Assignment2

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Severe weather events and their conscequences

Synopsis

In the USA, tornadoes have killed and hurt the largest number of American people.From 1950 to 2011, 5633 people have lost their lives due to tornadoes and more than 91000 people got injured. Moreover, tornadoes also caused the largest damage of properties. In the same period, the loss of property was estimated as $90 billion, while hail caused estimatedly total crop damage of more than $4 million. The estimation can be more precise if the type of the weather events was more generalized.

1. Data Reading and Processing

```
file <- "repdata_data_StormData.csv.bz2"
if (!file.exists(file)) {
  download.file('https://d396qusza40orc.cloudfront.net/repdata%2Fdata%2FStormData.csv.bz2', file,method="curl")
       unzip("repdata_data_StormData.csv.bz2",exdir="data")
}

raw <- read.csv(file,header=T,sep=",")
dim(raw)
```

```
## [1] 902297     37
```

```
str(raw)
```

```
## 'data.frame':    902297 obs. of  37 variables:
##  $ STATE__   : num  1 1 1 1 1 1 1 1 1 1 ...
##  $ BGN_DATE  : Factor w/ 16335 levels "1/1/1966 0:00:00",..: 6523 6523 4242 11116 2224 2224 2260 383 3980 3980 ...
##  $ BGN_TIME  : Factor w/ 3608 levels "00:00:00 AM",..: 272 287 2705 1683 2584 3186 242 1683 3186 3186 ...
##  $ TIME_ZONE : Factor w/ 22 levels "ADT","AKS","AST",..: 7 7 7 7 7 7 7 7 7 7 ...
##  $ COUNTY    : num  97 3 57 89 43 77 9 123 125 57 ...
##  $ COUNTYNAME: Factor w/ 29601 levels "","5NM E OF MACKINAC BRIDGE TO PRESQUE ISLE LT MI",..: 13513 1873 4598 10592 4372 10094 197
3 23873 24418 4598 ...
##  $ STATE     : Factor w/ 72 levels "AK","AL","AM",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ EVTYPE    : Factor w/ 985 levels "   HIGH SURF ADVISORY",..: 834 834 834 834 834 834 834 834 834 834 ...
##  $ BGN_RANGE : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ BGN_AZI   : Factor w/ 35 levels "","  N"," NW",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ BGN_LOCATI: Factor w/ 54429 levels ""," Christiansburg",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ END_DATE  : Factor w/ 6663 levels "","1/1/1993 0:00:00",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ END_TIME  : Factor w/ 3647 levels ""," 0900CST",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ 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   : Factor w/ 24 levels "","E","ENE","ESE",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ END_LOCATI: Factor w/ 34506 levels ""," CANTON"," TULIA",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ 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: Factor w/ 19 levels "","-","?","+",..: 17 17 17 17 17 17 17 17 17 17 ...
##  $ CROPDMG   : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ CROPDMGEXP: Factor w/ 9 levels "","?","0","2",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ WFO       : Factor w/ 542 levels ""," CI","%SD",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ STATEOFFIC: Factor w/ 250 levels "","ALABAMA, Central",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ ZONENAMES : Factor w/ 25112 levels "","                                                                    "| __truncated__,..: 1 1 1 1 1
1 1 1 1 1 ...
##  $ 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   : Factor w/ 436781 levels "","\t","\t\t",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ REFNUM    : num  1 2 3 4 5 6 7 8 9 10 ...
```

```r
# Let the unit of the damage value in columns "PROPDMGEXP" and "CROPDMGEXP" just be $
summary(raw)
```

```
##     STATE__                  BGN_DATE             BGN_TIME     
##  Min.   : 1.0   5/25/2011 0:00:00:  1202   12:00:00 AM: 10163  
##  1st Qu.:19.0   4/27/2011 0:00:00:  1193   06:00:00 PM:  7350  
##  Median :30.0   6/9/2011 0:00:00 :  1030   04:00:00 PM:  7261  
##  Mean   :31.2   5/30/2004 0:00:00:  1016   05:00:00 PM:  6891  
##  3rd Qu.:45.0   4/4/2011 0:00:00 :  1009   12:00:00 PM:  6703  
##  Max.   :95.0   4/2/2006 0:00:00 :   981   03:00:00 PM:  6700  
##                 (Other)          :895866   (Other)    :857229  
##    TIME_ZONE          COUNTY           COUNTYNAME         STATE       
##  CST    :547493   Min.   :  0.0   JEFFERSON :  7840   TX     : 83728  
##  EST    :245558   1st Qu.: 31.0   WASHINGTON:  7603   KS     : 53440  
##  MST    : 68390   Median : 75.0   JACKSON   :  6660   OK     : 46802  
##  PST    : 28302   Mean   :100.6   FRANKLIN  :  6256   MO     : 35648  
##  AST    :  6360   3rd Qu.:131.0   LINCOLN   :  5937   IA     : 31069  
##  HST    :  2563   Max.   :873.0   MADISON   :  5632   NE     : 30271  
##  (Other):  3631                   (Other)   :862369   (Other):621339  
##                EVTYPE         BGN_RANGE           BGN_AZI      
##  HAIL             :288661   Min.   :   0.000          :547332  
##  TSTM WIND        :219940   1st Qu.:   0.000   N      : 86752  
##  THUNDERSTORM WIND: 82563   Median :   0.000   W      : 38446  
##  TORNADO          : 60652   Mean   :   1.484   S      : 37558  
##  FLASH FLOOD      : 54277   3rd Qu.:   1.000   E      : 33178  
##  FLOOD            : 25326   Max.   :3749.000   NW     : 24041  
##  (Other)          :170878                      (Other):134990  
##          BGN_LOCATI                  END_DATE             END_TIME     
##               :287743                    :243411              :238978  
##  COUNTYWIDE   : 19680   4/27/2011 0:00:00:  1214   06:00:00 PM:  9802  
##  Countywide   :   993   5/25/2011 0:00:00:  1196   05:00:00 PM:  8314  
##  SPRINGFIELD  :   843   6/9/2011 0:00:00 :  1021   04:00:00 PM:  8104  
##  SOUTH PORTION:   810   4/4/2011 0:00:00 :  1007   12:00:00 PM:  7483  
##  NORTH PORTION:   784   5/30/2004 0:00:00:   998   11:59:00 PM:  7184  
##  (Other)      :591444   (Other)          :653450   (Other)    :622432  
##    COUNTY_END COUNTYENDN       END_RANGE           END_AZI      
##  Min.   :0    Mode:logical   Min.   :  0.0000          :724837  
##  1st Qu.:0    NA's:902297    1st Qu.:  0.0000   N      : 28082  
##  Median :0                   Median :  0.0000   S      : 22510  
##  Mean   :0                   Mean   :  0.9862   W      : 20119  
##  3rd Qu.:0                   3rd Qu.:  0.0000   E      : 20047  
##  Max.   :0                   Max.   :925.0000   NE     : 14606  
##                                                 (Other): 72096  
##            END_LOCATI         LENGTH              WIDTH         
##                 :499225   Min.   :   0.0000   Min.   :   0.000  
##  COUNTYWIDE     : 19731   1st Qu.:   0.0000   1st Qu.:   0.000  
##  SOUTH PORTION  :   833   Median :   0.0000   Median :   0.000  
##  NORTH PORTION  :   780   Mean   :   0.2301   Mean   :   7.503  
##  CENTRAL PORTION:   617   3rd Qu.:   0.0000   3rd Qu.:   0.000  
##  SPRINGFIELD    :   575   Max.   :2315.0000   Max.   :4400.000  
##  (Other)        :380536                                         
##        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          :465934   Min.   :  0.000          :618413  
##  1st Qu.:   0.00   K      :424665   1st Qu.:  0.000   K      :281832  
##  Median :   0.00   M      : 11330   Median :  0.000   M      :  1994  
##  Mean   :  12.06   0      :   216   Mean   :  1.527   k      :    21  
##  3rd Qu.:   0.50   B      :    40   3rd Qu.:  0.000   0      :    19  
##  Max.   :5000.00   5      :    28   Max.   :990.000   B      :     9  
##                    (Other):    84                     (Other):     9  
##       WFO                                       STATEOFFIC    
##         :142069                                      :248769  
##  OUN    : 17393   TEXAS, North                       : 12193  
##  JAN    : 13889   ARKANSAS, Central and North Central: 11738  
##  LWX    : 13174   IOWA, Central                      : 11345  
##  PHI    : 12551   KANSAS, Southwest                  : 11212  
##  TSA    : 12483   GEORGIA, North and Central         : 11120  
##  (Other):690738   (Other)                            :595920  
##                                                                                                                                ZONENAMES
```

```
##                                                                                                           :594029
##                                                                                                           :205988
##  GREATER RENO / CARSON CITY / M - GREATER RENO / CARSON CITY / M
:  639
##  GREATER LAKE TAHOE AREA - GREATER LAKE TAHOE AREA
:  592
##  JEFFERSON - JEFFERSON
:  303
##  MADISON - MADISON                                                                                              :
302
