..C.         : num  9.47 9.36 9.38 8.29 8.76 ...
##  $ Apparent.Temperature..C.: num  7.39 7.23 9.38 5.94 6.98 ...
##  $ Humidity                : num  0.89 0.86 0.89 0.83 0.83 0.85 0.95 0.89 0.82 0.72 ...
##  $ Wind.Speed..km.h.       : num  14.12 14.26 3.93 14.1 11.04 ...
##  $ Wind.Bearing..degrees.  : num  251 259 204 269 259 258 259 260 259 279 ...
##  $ Visibility..km.         : num  15.8 15.8 15 15.8 15.8 ...
##  $ Loud.Cover              : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Pressure..millibars.    : num  1015 1016 1016 1016 1017 ...
##  $ Daily.Summary           : chr  "Partly cloudy throughout the day." "Partly cloudy througho
ut the day." "Partly cloudy throughout the day." "Partly cloudy throughout the day." ...
##  $ Temperature.TempDiff    : num  2.08 2.13 0 2.34 1.78 ...
```

Convert Precip.Type and Summary to factors (since they only have a few possible values)

```
df$Precip.Type <- as.factor(df$Precip.Type)
df$Summary <- as.factor(df$Summary)
str(df)
```

```
## 'data.frame':    96453 obs. of  13 variables:
##  $ Formatted.Date          : chr  "2006-04-01 00:00:00.000 +0200" "2006-04-01 01:00:00.000 +0
200" "2006-04-01 02:00:00.000 +0200" "2006-04-01 03:00:00.000 +0200" ...
##  $ Summary                 : Factor w/ 27 levels "Breezy","Breezy and Dry",..: 20 20 18 20 18
20 20 20 20 20 ...
##  $ Precip.Type             : Factor w/ 3 levels "null","rain",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ Temperature..C.         : num  9.47 9.36 9.38 8.29 8.76 ...
##  $ Apparent.Temperature..C.: num  7.39 7.23 9.38 5.94 6.98 ...
##  $ Humidity                : num  0.89 0.86 0.89 0.83 0.83 0.85 0.95 0.89 0.82 0.72 ...
##  $ Wind.Speed..km.h.       : num  14.12 14.26 3.93 14.1 11.04 ...
##  $ Wind.Bearing..degrees.  : num  251 259 204 269 259 258 259 260 259 279 ...
##  $ Visibility..km.         : num  15.8 15.8 15 15.8 15.8 ...
##  $ Loud.Cover              : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ Pressure..millibars.    : num  1015 1016 1016 1016 1017 ...
##  $ Daily.Summary           : chr  "Partly cloudy throughout the day." "Partly cloudy througho
ut the day." "Partly cloudy throughout the day." "Partly cloudy throughout the day." ...
##  $ Temperature.TempDiff    : num  2.08 2.13 0 2.34 1.78 ...
```

Our goal is to see if we can see how other weather factors, such as Wind Speed and Humidity, relate to the difference between Apparent Temperature and actual Temperature. Though we identify apparent temperature as a very good predictor of the difference, we do not use this in this assignment as we are interested in exploring more the other factors that influence the disparity.

##a. We'll divide the data into train, test, and validate.

```
set.seed(1234)
spec <- c(train=.6, test=.2, validate=.2)
i <- sample(cut(1:nrow(df),
                nrow(df)*cumsum(c(0,spec)), labels=names(spec)))
train <- df[i=="train",]
test <- df[i=="test",]
vald <- df[i=="validate",]
```

##b. Exploring training data:

```
names(df)   # getting col names
```

```
##  [1] "Formatted.Date"           "Summary"
##  [3] "Precip.Type"              "Temperature..C."
##  [5] "Apparent.Temperature..C." "Humidity"
##  [7] "Wind.Speed..km.h."        "Wind.Bearing..degrees."
##  [9] "Visibility..km."          "Loud.Cover"
## [11] "Pressure..millibars."     "Daily.Summary"
## [13] "Temperature.TempDiff"
```

```
dim(df)   # getting number of rows and cols
```

```
## [1] 96453    13
```

```
head(df)  # getting first 6 rows
```

```
##                 Formatted.Date       Summary Precip.Type Temperature..C.
## 1 2006-04-01 00:00:00.000 +0200 Partly Cloudy        rain        9.472222
## 2 2006-04-01 01:00:00.000 +0200 Partly Cloudy        rain        9.355556
## 3 2006-04-01 02:00:00.000 +0200 Mostly Cloudy        rain        9.377778
## 4 2006-04-01 03:00:00.000 +0200 Partly Cloudy        rain        8.288889
## 5 2006-04-01 04:00:00.000 +0200 Mostly Cloudy        rain        8.755556
## 6 2006-04-01 05:00:00.000 +0200 Partly Cloudy        rain        9.222222
##   Apparent.Temperature..C. Humidity Wind.Speed..km.h. Wind.Bearing..degrees.
## 1                 7.388889     0.89           14.1197                    251
## 2                 7.227778     0.86           14.2646                    259
## 3                 9.377778     0.89            3.9284                    204
## 4                 5.944444     0.83           14.1036                    269
## 5                 6.977778     0.83           11.0446                    259
## 6                 7.111111     0.85           13.9587                    258
##   Visibility..km. Loud.Cover Pressure..millibars.
## 1         15.8263          0              1015.13
## 2         15.8263          0              1015.63
## 3         14.9569          0              1015.94
## 4         15.8263          0              1016.41
## 5         15.8263          0              1016.51
## 6         14.9569          0              1016.66
##                       Daily.Summary Temperature.TempDiff
## 1 Partly cloudy throughout the day.             2.083333
## 2 Partly cloudy throughout the day.             2.127778
## 3 Partly cloudy throughout the day.             0.000000
## 4 Partly cloudy throughout the day.             2.344444
## 5 Partly cloudy throughout the day.             1.777778
## 6 Partly cloudy throughout the day.             2.111111
```

```
colMeans(df[4:11])   # calculating mean of linear cols
```

```
##          Temperature..C. Apparent.Temperature..C.                 Humidity
##                11.932678                10.855029                 0.734899
##        Wind.Speed..km.h.   Wind.Bearing..degrees.          Visibility..km.
##                10.810640               187.509232                10.347325
##               Loud.Cover     Pressure..millibars.
##                 0.000000              1003.235956
```

Since Loud.Cover col has a mean of 0, it might have NA values.

```
colSums(is.na(df))
```

```
##           Formatted.Date                    Summary                Precip.Type
##                        0                          0                          0
##          Temperature..C. Apparent.Temperature..C.                   Humidity
##                        0                          0                          0
##        Wind.Speed..km.h.   Wind.Bearing..degrees.          Visibility..km.
##                        0                          0                          0
##               Loud.Cover     Pressure..millibars.             Daily.Summary
##                        0                          0                          0
##     Temperature.TempDiff
##                        0
```

```
sum(df$Loud.Cover)
```

```
## [1] 0
```

In actuality, there are no NA values in Loud.Cover col. But since all the values there are 0, we will not gain much from using it in the prediction model. So we'll ignore it.

