Project2

Mayar

1/22/2022

Peer Graded Assignment Course Project 2

Title: Analysis of weather data

Synopsis: Analysis of weather data (Storms and other severe weather events) Storms and other severe weather events can cause both public health and economic problems for communities and municipalities. Many severe events can result in fatalities, injuries, and property damage, and preventing such outcomes to the extent possible is a key concern. This project involves exploring the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. This database tracks characteristics of major storms and weather events in the United States, including when and where they occur, as well as estimates of any fatalities, injuries, and property damage.

Data Processing The data for this assignment come in the form of a comma-separated-value file compressed via the bzip2 algorithm to reduce its size. You can download the file from the course web site:

Read the data in

```
# first clean the environment and setup the working directory
rm(list= ls())


# now download file
if (!file.exists("StormData.csv.bz2")) {
    fileURL <- 'https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2'
    download.file(fileURL, destfile='StormData.csv.bz2', method = 'curl')
}
noaaDF <- read.csv(bzfile('StormData.csv.bz2'),header=TRUE, stringsAsFactors = FALSE)
```

load the various needed packages

```
## Loading required package: dplyr
##
## Attaching package: 'dplyr'
## The following objects are masked from 'package:stats':
##
##     filter, lag
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

require(dplyr)
```

```
## Loading required package: dplyr
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
require(tidyr)
```

```
## Loading required package: tidyr
```

```
## Loading required package: tidyr
require(lubridate)
```

```
## Loading required package: lubridate

##
## Attaching package: 'lubridate'

## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
## Loading required package: lubridate
##
## Attaching package: 'lubridate'
## The following object is masked from 'package:base':
##
##     date


require(ggplot2)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: ggplot2
```

