Data Cleaning
for
Kelowna Weather-Crash Project

Section 1

remove all 'flag' variables

group weather data based on time groups in crash dataset, then join weather data on crash table (1 case = 1 crash, what was the weather like when this crash occurred?)

is 'weather' reliable? may need to correct it if there is precipitation but NA for 'weather'

Loading in weather data:

```
> fullWeather = c()
> for (i in c(2017:2021)){
+   for (j in c(1:12)){
+     temp = subset(read.csv(paste0('../../weatherdata/en_climate_hourly_BC_1123939_',
+       sprintf("%02d", j), '-', i, '_P1H.csv')),
+       select = - c(`Temp.Flag`,
+       `Dew.Point.Temp.Flag`, `Rel.Hum.Flag`,
+       `Precip..Amount.Flag`, `Wind.Dir.Flag`,
+       `Wind.Spd.Flag`, `Visibility.Flag`,
+       `Stn.Press.Flag`, `Hmdx`, `Hmdx.Flag`, `Wind.Chill.Flag`))
+     fullWeather = rbind(fullWeather, temp)
+   }
+ }
> nrow(fullWeather)

[1] 43824

> 24*365*5 + 24 #2020 was a leap year

[1] 43824

> #assigning a Julian day variable
> library(lubridate)
> fullWeather$julianday = yday(as.Date(fullWeather$Date.Time..LST., tz='LST'))
> summary(fullWeather)

 Longitude..x.     Latitude..y.    Station.Name     Climate.ID
 Min.   :-119.4   Min.   :49.96   KELOWNA:43824   Min.   :1123939
 1st Qu.:-119.4   1st Qu.:49.96                   1st Qu.:1123939
 Median :-119.4   Median :49.96                   Median :1123939
 Mean   :-119.4   Mean   :49.96                   Mean   :1123939
 3rd Qu.:-119.4   3rd Qu.:49.96                   3rd Qu.:1123939
 Max.   :-119.4   Max.   :49.96                   Max.   :1123939

        Date.Time..LST.       Year          Month             Day
 2017-01-01 00:00:    1   Min.   :2017   Min.   : 1.000   Min.   : 1.00
 2017-01-01 01:00:    1   1st Qu.:2018   1st Qu.: 4.000   1st Qu.: 8.00
 2017-01-01 02:00:    1   Median :2019   Median : 7.000   Median :16.00
```

```
2017-01-01 03:00:    1   Mean   :2019   Mean   : 6.524   Mean   :15.73
2017-01-01 04:00:    1   3rd Qu.:2020   3rd Qu.:10.000   3rd Qu.:23.00
2017-01-01 05:00:    1   Max.   :2021   Max.   :12.000   Max.   :31.00
(Other)          :43818
  Time..LST.      Temp...C.       Dew.Point.Temp...C.  Rel.Hum....
00:00  : 1826   Min.   :-28.900   Min.   :-32.800     Min.   : 12.00
01:00  : 1826   1st Qu.:  0.800   1st Qu.: -2.100     1st Qu.: 52.00
02:00  : 1826   Median :  7.800   Median :  2.300     Median : 74.00
03:00  : 1826   Mean   :  8.511   Mean   :  2.043     Mean   : 69.33
04:00  : 1826   3rd Qu.: 15.700   3rd Qu.:  7.500     3rd Qu.: 89.00
05:00  : 1826   Max.   : 43.800   Max.   : 19.700     Max.   :100.00
(Other):32868   NA's   :30        NA's   :29          NA's   :24
Precip..Amount..mm. Wind.Dir..10s.deg. Wind.Spd..km.h.  Visibility..km.
Min.   :0.00000     Min.   : 1.00      Min.   : 0.000   Min.   : 0.0
1st Qu.:0.00000     1st Qu.: 9.00      1st Qu.: 4.000   1st Qu.:16.1
Median :0.00000     Median :18.00      Median : 5.000   Median :16.1
Mean   :0.02999     Mean   :19.13      Mean   : 8.415   Mean   :15.1
3rd Qu.:0.00000     3rd Qu.:33.00      3rd Qu.:11.000   3rd Qu.:16.1
Max.   :7.10000     Max.   :36.00      Max.   :58.000   Max.   :16.1
NA's   :24          NA's   :13955      NA's   :52       NA's   :31
Stn.Press..kPa.   Wind.Chill         Weather        julianday
Min.   :93.73   Min.   :-34.00   Rain    : 2069   Min.   :  1.0
1st Qu.:96.10   1st Qu.:-11.00   Snow    : 1662   1st Qu.: 92.0
Median :96.52   Median : -6.00   Haze    : 1187   Median :183.0
Mean   :96.55   Mean   : -8.22   Fog     :  873   Mean   :183.1
3rd Qu.:96.96   3rd Qu.: -4.00   Rain,Fog:  233   3rd Qu.:274.0
Max.   :99.34   Max.   : -1.00   (Other) :  246   Max.   :366.0
NA's   :34      NA's   :36294    NA's    :37554
```