```
summary(df)
```

```
##  Formatted.Date                   Summary      Precip.Type  Temperature..C.
##  Length:96453       Partly Cloudy      :31733   null:  517   Min.   :-21.822
##  Class :character   Mostly Cloudy      :28094   rain:85224   1st Qu.:  4.689
##  Mode  :character   Overcast           :16597   snow:10712   Median : 12.000
##                     Clear              :10890                Mean   : 11.933
##                     Foggy              : 7148                3rd Qu.: 18.839
##                     Breezy and Overcast:  528                Max.   : 39.906
##                     (Other)            : 1463
##  Apparent.Temperature..C.    Humidity      Wind.Speed..km.h.
##  Min.   :-27.717          Min.   :0.0000   Min.   : 0.000
##  1st Qu.:  2.311          1st Qu.:0.6000   1st Qu.: 5.828
##  Median : 12.000          Median :0.7800   Median : 9.966
##  Mean   : 10.855          Mean   :0.7349   Mean   :10.811
##  3rd Qu.: 18.839          3rd Qu.:0.8900   3rd Qu.:14.136
##  Max.   : 39.344          Max.   :1.0000   Max.   :63.853
##
##  Wind.Bearing..degrees. Visibility..km.   Loud.Cover Pressure..millibars.
##  Min.   :  0.0          Min.   : 0.00   Min.   :0    Min.   :   0
##  1st Qu.:116.0          1st Qu.: 8.34   1st Qu.:0    1st Qu.:1012
##  Median :180.0          Median :10.05   Median :0    Median :1016
##  Mean   :187.5          Mean   :10.35   Mean   :0    Mean   :1003
##  3rd Qu.:290.0          3rd Qu.:14.81   3rd Qu.:0    3rd Qu.:1021
##  Max.   :359.0          Max.   :16.10   Max.   :0    Max.   :1046
##
##  Daily.Summary      Temperature.TempDiff
##  Length:96453       Min.   :-4.811
##  Class :character   1st Qu.: 0.000
##  Mode  :character   Median : 0.000
##                     Mean   : 1.078
##                     3rd Qu.: 2.217
##                     Max.   :10.183
##
```

```
summary(df$Summary)
```

```
##                            Breezy                      Breezy and Dry
##                                54                                   1
##                   Breezy and Foggy            Breezy and Mostly Cloudy
##                                35                                 516
##                 Breezy and Overcast            Breezy and Partly Cloudy
##                               528                                 386
##                             Clear Dangerously Windy and Partly Cloudy
##                             10890                                   1
##                           Drizzle                                 Dry
##                                39                                  34
##               Dry and Mostly Cloudy               Dry and Partly Cloudy
##                                14                                  86
##                             Foggy             Humid and Mostly Cloudy
##                              7148                                  40
##                  Humid and Overcast             Humid and Partly Cloudy
##                                 7                                  17
##                         Light Rain                       Mostly Cloudy
##                                63                                28094
##                           Overcast                       Partly Cloudy
##                             16597                                31733
##                              Rain                               Windy
##                                10                                   8
##                       Windy and Dry                    Windy and Foggy
##                                 1                                   4
##             Windy and Mostly Cloudy                 Windy and Overcast
##                                35                                  45
##             Windy and Partly Cloudy
##                                67
```

```
sum(df$Wind.Speed..km.h.==0)
```

```
## [1] 1297
```

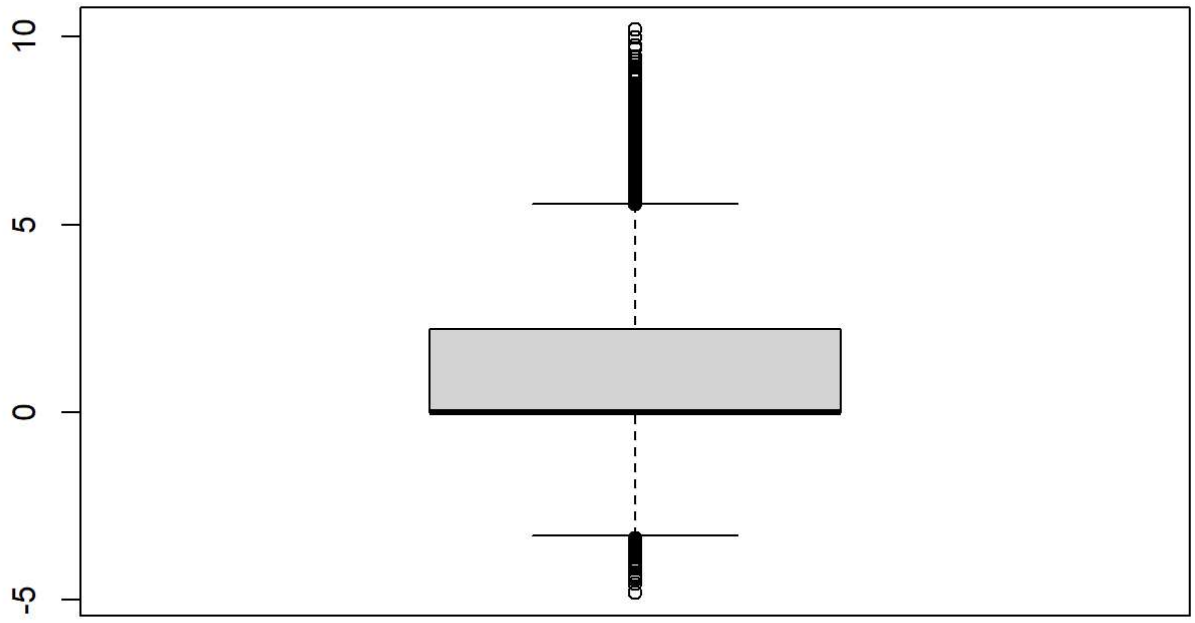
It is unlikely that there is absolutely no wind so some of this data may not be accurate.

We'll pull up some graphs to get a better idea of what we have to do, now. Yellow dots are null precipitation days, green is rain, and blue is snow.

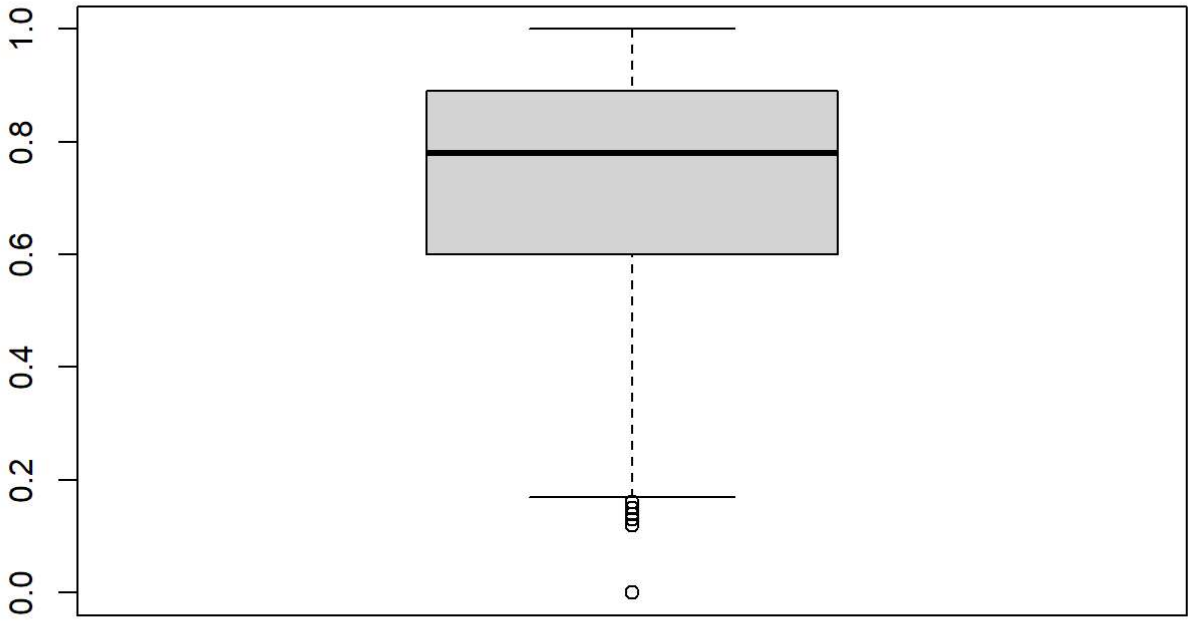
```
cor(df[4:7])
```