preliminary analysis First a summary of the NU.S. National Oceanic and Atmospheric Administration's (NOAA) storm database:

```
summary(noaaDF)
```

```
##     STATE__        BGN_DATE           BGN_TIME          TIME_ZONE
##  Min.   : 1.0   Length:902297      Length:902297      Length:902297
##  1st Qu.:19.0   Class :character   Class :character   Class :character
##  Median :30.0   Mode  :character   Mode  :character   Mode  :character
```

```
##  Mean   :31.2
##  3rd Qu.:45.0
##  Max.   :95.0
##
##      COUNTY       COUNTYNAME           STATE              EVTYPE
##  Min.   :  0.0   Length:902297      Length:902297      Length:902297
##  1st Qu.: 31.0   Class :character   Class :character   Class :character
##  Median : 75.0   Mode  :character   Mode  :character   Mode  :character
##  Mean   :100.6
##  3rd Qu.:131.0
##  Max.   :873.0
##
##    BGN_RANGE          BGN_AZI           BGN_LOCATI          END_DATE
##  Min.   :   0.000   Length:902297      Length:902297      Length:902297
##  1st Qu.:   0.000   Class :character   Class :character   Class :character
##  Median :   0.000   Mode  :character   Mode  :character   Mode  :character
##  Mean   :   1.484
##  3rd Qu.:   1.000
##  Max.   :3749.000
##
##    END_TIME           COUNTY_END COUNTYENDN       END_RANGE
##  Length:902297      Min.   :0    Mode:logical   Min.   :  0.0000
##  Class :character   1st Qu.:0    NA's:902297    1st Qu.:  0.0000
##  Mode  :character   Median :0                   Median :  0.0000
##                     Mean   :0                   Mean   :  0.9862
##                     3rd Qu.:0                   3rd Qu.:  0.0000
##                     Max.   :0                   Max.   :925.0000
##
##    END_AZI            END_LOCATI            LENGTH              WIDTH
##  Length:902297      Length:902297      Min.   :   0.0000   Min.   :   0.000
##  Class :character   Class :character   1st Qu.:   0.0000   1st Qu.:   0.000
##  Mode  :character   Mode  :character   Median :   0.0000   Median :   0.000
##                                        Mean   :   0.2301   Mean   :   7.503
##                                        3rd Qu.:   0.0000   3rd Qu.:   0.000
##                                        Max.   :2315.0000   Max.   :4400.000
##
##        F               MAG            FATALITIES          INJURIES
##  Min.   :0.0      Min.   :    0.0   Min.   :  0.0000   Min.   :   0.0000
##  1st Qu.:0.0      1st Qu.:    0.0   1st Qu.:  0.0000   1st Qu.:   0.0000
##  Median :1.0      Median :   50.0   Median :  0.0000   Median :   0.0000
##  Mean   :0.9      Mean   :   46.9   Mean   :  0.0168   Mean   :   0.1557
##  3rd Qu.:1.0      3rd Qu.:   75.0   3rd Qu.:  0.0000   3rd Qu.:   0.0000
##  Max.   :5.0      Max.   :22000.0   Max.   :583.0000   Max.   :1700.0000
##  NA's   :843563
##     PROPDMG          PROPDMGEXP           CROPDMG          CROPDMGEXP
##  Min.   :   0.00   Length:902297      Min.   :  0.000   Length:902297
##  1st Qu.:   0.00   Class :character   1st Qu.:  0.000   Class :character
##  Median :   0.00   Mode  :character   Median :  0.000   Mode  :character
##  Mean   :  12.06                      Mean   :  1.527
##  3rd Qu.:   0.50                      3rd Qu.:  0.000
##  Max.   :5000.00                      Max.   :990.000
##
##      WFO             STATEOFFIC         ZONENAMES            LATITUDE
##  Length:902297      Length:902297      Length:902297      Min.   :   0
```