There are 22 empty strings in the `Weather` variable that should be NAs.

```
> length(fullWeather[fullWeather$Weather == "" &
+                 is.na(fullWeather$Weather) == FALSE, "Weather"])

[1] 22

> ## SETTING EMPTY TO NA
> fullWeather$Weather[fullWeather$Weather == "" &
+                 is.na(fullWeather$Weather) == FALSE] = NA
> ## CHECKING
> length(fullWeather[fullWeather$Weather == "" &
+                 is.na(fullWeather$Weather) == FALSE, "Weather"])

[1] 0
```

Need to relevel factor to remove empty string option:

```
> "" %in% levels(fullWeather$Weather)

[1] TRUE

> fullWeather$Weather = droplevels(fullWeather$Weather)
> "" %in% levels(fullWeather$Weather)

[1] FALSE
```

Changing `Weather` factor variable to many indicator variables.

```
> #creating columns
> lst = c()
> for (i in levels(fullWeather$Weather)){
+   temp = unlist(strsplit(as.character(i), ","))
+   lst = c(lst, temp)
+ }
> lst = lst[!(duplicated(lst))] #removing duplicates
> lst

 [1] "Fog"           "Freezing Fog"  "Freezing Rain" "Snow"
 [5] "Haze"          "Rain"          "Moderate Snow" "Moderate Rain"
 [9] "Thunderstorms" "Heavy Rain"    "Heavy Snow"    "Blowing Snow"

> for (i in lst){
+   fullWeather[, i] = factor("0", levels = c("0", "1"))
+ }
> names(fullWeather)

 [1] "Longitude..x."       "Latitude..y."        "Station.Name"
 [4] "Climate.ID"          "Date.Time..LST."     "Year"
 [7] "Month"               "Day"                 "Time..LST."
[10] "Temp...C."           "Dew.Point.Temp...C." "Rel.Hum...."
[13] "Precip..Amount..mm." "Wind.Dir..10s.deg."  "Wind.Spd..km.h."
[16] "Visibility..km."     "Stn.Press..kPa."     "Wind.Chill"
[19] "Weather"             "julianday"           "Fog"
[22] "Freezing Fog"        "Freezing Rain"       "Snow"
[25] "Haze"                "Rain"                "Moderate Snow"
[28] "Moderate Rain"       "Thunderstorms"       "Heavy Rain"
[31] "Heavy Snow"          "Blowing Snow"

> ############
>
> #assigning values
> for (i in 1:nrow(fullWeather)){
+   if (!is.na(fullWeather$Weather[i])){
+     temp = as.character(fullWeather$Weather[i])
+     temp = unlist(strsplit(temp, ","))
+     for (j in temp){
+       fullWeather[i, j] = "1"
+     }
+   }
+ }
> ############
>
> #collapsing to only: Rain, Snow, Thunderstorms, Fog, Freezing Rain
> fullWeather$Rain[fullWeather$'Moderate Rain' == 1] = 1
> fullWeather$Rain[fullWeather$'Heavy Rain' == 1] = 1
> fullWeather$Snow[fullWeather$'Moderate Snow' == 1] = 1
> fullWeather$Snow[fullWeather$'Heavy Snow' == 1] = 1
> fullWeather$Snow[fullWeather$'Blowing Snow' == 1] = 1
```

```
> fullWeather$Fog[fullWeather$'Freezing Fog' == 1] = 1
> fullWeather$Fog[fullWeather$'Haze' == 1] = 1
> fullWeather = subset(fullWeather, select = - c(`Moderate Rain`,
+                `Heavy Rain`, `Moderate Snow`, `Heavy Snow`,
+                `Blowing Snow`, `Freezing Fog`, `Haze`))
> summary(fullWeather[,c("Weather", "Rain", "Fog", "Snow",
+                        "Thunderstorms", "Freezing Rain")])
```

```
     Weather       Rain       Fog        Snow       Thunderstorms Freezing Rain
 Rain    : 2069   0:41370   0:41429   0:42132   0:43794       0:43819
 Snow    : 1662   1: 2454   1: 2395   1: 1692   1:   30       1:    5
 Haze    : 1187
 Fog     :  873
 Rain,Fog:  233
 (Other) :  224
 NA's    :37576
```