```
##                          Temperature..C. Apparent.Temperature..C.   Humidity
## Temperature..C.               1.000000000                0.9926286 -0.6322547
## Apparent.Temperature..C.      0.992628564                1.0000000 -0.6025710
## Humidity                     -0.632254675               -0.6025710  1.0000000
## Wind.Speed..km.h.             0.008956968               -0.0566497 -0.2249515
##                          Wind.Speed..km.h.
## Temperature..C.                0.008956968
## Apparent.Temperature..C.      -0.056649698
## Humidity                      -0.224951456
## Wind.Speed..km.h.              1.000000000
```

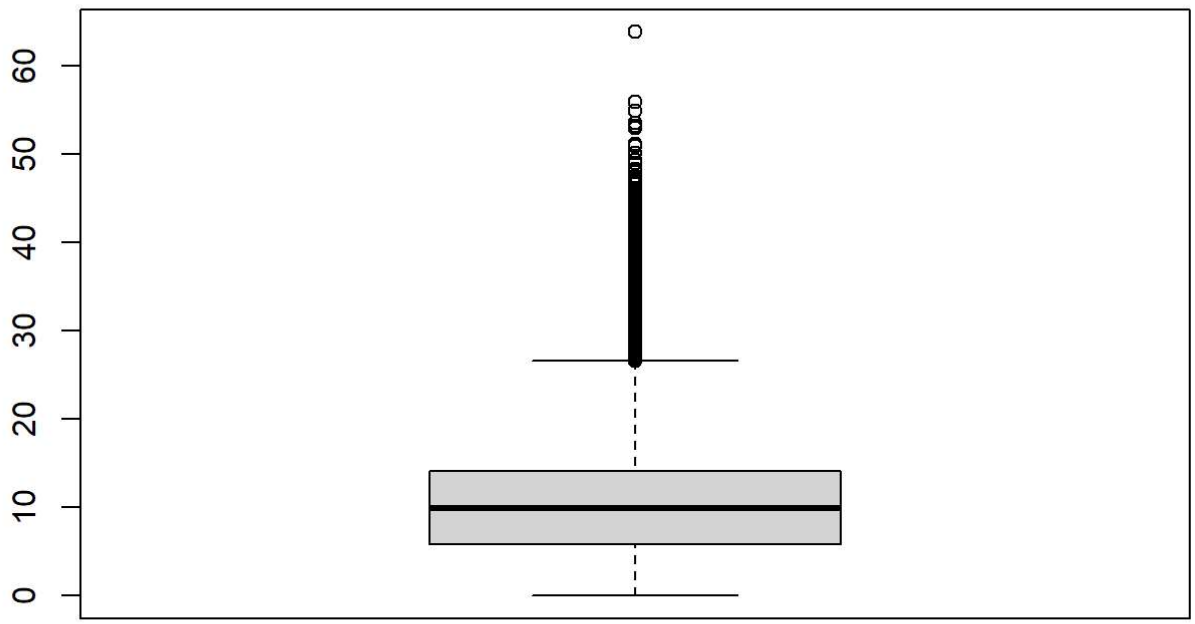
```
boxplot(df$Temperature.TempDiff)
```



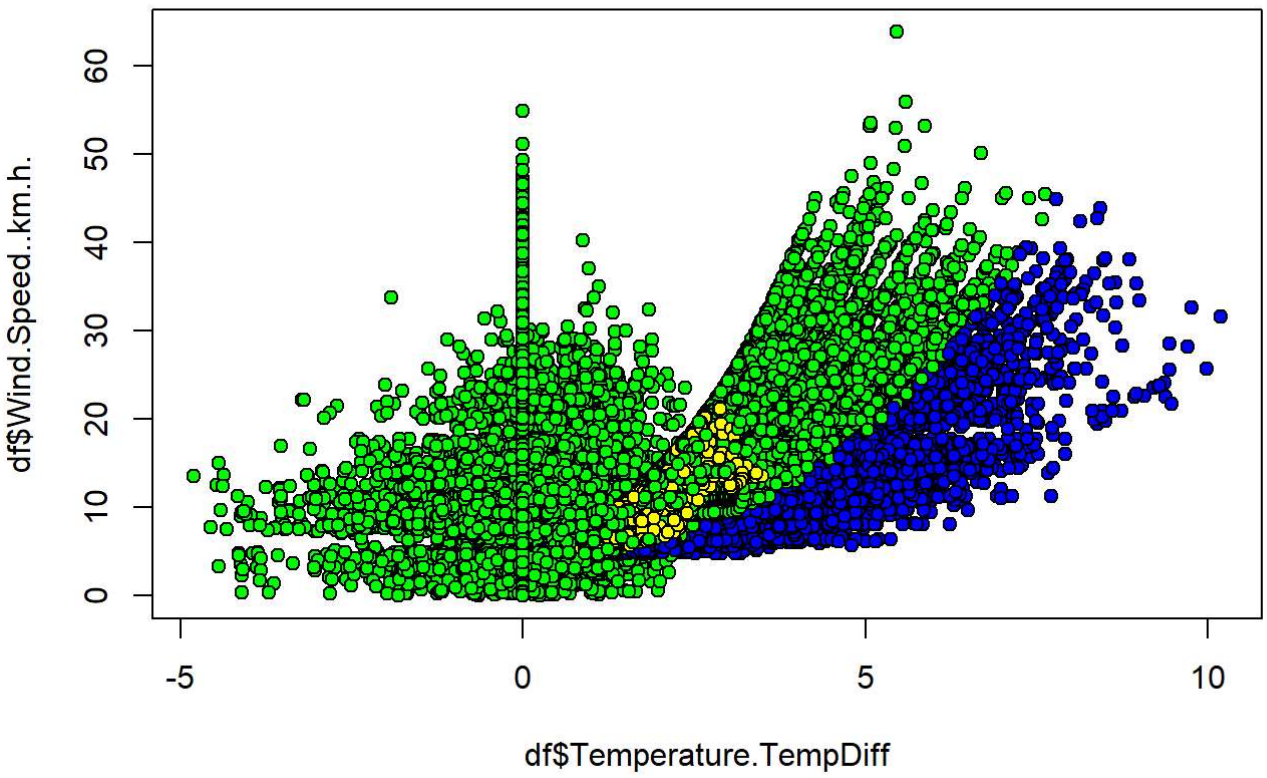