```
##  Class :character   Class :character   Class :character   1st Qu.:2802
##  Mode  :character   Mode  :character   Mode  :character   Median :3540
##                                                          Mean   :2875
##                                                          3rd Qu.:4019
##                                                          Max.   :9706
##                                                          NA's   :47
##    LONGITUDE        LATITUDE_E     LONGITUDE_       REMARKS
##  Min.   :-14451   Min.   :   0   Min.   :-14455   Length:902297
##  1st Qu.:  7247   1st Qu.:   0   1st Qu.:     0   Class :character
##  Median :  8707   Median :   0   Median :     0   Mode  :character
##  Mean   :  6940   Mean   :1452   Mean   :  3509
##  3rd Qu.:  9605   3rd Qu.:3549   3rd Qu.:  8735
##  Max.   : 17124   Max.   :9706   Max.   :106220
##                   NA's   :40
##      REFNUM
##  Min.   :     1
##  1st Qu.:225575
##  Median :451149
##  Mean   :451149
##  3rd Qu.:676723
##  Max.   :902297
##
```

```
str(noaaDF)
```

```
## 'data.frame':    902297 obs. of  37 variables:
##  $ STATE__   : num  1 1 1 1 1 1 1 1 1 1 ...
##  $ BGN_DATE  : chr  "4/18/1950 0:00:00" "4/18/1950 0:00:00" "2/20/1951 0:00:00" "6/8/1951 0:00:00" .
##  $ BGN_TIME  : chr  "0130" "0145" "1600" "0900" ...
##  $ TIME_ZONE : chr  "CST" "CST" "CST" "CST" ...
##  $ COUNTY    : num  97 3 57 89 43 77 9 123 125 57 ...
##  $ COUNTYNAME: chr  "MOBILE" "BALDWIN" "FAYETTE" "MADISON" ...
##  $ STATE     : chr  "AL" "AL" "AL" "AL" ...
##  $ EVTYPE    : chr  "TORNADO" "TORNADO" "TORNADO" "TORNADO" ...
##  $ BGN_RANGE : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ BGN_AZI   : chr  "" "" "" "" ...
##  $ BGN_LOCATI: chr  "" "" "" "" ...
##  $ END_DATE  : chr  "" "" "" "" ...
##  $ END_TIME  : chr  "" "" "" "" ...
##  $ COUNTY_END: num  0 0 0 0 0 0 0 0 0 0 ...
##  $ COUNTYENDN: logi  NA NA NA NA NA NA ...
##  $ END_RANGE : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ END_AZI   : chr  "" "" "" "" ...
##  $ END_LOCATI: chr  "" "" "" "" ...
##  $ LENGTH    : num  14 2 0.1 0 0 1.5 1.5 0 3.3 2.3 ...
##  $ WIDTH     : num  100 150 123 100 150 177 33 33 100 100 ...
##  $ F         : int  3 2 2 2 2 2 2 1 3 3 ...
##  $ MAG       : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ FATALITIES: num  0 0 0 0 0 0 0 0 1 0 ...
##  $ INJURIES  : num  15 0 2 2 2 6 1 0 14 0 ...
##  $ PROPDMG   : num  25 2.5 25 2.5 2.5 2.5 2.5 2.5 25 25 ...
##  $ PROPDMGEXP: chr  "K" "K" "K" "K" ...
##  $ CROPDMG   : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ CROPDMGEXP: chr  "" "" "" "" ...
```

```
##  $ WFO       : chr  "" "" "" "" ...
##  $ STATEOFFIC: chr  "" "" "" "" ...
##  $ ZONENAMES : chr  "" "" "" "" ...
##  $ LATITUDE  : num  3040 3042 3340 3458 3412 ...
##  $ LONGITUDE : num  8812 8755 8742 8626 8642 ...
##  $ LATITUDE_E: num  3051 0 0 0 0 ...
##  $ LONGITUDE_: num  8806 0 0 0 0 ...
##  $ REMARKS   : chr  "" "" "" "" ...
##  $ REFNUM    : num  1 2 3 4 5 6 7 8 9 10 ...
```