##  (Other)                                                                                                      :100444
##     LATITUDE      LONGITUDE        LATITUDE_E     LONGITUDE_
##  Min.   :   0   Min.   :-14451   Min.   :   0   Min.   :-14455
##  1st Qu.:2802   1st Qu.:  7247   1st Qu.:   0   1st Qu.:      0
##  Median :3540   Median :  8707   Median :   0   Median :      0
##  Mean   :2875   Mean   :  6940   Mean   :1452   Mean   :  3509
##  3rd Qu.:4019   3rd Qu.:  9605   3rd Qu.:3549   3rd Qu.:  8735
##  Max.   :9706   Max.   : 17124   Max.   :9706   Max.   :106220
##  NA's   :47                      NA's   :40
##                                            REMARKS           REFNUM
##                                                :287433   Min.   :      1
##                                                : 24013   1st Qu.:225575
##  Trees down.\n                                 :  1110   Median :451149
##  Several trees were blown down.\n              :   568   Mean   :451149
##  Trees were downed.\n                          :   446   3rd Qu.:676723
##  Large trees and power lines were blown down.\n:   432   Max.   :902297
##  (Other)                                       :588295
```

```
table(raw$PROPDMGEXP)
```

```
##
##             -      ?      +      0      1      2      3      4      5      6
## 465934      1      8      5    216     25     13      4      4     28      4
##      7      8      B      h      H      K      m      M
##      5      1     40      1      6 424665      7  11330
```

```
table(raw$CROPDMGEXP)
```

```
##
##             ?      0      2      B      k      K      m      M
## 618413      7     19      1      9     21 281832      1   1994
```

```
unit_fun <- function(unit){
  if (unit=="") {
    return(1)
  } else if(unit %in% c("?","-","+")){
    return(0)
  } else if(as.numeric(unit) %in%c(1:10)){
    return(as.numeric(unit))
  } else if(unit %in% c("k","K")){
    return(10^3)
  } else if(unit %in% c("m","M")){
    return(10^6)
  } else if(unit %in% c("h","H")){
    return(10^2)
  } else if(unit %in% c("B","b")){
    return(10^9)
  }

  }
temp_p <- sapply(raw$PROPDMGEXP,unit_fun)
temp_c <- sapply(raw$CROPDMGEXP,unit_fun)
library(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
```

```
raw <- raw %>%
 transform(PROPDMG=PROPDMG*unlist(temp_p),CROPDMG=CROPDMG*unlist(temp_c)) # unit is now $
```

```
## Warning in PROPDMG * unlist(temp_p): Länge des längeren Objektes
##       ist kein Vielfaches der Länge des kürzeren Objektes
```

```
raw <-  raw %>% mutate(PROPDMG_BIO=PROPDMG/10^9,CROPDMG_BIO=CROPDMG/10^9) # unit is now billion $

head(raw)
```

```
##   STATE__           BGN_DATE BGN_TIME TIME_ZONE COUNTY COUNTYNAME STATE  EVTYPE
## 1       1  4/18/1950 0:00:00     0130       CST     97     MOBILE    AL TORNADO
## 2       1  4/18/1950 0:00:00     0145       CST      3    BALDWIN    AL TORNADO
## 3       1  2/20/1951 0:00:00     1600       CST     57    FAYETTE    AL TORNADO
## 4       1   6/8/1951 0:00:00     0900       CST     89    MADISON    AL TORNADO
## 5       1 11/15/1951 0:00:00     1500       CST     43    CULLMAN    AL TORNADO
## 6       1 11/15/1951 0:00:00     2000       CST     77 LAUDERDALE    AL TORNADO
##   BGN_RANGE BGN_AZI BGN_LOCATI END_DATE END_TIME COUNTY_END COUNTYENDN
## 1         0                               0        NA
## 2         0                               0        NA
## 3         0                               0        NA
## 4         0                               0        NA
## 5         0                               0        NA
## 6         0                               0        NA
##   END_RANGE END_AZI END_LOCATI LENGTH WIDTH F MAG FATALITIES INJURIES PROPDMG
## 1         0                14.0   100 3   0         0       15   25000
## 2         0                 2.0   150 2   0         0        0    2500
## 3         0                 0.1   123 2   0         0        2   25000
## 4         0                 0.0   100 2   0         0        2    2500
## 5         0                 0.0   150 2   0         0        2    2500
## 6         0                 1.5   177 2   0         0        6    2500
##   PROPDMGEXP CROPDMG CROPDMGEXP WFO STATEOFFIC ZONENAMES LATITUDE LONGITUDE
## 1          K       0                          3040      8812
## 2          K       0                          3042      8755
## 3          K       0                          3340      8742
## 4          K       0                          3458      8626
## 5          K       0                          3412      8642
## 6          K       0                          3450      8748
##   LATITUDE_E LONGITUDE_ REMARKS REFNUM PROPDMG_BIO CROPDMG_BIO
## 1       3051       8806           1     2.5e-05          0
## 2          0          0       2     2.5e-06          0
## 3          0          0       3     2.5e-05          0
## 4          0          0       4     2.5e-06          0
## 5          0          0       5     2.5e-06          0
## 6          0          0       6     2.5e-06          0
```

```
dim(raw)
```

```
## [1] 902297     39
```