```
boxplot(df$Humidity)
```



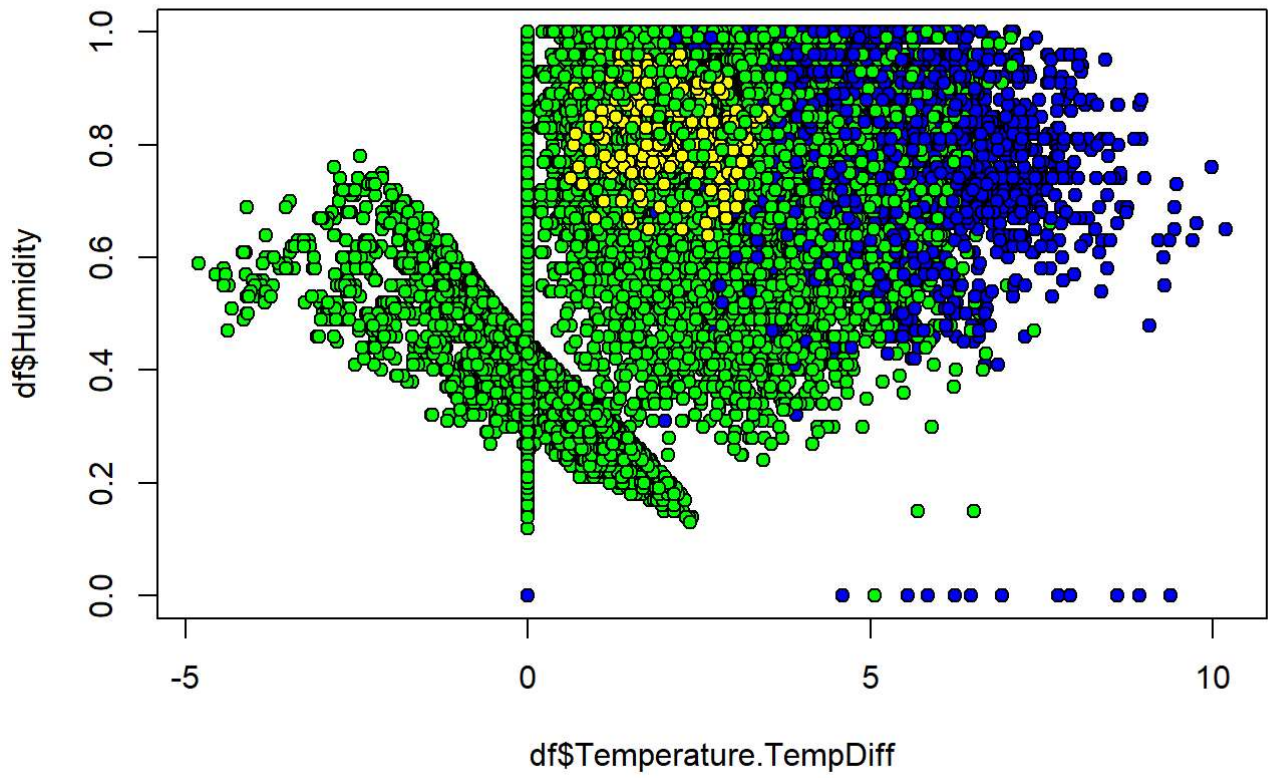

```
boxplot(df$Wind.Speed..km.h.)
```



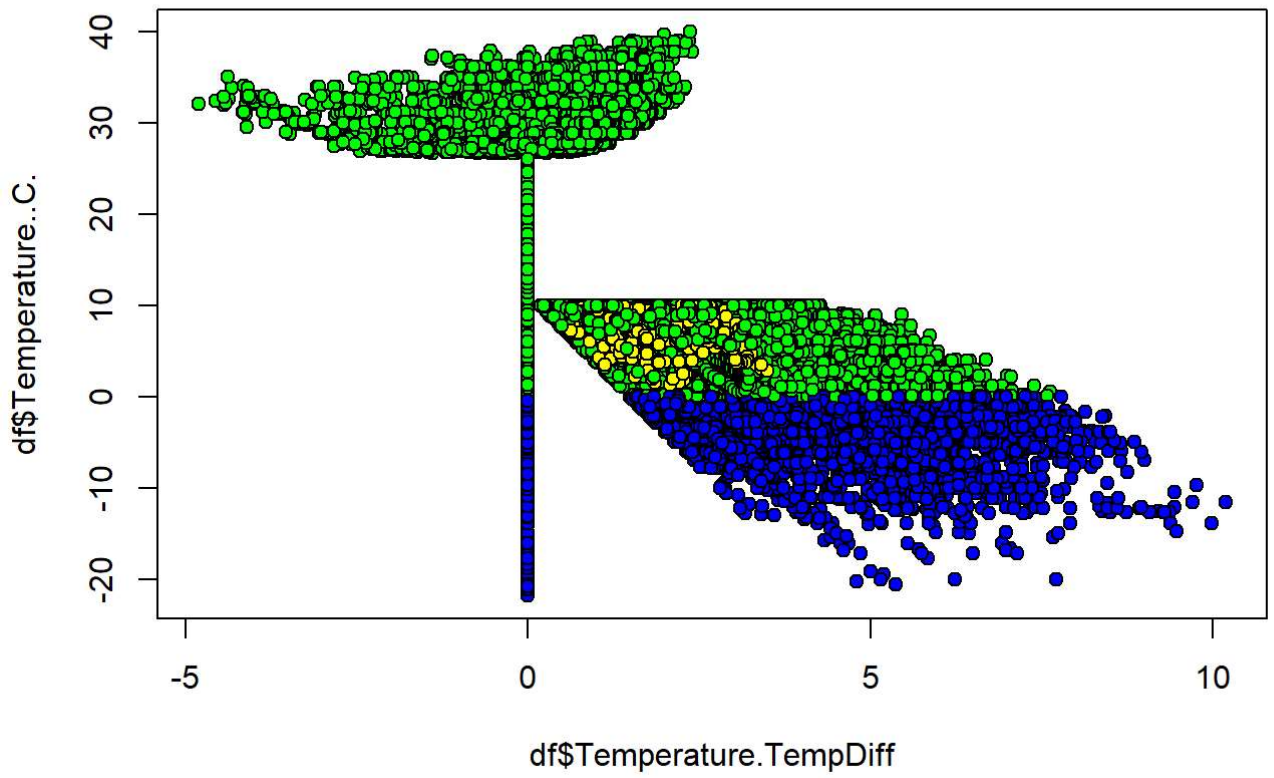

```
plot(df$Temperature.TempDiff,df$Wind.Speed..km.h.,pch=21,bg=c("yellow","green","blue")[as.integer(df$Precip.Type)])  # lots of 0 values
```




```
plot(df$Temperature.TempDiff,df$Humidity,pch=21,bg=c("yellow","green","blue")[as.integer(df$Prec
ip.Type)])  # lots of 0 values
```




```
plot(df$Temperature.TempDiff,df$Temperature..C.,pch=21,bg=c("yellow","green","blue")[as.integer
(df$Precip.Type)])  # lots of 0 values
```



Now, we'll clean up the data according to what we found. We'll clean up only what is referenced, but we will delete what we are uncertain about, since we have such a large amount of data.

```
df[,6:7][df[,6:7]==0] <- NA  # change 0s to NA values in Humidity and Wind Speed cols
df[,13:13][df[,13:13]==0] <- NA  # change 0s to NA values in TempDiff col
df <- na.omit(df)  # since we have enough data we can omit those which have NA values
summary(df)
```