1: address the question of which types of events are most harmful to population health Calculate the fatalities and injuries seperately

The fatalities:

Results

```
totFatalities <- aggregate(noaaDF$FATALITIES, by = list(noaaDF$EVTYPE), "sum")
names(totFatalities) <- c("Event", "Fatalities")
totFatalitiesSorted <- totFatalities[order(-totFatalities$Fatalities), ][1:20, ]
totFatalitiesSorted
```

```
##                       Event Fatalities
## 834                 TORNADO       5633
## 130          EXCESSIVE HEAT       1903
## 153             FLASH FLOOD        978
## 275                    HEAT        937
## 464               LIGHTNING        816
## 856               TSTM WIND        504
## 170                   FLOOD        470
## 585             RIP CURRENT        368
## 359               HIGH WIND        248
## 19                AVALANCHE        224
## 972            WINTER STORM        206
## 586            RIP CURRENTS        204
## 278               HEAT WAVE        172
## 140            EXTREME COLD        160
## 760       THUNDERSTORM WIND        133
## 310               HEAVY SNOW        127
## 141 EXTREME COLD/WIND CHILL        125
## 676             STRONG WIND        103
## 30                 BLIZZARD        101
## 350               HIGH SURF        101
```

The injuries:

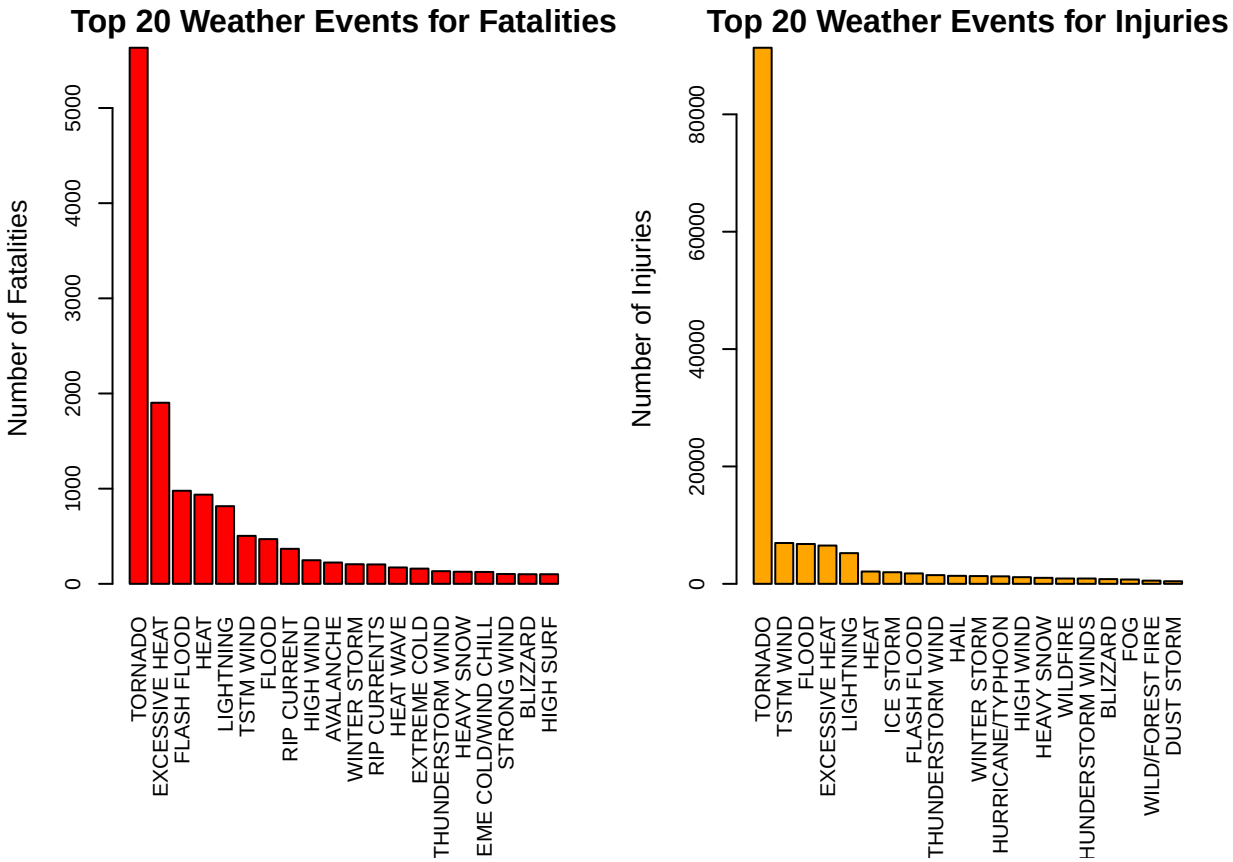
```
totInjuries <- aggregate(noaaDF$INJURIES, by = list(noaaDF$EVTYPE), "sum")
names(totInjuries) <- c("Event", "Injuries")
totInjuriesSorted <- totInjuries[order(-totInjuries$Injuries), ][1:20, ]
totInjuriesSorted
```

```
##                 Event Injuries
## 834           TORNADO    91346
```

```
## 856          TSTM WIND     6957
## 170              FLOOD     6789
## 130     EXCESSIVE HEAT     6525
## 464          LIGHTNING     5230
## 275               HEAT     2100
## 427          ICE STORM     1975
## 153        FLASH FLOOD     1777
## 760  THUNDERSTORM WIND     1488
## 244               HAIL     1361
## 972       WINTER STORM     1321
## 411  HURRICANE/TYPHOON     1275
## 359          HIGH WIND     1137
## 310         HEAVY SNOW     1021
## 957           WILDFIRE      911
## 786 THUNDERSTORM WINDS      908
## 30            BLIZZARD      805
## 188                 FOG      734
## 955   WILD/FOREST FIRE      545
## 117         DUST STORM      440
```

Finally plot both the fatalities and injuries in a single plot:

```
par(mfrow = c(1, 2), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main = 1.4, cex.lab = 1.2)
barplot(totFatalitiesSorted$Fatalities, names.arg = totFatalitiesSorted$Event, col = 'red',
        main = 'Top 20 Weather Events for Fatalities', ylab = 'Number of Fatalities')
barplot(totInjuriesSorted$Injuries, names.arg = totInjuriesSorted$Event, col = 'orange',
        main = 'Top 20 Weather Events for Injuries', ylab = 'Number of Injuries')
```