I realize that I could have used a regex solution here to shorten the code, but the solution above is more general. This is important if I wanted to add/remove groups to/from the reduced list of weather types later on (ie. adding 'Heavy Snow').

*Note that I kept `Rain` and `Freezing Rain` separate and mutually exclusive. Therefore, if an hour had freezing rain, the indicator variables will have "1" for `Freezing Rain`, and a "0" for `Rain`.

Testing if any hours have precipitation without the appropriate `Weather` variable:

```
> precip = which(fullWeather$Precip..Amount..mm. > 0 &
+                      is.na(fullWeather$Precip..Amount..mm.) == FALSE &
+                      is.na(fullWeather$Weather)
+ ) #gives rows that have precip but NA for weather
> length(precip)

[1] 356
```

There are 356 cases where there is precipitation but no associated `Weather` variable!

To fix this, we want to assign the appropriate `Weather` depending on the temperature. However, this is easier said than done. At what temperature does it snow versus rain?

We can ask the data:

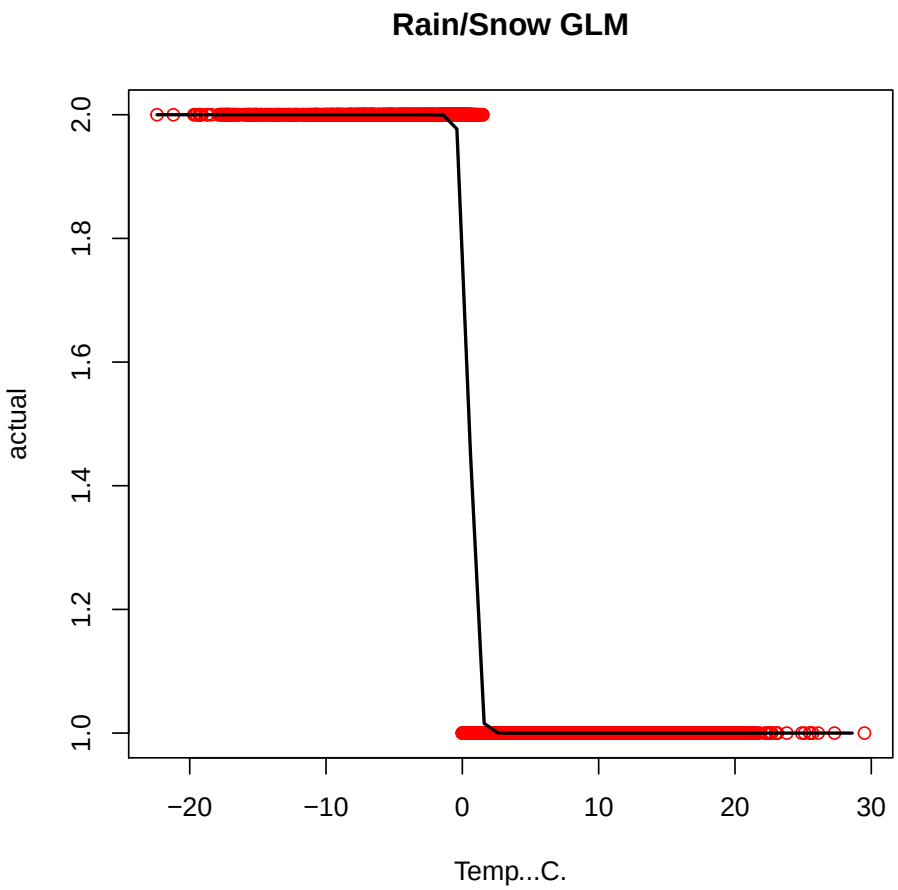
```
> fullWeather$actual = NA
> for (i in 1:nrow(fullWeather)){
+   if (fullWeather$Rain[i] == 1){
+     fullWeather$actual[i] = 'Rain'
+   }
+   if (fullWeather$Snow[i] == 1){
+     fullWeather$actual[i] = 'Snow'
+   }
+ }
> assign = function(x){
+   if (is.na(x)){
+     return(NA)
+   }
+   if (x > 0){
+     return("Above 0")
+   } else {
+     return("Below 0")
+   }
+ }
> #classification table
> fullWeather$expected = sapply(fullWeather$Temp...C., assign)
> rainsnow = table(fullWeather$expected, fullWeather$actual)
> rainsnow

          Rain Snow
  Above 0 2438  202
  Below 0    3 1490

> #probabilities
> #chance of raining if above 0
> rainprob = rainsnow[1,1]/(rainsnow[1,1]+rainsnow[1,2])
> rainprob

[1] 0.9234848

> #chance of snowing if below 0
> snowprob = rainsnow[2,2]/(rainsnow[2,2]+rainsnow[2,1])
> snowprob
```

```