```
##  Formatted.Date                   Summary      Precip.Type  Temperature..C.
##  Length:40660       Partly Cloudy      :11421   null:  237   Min.   :-20.556
##  Class :character   Mostly Cloudy      :10907   rain:32750   1st Qu.:  1.139
##  Mode  :character   Overcast           : 9062   snow: 7673   Median :  5.122
##                     Clear              : 4167                Mean   :  7.924
##                     Foggy              : 3969                3rd Qu.:  8.867
##                     Breezy and Overcast:  375                Max.   : 39.906
##                     (Other)            :  759
##  Apparent.Temperature..C.    Humidity      Wind.Speed..km.h.
##  Min.   :-27.717          Min.   :0.1300   Min.   : 0.1288
##  1st Qu.: -2.267          1st Qu.:0.6500   1st Qu.: 8.1788
##  Median :  2.544          Median :0.8200   Median :11.2217
##  Mean   :  5.370          Mean   :0.7524   Mean   :12.8271
##  3rd Qu.:  6.839          3rd Qu.:0.9100   3rd Qu.:15.4721
##  Max.   : 39.344          Max.   :1.0000   Max.   :63.8526
##
##  Wind.Bearing..degrees. Visibility..km.    Loud.Cover Pressure..millibars.
##  Min.   :  0.0          Min.   : 0.000   Min.   :0    Min.   :   0
##  1st Qu.:129.0          1st Qu.: 6.311   1st Qu.:0    1st Qu.:1012
##  Median :175.0          Median : 9.982   Median :0    Median :1017
##  Mean   :186.1          Mean   : 9.471   Mean   :0    Mean   :1001
##  3rd Qu.:280.0          3rd Qu.:11.270   3rd Qu.:0    3rd Qu.:1022
##  Max.   :359.0          Max.   :16.100   Max.   :0    Max.   :1046
##
##  Daily.Summary      Temperature.TempDiff
##  Length:40660       Min.   :-4.811
##  Class :character   1st Qu.: 1.483
##  Mode  :character   Median : 2.589
##                     Mean   : 2.554
##                     3rd Qu.: 3.628
##                     Max.   :10.183
##
```

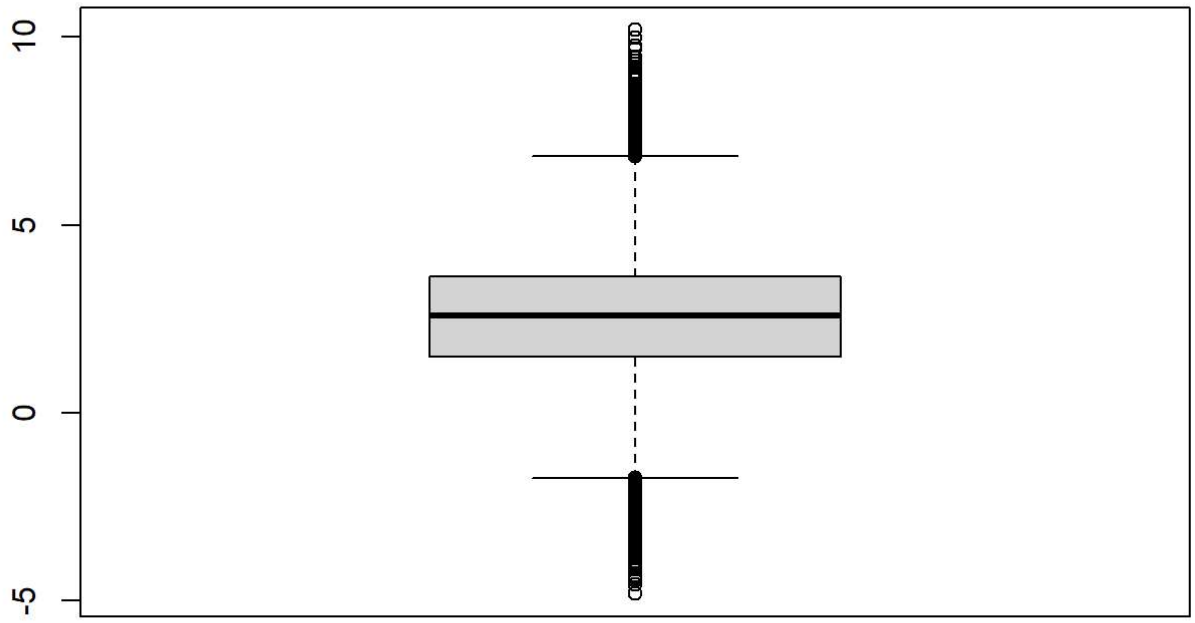
```
#df_temp <- df
```

Make the graphs again.

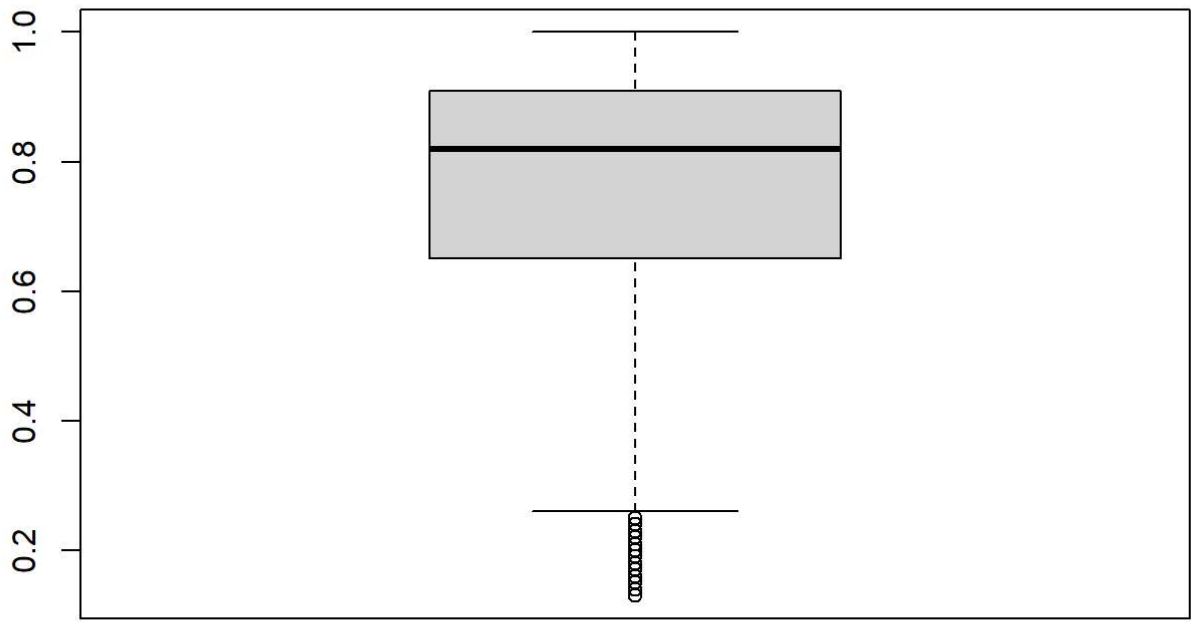
```
cor(df[4:7])
```

```
##                          Temperature..C. Apparent.Temperature..C.    Humidity
## Temperature..C.               1.00000000                0.9957386 -0.78282238
## Apparent.Temperature..C.      0.99573857                1.0000000 -0.75587228
## Humidity                     -0.78282238               -0.7558723  1.00000000
## Wind.Speed..km.h.            -0.08571425               -0.1545778 -0.06160538
##                          Wind.Speed..km.h.
## Temperature..C.               -0.08571425
## Apparent.Temperature..C.      -0.15457779
## Humidity                      -0.06160538
## Wind.Speed..km.h.              1.00000000
```

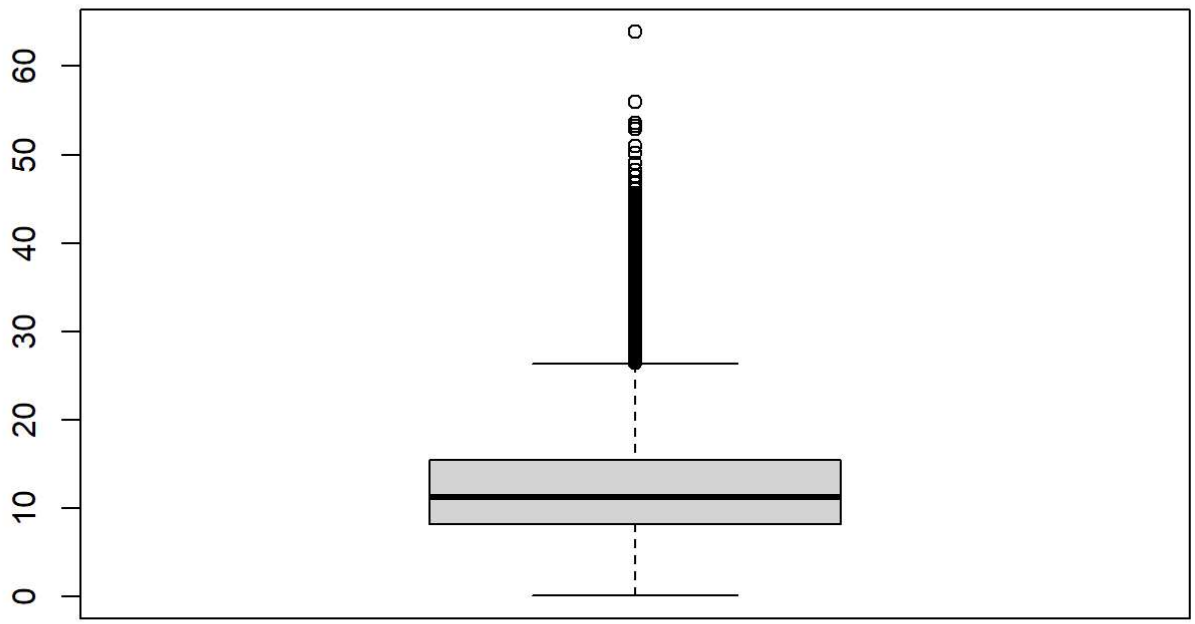
```
boxplot(df$Temperature.TempDiff)
```



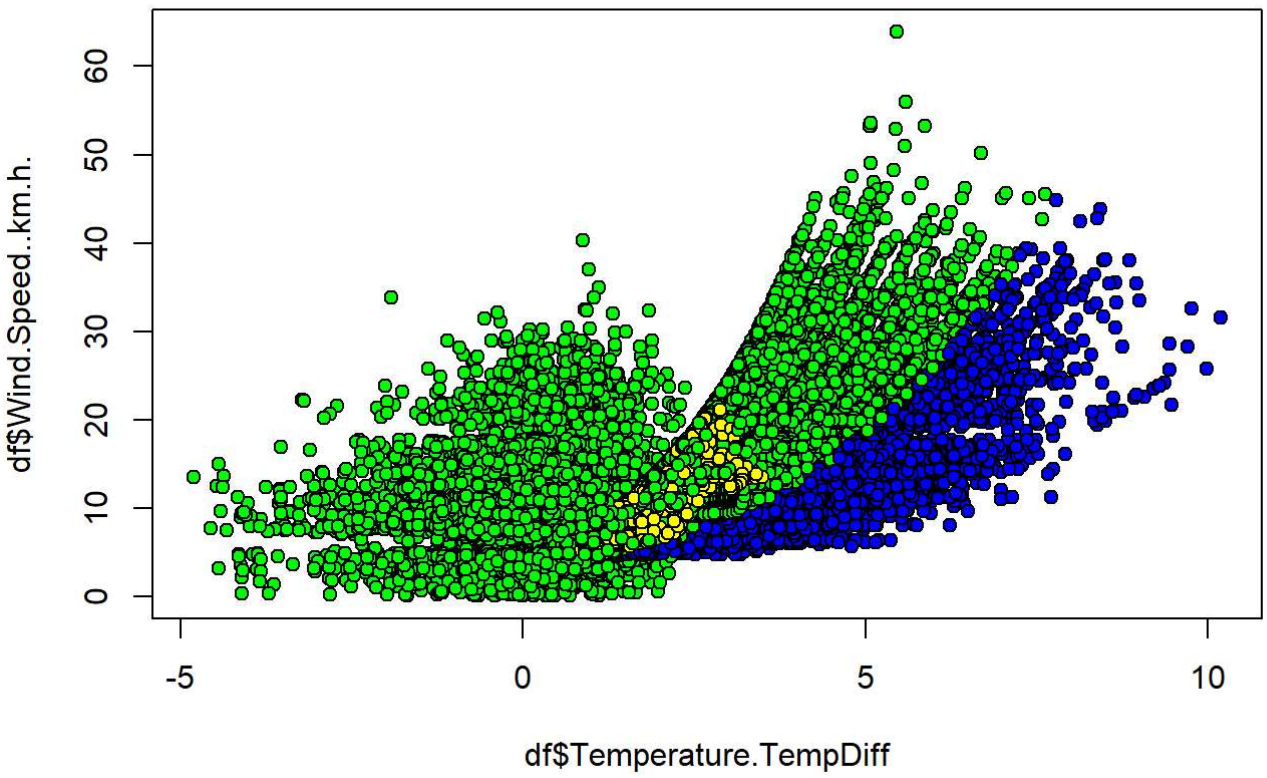