Thus we see that Tornados cause most deaths and injuries in the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. But Excessive heat causes second most deaths, whereas as far as injuries are conserned second to fourth causes have very similar values. address the question of which types of events have the greatest economic consequences Calculate the cost of property and crop damages seperately The property:

```
totProperty <- aggregate(noaaDF$PROPDMG, by = list(noaaDF$EVTYPE), "sum")
names(totProperty) <- c("Event", "Property")
totPropertySorted <- totProperty[order(-totProperty$Property), ][1:20, ]
totPropertySorted
```

```
##                   Event   Property
## 834             TORNADO 3212258.16
## 153         FLASH FLOOD 1420124.59
## 856           TSTM WIND 1335965.61
## 170               FLOOD  899938.48
## 760  THUNDERSTORM WIND  876844.17
## 244                HAIL  688693.38
## 464           LIGHTNING  603351.78
## 786   THUNDERSTORM WINDS  446293.18
## 359           HIGH WIND  324731.56
## 972        WINTER STORM  132720.59
## 310          HEAVY SNOW  122251.99
## 957            WILDFIRE   84459.34
## 427           ICE STORM   66000.67
## 676         STRONG WIND   62993.81
```

```
## 376           HIGH WINDS   55625.00
## 290           HEAVY RAIN   50842.14
## 848       TROPICAL STORM   48423.68
## 955     WILD/FOREST FIRE   39344.95
## 164       FLASH FLOODING   28497.15
## 919 URBAN/SML STREAM FLD   26051.94
```

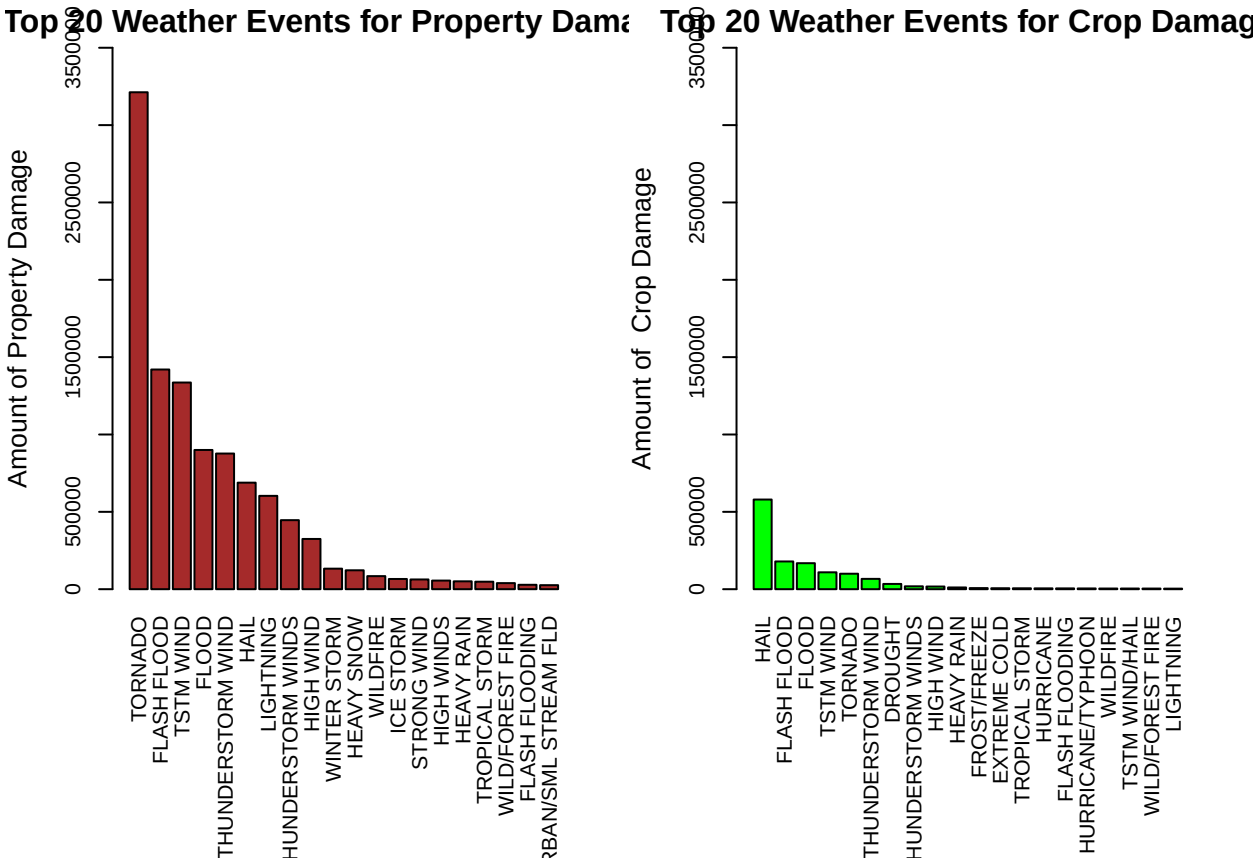
The crop:

```
totCrop <- aggregate(noaaDF$CROPDMG, by = list(noaaDF$EVTYPE), "sum")
names(totCrop) <- c("Event", "Crop")
totCropSorted <- totCrop[order(-totCrop$Crop), ][1:20, ]
totCropSorted
```

```
##                  Event      Crop
## 244               HAIL 579596.28
## 153        FLASH FLOOD 179200.46
## 170              FLOOD 168037.88
## 856          TSTM WIND 109202.60
## 834            TORNADO 100018.52
## 760  THUNDERSTORM WIND  66791.45
## 95              DROUGHT  33898.62
## 786 THUNDERSTORM WINDS  18684.93
## 359          HIGH WIND  17283.21
## 290         HEAVY RAIN  11122.80
## 212       FROST/FREEZE   7034.14
## 140       EXTREME COLD   6121.14
## 848     TROPICAL STORM   5899.12
## 402           HURRICANE   5339.31
## 164     FLASH FLOODING   5126.05
## 411  HURRICANE/TYPHOON   4798.48
## 957           WILDFIRE   4364.20
## 873     TSTM WIND/HAIL   4356.65
## 955   WILD/FOREST FIRE   4189.54
## 464           LIGHTNING   3580.61
```