[1] 0.9979906
```

In other words, whenever the temperature is above 0, it is usually raining (0.92%). Similarly, whenever the temperature is below 0, it is basically always snowing (0.998%).

Therefore, we could assign our missing values based on these probabilities. However, it is intuitively true that as you get further from zero, these probabilities would change. Therefore, we can just use a general linear model to predict whether or not it will be snowing or raining based on the temperature:

```
> training = subset(fullWeather[-precip,],
+                   subset = (is.na(fullWeather$actual[-precip]) == FALSE),
+                   select=c('Temp...C.', 'actual'))
> training$actual = as.factor(training$actual)
> rainsnow.glm = glm(actual~Temp...C., data = training,
+                    family = binomial)
> #summary(rainsnow.glm)
> plot(training, col='red', main="Rain/Snow GLM")
> test = min(training$Temp...C.):max(training$Temp...C.)
> lines(test, predict(rainsnow.glm,
+                     data.frame(Temp...C. = test), type = "response")+1, lwd=2)
> #predicting missing (precip) values
> rainsnowpredict = round(predict(rainsnow.glm,
+                   fullWeather[precip,], type = "response"))
> #where 0 = raining and 1 = snowing
> for (i in names(rainsnowpredict)){
+   if (rainsnowpredict[i] == 0){
+     fullWeather[as.numeric(i), 'Rain'] = 1
+     fullWeather[as.numeric(i), 'Weather'] = 'Rain'
+   } else {
+     fullWeather[as.numeric(i), 'Snow'] = 1
+     fullWeather[as.numeric(i), 'Weather'] = 'Snow'
+   }
+ }
> #new Rain and Snow variables
> summary(fullWeather$Rain)

    0     1
41065  2759

> summary(fullWeather$Snow)

    0     1
42081  1743

> #checking that it worked
> length(which(fullWeather$Precip..Amount..mm. > 0 &
+                     is.na(fullWeather$Precip..Amount..mm.) == FALSE &
+                     is.na(fullWeather$Weather)))

[1] 0
```


Rain/Snow GLM
actual
1.0
1.2
1.4
1.6
1.8
2.0
−20
−10
0
10
20
30
Temp...C.