```
boxplot(df$Humidity)
```



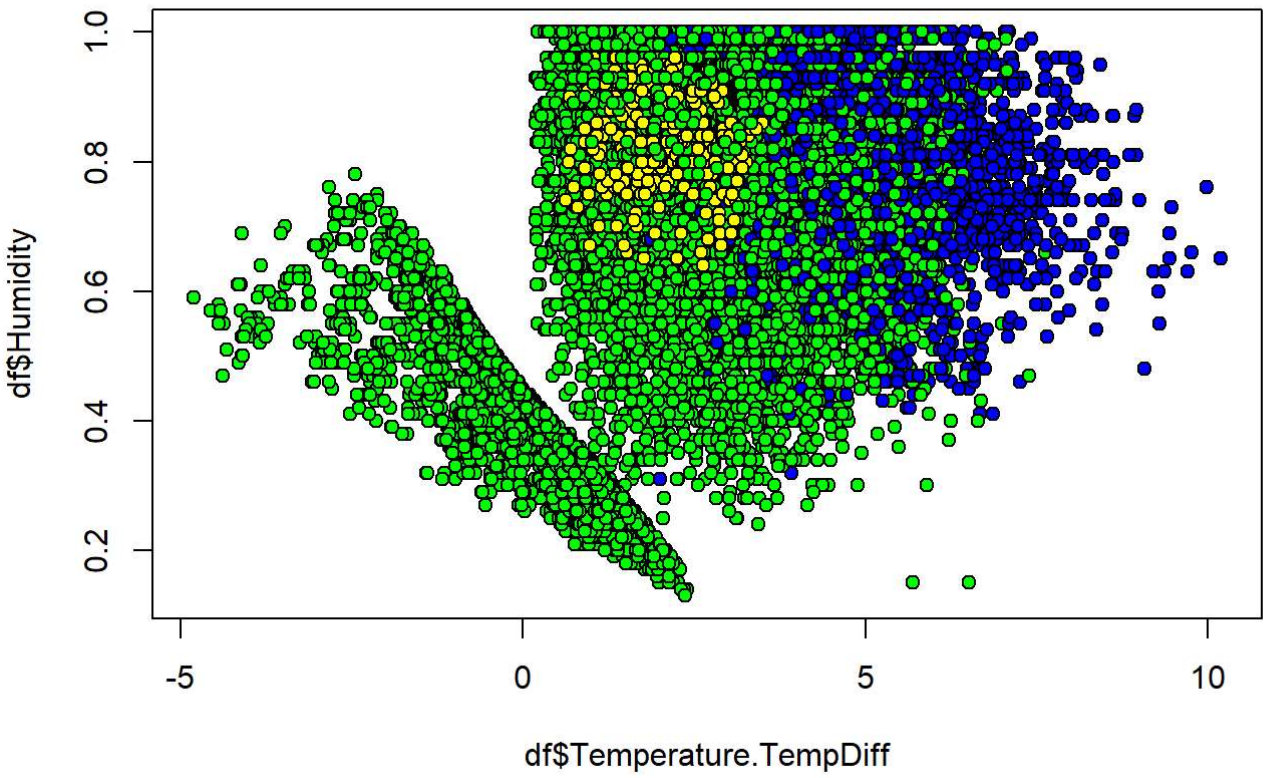

```
boxplot(df$Wind.Speed..km.h.)
```



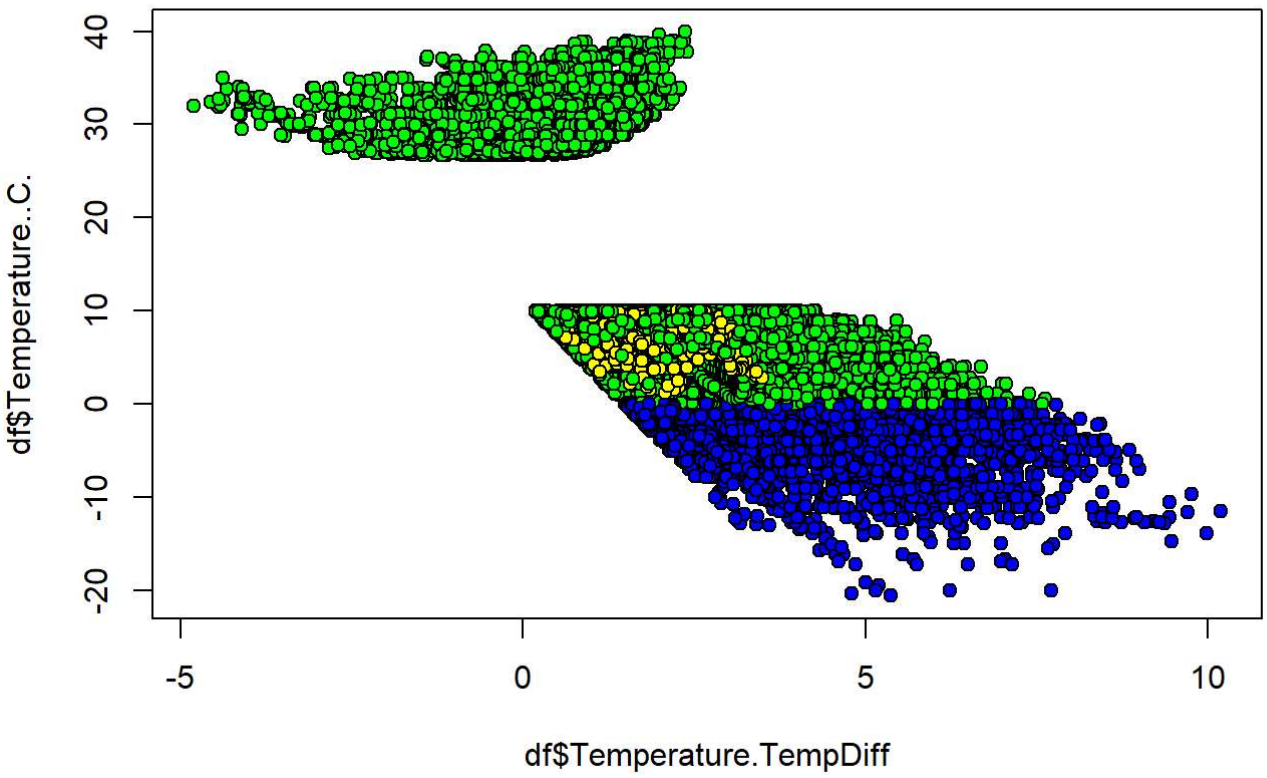