Next plot both the cost of property and crop damages in a single plot:

```
par(mfrow = c(1, 2), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main = 1.4, cex.lab = 1.2)
barplot(totPropertySorted$Property, names.arg = totPropertySorted$Event, col = 'Brown',
        main = 'Top 20 Weather Events for Property Damage ', ylab = 'Amount of Property Damage', ylim =
barplot(totCropSorted$Crop, names.arg = totCropSorted$Event, col = 'Green',
        main = 'Top 20 Weather Events for Crop Damage', ylab = 'Amount of  Crop Damage', ylim = c(0, 35
```



Finally the totl damage by adding both costs (property and crop damage)

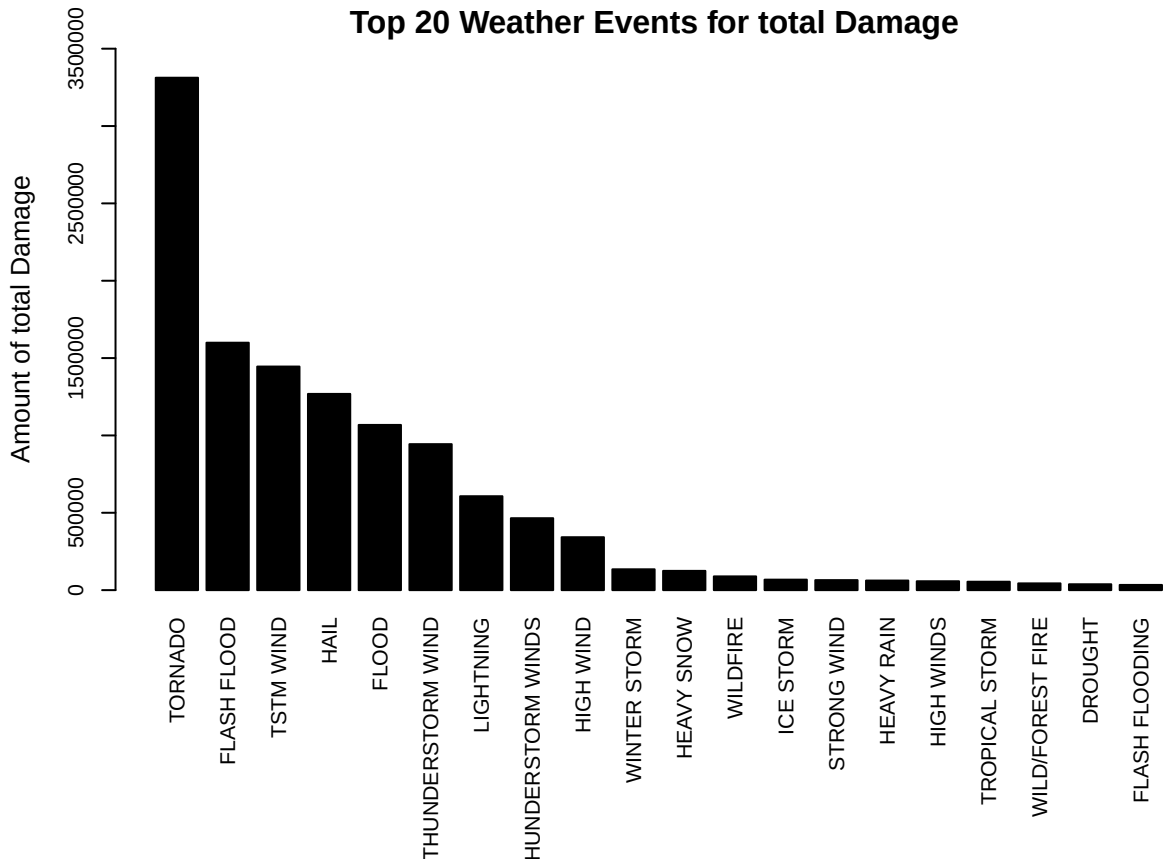
```
totTotalCost <- aggregate(noaaDF$CROPDMG+noaaDF$PROPDMG, by = list(noaaDF$EVTYPE), "sum")
names(totTotalCost) <- c("Event", "TotalCost")
totTotalCostSorted <- totTotalCost[order(-totTotalCost$TotalCost), ][1:20, ]
totTotalCostSorted
```

```
##                 Event  TotalCost
## 834           TORNADO 3312276.68
## 153       FLASH FLOOD 1599325.05
## 856         TSTM WIND 1445168.21
## 244              HAIL 1268289.66
## 170             FLOOD 1067976.36
## 760 THUNDERSTORM WIND  943635.62
## 464         LIGHTNING  606932.39
## 786 THUNDERSTORM WINDS  464978.11
## 359         HIGH WIND  342014.77
## 972      WINTER STORM  134699.58
## 310        HEAVY SNOW  124417.71
## 957          WILDFIRE   88823.54
## 427         ICE STORM   67689.62
## 676       STRONG WIND   64610.71
## 290        HEAVY RAIN   61964.94
## 376        HIGH WINDS   57384.60
## 848    TROPICAL STORM   54322.80
## 955  WILD/FOREST FIRE   43534.49
```

```
## 95              DROUGHT   37997.67
## 164     FLASH FLOODING   33623.20
```