Loading in crash data:

```
> fullCrash = subset(read.csv('../../crashdata/Southern Interior_Full Data_data.csv'),
+           select = - c(`Crash.Breakdown.2`, `Region`,
+                        `Municipality.Name..ifnull.`))
> summary(fullCrash)

 Date.Of.Loss.Year Animal.Flag              Crash.Severity  Cyclist.Flag
 Min.   :2017      No :54118   CASUALTY CRASH      :11473   No :55725
 1st Qu.:2018      Yes: 2018   PROPERTY DAMAGE ONLY:44663   Yes:  411
 Median :2019
 Mean   :2019
 3rd Qu.:2020
 Max.   :2021

    Day.Of.Week                Derived.Crash.Configuration Heavy.Veh.Flag
 FRIDAY   :9316   REAR END                    :13024        No :54085
 MONDAY   :8024   SINGLE VEHICLE              :12495        Yes: 2051
 SATURDAY :6753   UNDETERMINED                :11453
 SUNDAY   :5464   SIDE IMPACT                 :11369
 THURSDAY :9061   CONFLICTED                  : 3068
 TUESDAY  :8728   SIDE SWIPE - SAME DIRECTION: 1833
 WEDNESDAY:8790   (Other)                     : 2894
 Intersection.Crash  Month.Of.Year   Motorcycle.Flag Parked.Vehicle.Flag
 No :31677           JULY    : 5152   No :55673       No :38567
 Yes:24459           DECEMBER: 5095   Yes:  463       Yes:17569
                     JANUARY : 5063
                     AUGUST  : 4907
                     OCTOBER : 4836
                     JUNE    : 4735
                     (Other) :26348
 Parking.Lot.Flag Pedestrian.Flag  Street.Full.Name..ifnull.
 No :37189        No :55790       HWY 97        : 6019
 Yes:18947        Yes:  346       HARVEY AVE    : 3168
                                  HWY 33        : 2064
                                  GORDON DR     : 1921
                                  LAKESHORE RD  : 1372
                                  SPRINGFIELD RD: 1326
                                  (Other)       :40266
     Time.Category      Municipality.Name Road.Location.Description
 12:00-14:59:14870   KELOWNA     :45943   UNKNOWN     : 2211
 15:00-17:59:14473   WEST KELOWNA:10193   HWY 97      : 1961
 09:00-11:59:11021                        HARVEY AVE  : 1670
 18:00-20:59: 5805                        LAKESHORE RD:  932
 06:00-08:59: 5489                        LOUIE DR    :  751
 21:00-23:59: 2684                        HWY 33      :  715
 (Other)    : 1794                        (Other)     :47896
       Street.Full.Name Metric.Selector Total.Crashes   Total.Victims
 HWY 97        : 6019   Min.   :1.000   Min.   :1.000   Min.   :0.0000
 HARVEY AVE    : 3168   1st Qu.:1.000   1st Qu.:1.000   1st Qu.:0.0000
 HWY 33        : 2064   Median :1.000   Median :1.000   Median :0.0000
 GORDON DR     : 1921   Mean   :1.006   Mean   :1.006   Mean   :0.2917
```

```
 LAKESHORE RD  : 1372   3rd Qu.:1.000   3rd Qu.:1.000   3rd Qu.:0.0000
 SPRINGFIELD RD: 1326   Max.   :3.000   Max.   :3.000   Max.   :9.0000
 (Other)       :40266
```

```
> #save(alldata, file = "../rda_files/all_data.rda")
```