```
plot(df$Temperature.TempDiff,df$Wind.Speed..km.h.,pch=21,bg=c("yellow","green","blue")[as.integer(df$Precip.Type)])  # lots of 0 values
```




```
plot(df$Temperature.TempDiff,df$Humidity,pch=21,bg=c("yellow","green","blue")[as.integer(df$Prec
ip.Type)])  # lots of 0 values
```




```
plot(df$Temperature.TempDiff,df$Temperature..C.,pch=21,bg=c("yellow","green","blue")[as.integer
(df$Precip.Type)])  # lots of 0 values
```



We'll clean up the train, test, and validate data again (removing the rows that had NA values).

```
set.seed(1234)
spec <- c(train=.6, test=.2, validate=.2)
# SVM result vector too big for ~40k rows so halving dataset to ~20k rows
df <- df[1:(nrow(df)/4),]
i <- sample(cut(1:nrow(df),
                nrow(df)*cumsum(c(0,spec)), labels=names(spec)))
train <- df[i=="train",]
test <- df[i=="test",]
vald <- df[i=="validate",]
```

c. SVM regression

Trying a linear kernel

```
library(e1071)
svm1 <- svm(Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Humidity + Wind.Spee
d..km.h. + Wind.Bearing..degrees. + Visibility..km. + Loud.Cover + Pressure..millibars. , data=t
rain, kernel="linear", cost=10, gamma=1, scale=TRUE)
```

```
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```

```
summary(svm1)
```

```
##
## Call:
## svm(formula = Temperature.TempDiff ~ Summary + Precip.Type + Temperature..C. +
##     Humidity + Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. +
##     Loud.Cover + Pressure..millibars., data = train, kernel = "linear",
##     cost = 10, gamma = 1, scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  eps-regression
##  SVM-Kernel:  linear
##        cost:  10
##       gamma:  1
##     epsilon:  0.1
##
##
## Number of Support Vectors:  6087
```

```
pred1 <- predict(svm1, newdata=test)
cor_svm1 <- cor(pred1, test$Temperature.TempDiff)
mse_svm1 <- mean((pred1 - test$Temperature.TempDiff)^2)

#Output results
print("-------Linear kernel Model-------")
```

```
## [1] "-------Linear kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm1))
```

```
## [1] "Correlation:  0.683442322865953"
```

```
print(paste("MSE: ", mse_svm1))
```

```
## [1] "MSE:  12.8986964148705"
```

```
print(paste("RMSE: ", sqrt(mse_svm1)))
```

```
## [1] "RMSE:  3.59147552057235"
```

Tune

```
tune_svm1 <- tune(svm, Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Humidity
+ Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. + Loud.Cover + Pressure..millibar
s., data=vald[1:200,], kernel="linear",
                  ranges=list(cost=c(0.1,1,10,100,1000),
                              gamma=c(0.5,1,2,3,4)))
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```

```
summary(tune_svm1)
```

```
##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost gamma
##   0.1   0.5
##
## - best performance: 0.2165464
##
## - Detailed performance results:
##     cost gamma        error   dispersion
## 1  1e-01   0.5 2.165464e-01 2.251344e-01
## 2  1e+00   0.5 4.447606e-01 8.047513e-01
## 3  1e+01   0.5 6.721190e+01 2.017283e+02
## 4  1e+02   0.5 6.678830e+02 1.038604e+03
## 5  1e+03   0.5 6.445819e+05 1.940902e+06
## 6  1e-01   1.0 2.165464e-01 2.251344e-01
## 7  1e+00   1.0 4.447606e-01 8.047513e-01
## 8  1e+01   1.0 6.721190e+01 2.017283e+02
## 9  1e+02   1.0 6.678830e+02 1.038604e+03
## 10 1e+03   1.0 6.445819e+05 1.940902e+06
## 11 1e-01   2.0 2.165464e-01 2.251344e-01
## 12 1e+00   2.0 4.447606e-01 8.047513e-01
## 13 1e+01   2.0 6.721190e+01 2.017283e+02
## 14 1e+02   2.0 6.678830e+02 1.038604e+03
## 15 1e+03   2.0 6.445819e+05 1.940902e+06
## 16 1e-01   3.0 2.165464e-01 2.251344e-01
## 17 1e+00   3.0 4.447606e-01 8.047513e-01
## 18 1e+01   3.0 6.721190e+01 2.017283e+02
## 19 1e+02   3.0 6.678830e+02 1.038604e+03
## 20 1e+03   3.0 6.445819e+05 1.940902e+06
## 21 1e-01   4.0 2.165464e-01 2.251344e-01
## 22 1e+00   4.0 4.447606e-01 8.047513e-01
## 23 1e+01   4.0 6.721190e+01 2.017283e+02
## 24 1e+02   4.0 6.678830e+02 1.038604e+03
## 25 1e+03   4.0 6.445819e+05 1.940902e+06
```

Evaluate on best linear svm

```
pred2 <- predict(tune_svm1$best.model, newdata=test)
cor_svm1_tune <- cor(pred2, test$Temperature.TempDiff)
mse_svm1_tune <- mean((pred2 - test$Temperature.TempDiff)^2)

#Output results
print("-------Best Linear kernel Model-------")
```

```
## [1] "-------Best Linear kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm1_tune))
```

```
## [1] "Correlation:  0.898050464801039"
```

```
print(paste("MSE: ", mse_svm1_tune))
```

```
## [1] "MSE:  1.27568583483927"
```

```
print(paste("RMSE: ", sqrt(mse_svm1_tune)))
```

```
## [1] "RMSE:  1.12946263100612"
```

Try a polynomial kernel

```
svm2 <- svm(Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Humidity + Wind.Spee
d..km.h. + Wind.Bearing..degrees. + Visibility..km. + Loud.Cover + Pressure..millibars., data=tr
ain, kernel="polynomial", cost=10, gamma=1, scale=TRUE)
```

```
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```

```
summary(svm2)
```

```
##
## Call:
## svm(formula = Temperature.TempDiff ~ Summary + Precip.Type + Temperature..C. +
##     Humidity + Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. +
##     Loud.Cover + Pressure..millibars., data = train, kernel = "polynomial",
##     cost = 10, gamma = 1, scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  eps-regression
##  SVM-Kernel:  polynomial
##        cost:  10
##      degree:  3
##       gamma:  1
##      coef.0:  0
##     epsilon:  0.1
##
##
## Number of Support Vectors:  127
```

```
pred3 <- predict(svm2, newdata=test)
cor_svm3 <- cor(pred3, test$Temperature.TempDiff)
mse_svm3 <- mean((pred3 - test$Temperature.TempDiff)^2)

#Output results
print("-------Polynomial kernel Model-------")
```

```
## [1] "-------Polynomial kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm3))
```

```
## [1] "Correlation:  -0.00517638803932094"
```

```
print(paste("MSE: ", mse_svm3))
```

```
## [1] "MSE:  15543772447436345344"
```

```
print(paste("RMSE: ", sqrt(mse_svm3)))
```

```
## [1] "RMSE:  3942559124.15227"
```

Tune

```
tune_svm2 <- tune(svm, Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Humidity
+ Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. + Loud.Cover + Pressure..millibar
s., data=vald[1:200,], kernel="polynomial",
                  ranges=list(cost=c(0.1,1,10,100,1000),
                              gamma=c(0.5,1,2,3,4)))
```