And a single plot

```
par(mfrow = c(1,1), mar = c(10, 4, 2, 2), las = 3, cex = 0.7, cex.main = 1.4, cex.lab = 1.2)
barplot(totTotalCostSorted$TotalCost, names.arg = totTotalCostSorted$Event, col = 'Black',
        main = 'Top 20 Weather Events for total Damage ', ylab = 'Amount of total Damage', ylim = c(0, 3
```



Thus we notice that tornadoes cause most total damage. the Problem Instructions Introduction

Storms and other severe weather events can cause both public health and economic problems for communities and municipalities. Many severe events can result in fatalities, injuries, and property damage, and preventing such outcomes to the extent possible is a key concern.

This project involves exploring the U.S. National Oceanic and Atmospheric Administration's (NOAA) storm database. This database tracks characteristics of major storms and weather events in the United States, including when and where they occur, as well as estimates of any fatalities, injuries, and property damage.

The data for this assignment come in the form of a comma-separated-value file compressed via the bzip2 algorithm to reduce its size. You can download the file from the course web site:

Storm data

There is also some documentation of the database available. Here you will find how some of the variables are constructed/defined.

National Weather Service National Climatic Data Center Storm Events

The events in the database start in the year 1950 and end in November 2011. In the earlier years of the database there are generally fewer events recorded, most likely due to a lack of good records. More recent years should be considered more complete. Review criteria