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```

```
summary(tune_svm2)
```

```
##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost gamma
##   0.1   0.5
##
## - best performance: 6.379074e+19
##
## - Detailed performance results:
##     cost gamma        error   dispersion
## 1  1e-01   0.5 6.379074e+19 1.107592e+20
## 2  1e+00   0.5 9.828227e+21 1.916334e+22
## 3  1e+01   0.5 6.317833e+23 1.128428e+24
## 4  1e+02   0.5 8.295008e+25 1.691320e+26
## 5  1e+03   0.5 1.410998e+28 3.476024e+28
## 6  1e-01   1.0 5.807429e+21 1.211861e+22
## 7  1e+00   1.0 3.234823e+23 4.783063e+23
## 8  1e+01   1.0 4.443233e+25 8.822337e+25
## 9  1e+02   1.0 4.655345e+27 9.405198e+27
## 10 1e+03   1.0 3.615308e+29 6.666785e+29
## 11 1e-01   2.0 1.528812e+23 1.188500e+23
## 12 1e+00   2.0 1.666332e+25 1.033399e+25
## 13 1e+01   2.0 1.460402e+27 1.960957e+27
## 14 1e+02   2.0 1.897605e+29 2.293618e+29
## 15 1e+03   2.0 2.028012e+31 2.776481e+31
## 16 1e-01   3.0 1.418632e+24 1.262507e+24
## 17 1e+00   3.0 8.176780e+25 4.083269e+25
## 18 1e+01   3.0 7.661523e+27 3.149980e+27
## 19 1e+02   3.0 1.560409e+30 1.495960e+30
## 20 1e+03   3.0 8.504284e+31 4.274057e+31
## 21 1e-01   4.0 1.998731e+25 3.764950e+25
## 22 1e+00   4.0 1.936304e+27 3.922649e+27
## 23 1e+01   4.0 1.006407e+29 7.255487e+28
## 24 1e+02   4.0 2.684197e+31 5.993383e+31
## 25 1e+03   4.0 3.036092e+33 7.173761e+33
```

Evaluate on best polynomial svm

```
pred4 <- predict(tune_svm2$best.model, newdata=test)
cor_svm1_tune2 <- cor(pred4, test$Temperature.TempDiff)
mse_svm1_tune2 <- mean((pred4 - test$Temperature.TempDiff)^2)

#Output results
print("-------Best Polynomial kernel Model-------")
```

```
## [1] "-------Best Polynomial kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm1_tune2))
```

```
## [1] "Correlation:  0.24656214538623"
```

```
print(paste("MSE: ", mse_svm1_tune2))
```

```
## [1] "MSE:  69984172304863862784"
```

```
print(paste("RMSE: ", sqrt(mse_svm1_tune2)))
```

```
## [1] "RMSE:  8365654326.16385"
```

Try a radial kernel

```
svm3 <- svm(Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Humidity + Wind.Spee
d..km.h. + Wind.Bearing..degrees. + Visibility..km. + Loud.Cover + Pressure..millibars., data=tr
ain, kernel="radial", cost=10, gamma=1, scale=TRUE)
```

```
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```

```
summary(svm3)
```

```
##
## Call:
## svm(formula = Temperature.TempDiff ~ Summary + Precip.Type + Temperature..C. +
##     Humidity + Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. +
##     Loud.Cover + Pressure..millibars., data = train, kernel = "radial",
##     cost = 10, gamma = 1, scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  eps-regression
##  SVM-Kernel:  radial
##        cost:  10
##       gamma:  1
##     epsilon:  0.1
##
##
## Number of Support Vectors:  5761
```

```
pred5 <- predict(svm3, newdata=test)
cor_svm5 <- cor(pred5, test$Temperature.TempDiff)
mse_svm5 <- mean((pred5 - test$Temperature.TempDiff)^2)

#Output results
print("-------Radial kernel Model-------")
```

```
## [1] "-------Radial kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm5))
```

```
## [1] "Correlation:  0.259191597849548"
```

```
print(paste("MSE: ", mse_svm5))
```

```
## [1] "MSE:  2.53599839828568"
```

```
print(paste("RMSE: ", sqrt(mse_svm5)))
```

```
## [1] "RMSE:  1.59248183609286"
```

Tune

```
tune_svm3 <- tune(svm, Temperature.TempDiff~ Summary + Precip.Type + Temperature..C. + Apparent.
Temperature..C. + Humidity + Wind.Speed..km.h. + Wind.Bearing..degrees. + Visibility..km. + Lou
d.Cover + Pressure..millibars., data=vald[1:200,], kernel="radial",
                  ranges=list(cost=c(0.1,1,10,100,1000),
                              gamma=c(0.5,1,2,3,4)))
```

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```
summary(tune_svm3)
```

```
##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost gamma
##    10   0.5
##
## - best performance: 1.705513
##
## - Detailed performance results:
##     cost gamma    error dispersion
## 1  1e-01   0.5 1.741637  0.5789271
## 2  1e+00   0.5 1.724076  0.5816108
## 3  1e+01   0.5 1.705513  0.5682204
## 4  1e+02   0.5 1.705513  0.5682204
## 5  1e+03   0.5 1.705513  0.5682204
## 6  1e-01   1.0 1.743524  0.5784693
## 7  1e+00   1.0 1.740302  0.5775828
## 8  1e+01   1.0 1.731465  0.5593963
## 9  1e+02   1.0 1.731465  0.5593963
## 10 1e+03   1.0 1.731465  0.5593963
## 11 1e-01   2.0 1.743897  0.5783759
## 12 1e+00   2.0 1.744037  0.5766133
## 13 1e+01   2.0 1.738422  0.5573092
## 14 1e+02   2.0 1.738422  0.5573092
## 15 1e+03   2.0 1.738422  0.5573092
## 16 1e-01   3.0 1.743913  0.5783640
## 17 1e+00   3.0 1.744242  0.5765553
## 18 1e+01   3.0 1.738832  0.5571880
## 19 1e+02   3.0 1.738832  0.5571880
## 20 1e+03   3.0 1.738832  0.5571880
## 21 1e-01   4.0 1.743915  0.5783636
## 22 1e+00   4.0 1.744255  0.5765515
## 23 1e+01   4.0 1.738858  0.5571802
## 24 1e+02   4.0 1.738858  0.5571802
## 25 1e+03   4.0 1.738858  0.5571802
```

Evaluate on best polynomial svm

```
pred6 <- predict(tune_svm3$best.model, newdata=test)
cor_svm1_tune3 <- cor(pred6, test$Temperature.TempDiff)
mse_svm1_tune3 <- mean((pred6 - test$Temperature.TempDiff)^2)

#Output results
print("-------Best Radial kernel Model-------")
```

```
## [1] "-------Best Radial kernel Model-------"
```

```
print(paste("Correlation: ", cor_svm1_tune3))
```

```
## [1] "Correlation:  0.057275151867772"
```

```
print(paste("MSE: ", mse_svm1_tune3))
```

```
## [1] "MSE:  2.695966346244"
```

```
print(paste("RMSE: ", sqrt(mse_svm1_tune3)))
```

```
## [1] "RMSE:  1.64193981200408"
```

d. Analysis

Out of all the kernel models, linear kernel had the best correlation (0.898) followed by the polynomial kernel (0.246) and radial kernel (0.057). The best model for linear and polynomial kernels had the cost as 0.1 and gamma as 0.5, while the best model for radial kernel had the cost as 10 and the gamma as 0.5. (This shows that low gamma values produces better results for this data set for all the kernels.) The MSEs for the kernels (from lowest to highest) are 1.27 (linear kernel), 2.696 (radial kernel), and 69984172304863862784 (polynomial kernel). I'm unsure why the polynomial kernel is such a high value but it might be due to highly inaccurate predictions for some of the temperature differences. As the initial relationship between the predictors and predicted value was linear, it is of no surprise that linear kernel does the best and radial kernel the worst. (As the polynomial and radial kernels were looking for a relationship which didn't exist, they did not do as well.)