Results

1) Across the United States, which types of events (as indicated in the EVTYPEEVTYPE variable) are most harmful with respect to population health?

```
injury <- raw %>% group_by(EVTYPE) %>%
      summarise(sum_injury=sum(INJURIES,na.rm=T)) %>%
      arrange(desc(sum_injury))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
# Top 10 severe weathers, which brought the most injuries
injury_top10 <- injury %>% top_n(10)
```

```
## Selecting by sum_injury
```

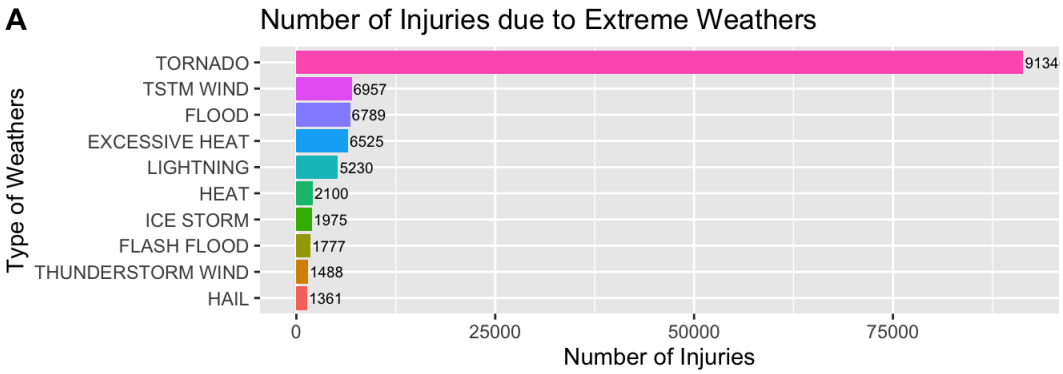
```
fatality <- raw %>% group_by(EVTYPE) %>%
      summarise(sum_fatality=sum(FATALITIES,na.rm=T)) %>%
      arrange(desc(sum_fatality))
```

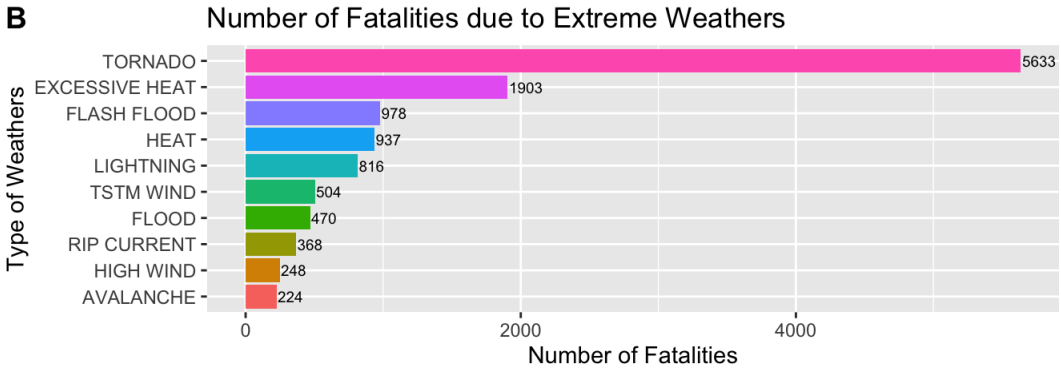
```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
# Top 10 severe weathers, which led to the most fatalities
fatality_top10 <- fatality %>% top_n(10)
```

```
## Selecting by sum_fatality
```

```
##
## The downloaded binary packages are in
##  /var/folders/5x/5xkzjtpx77l47xk83kvx7fl00000gn/T//RtmpQD5MO5/downloaded_packages
```





2) Across the United States, which types of events have the greatest economic consequences?

```
prop_damage <- raw %>% group_by(EVTYPE) %>%
      summarise(damage_p=sum(PROPDMG_BIO,na.rm=T))%>%
      arrange(desc(damage_p))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
prop_damage_top10 <- prop_damage %>% top_n(10)
```

```
## Selecting by damage_p
```

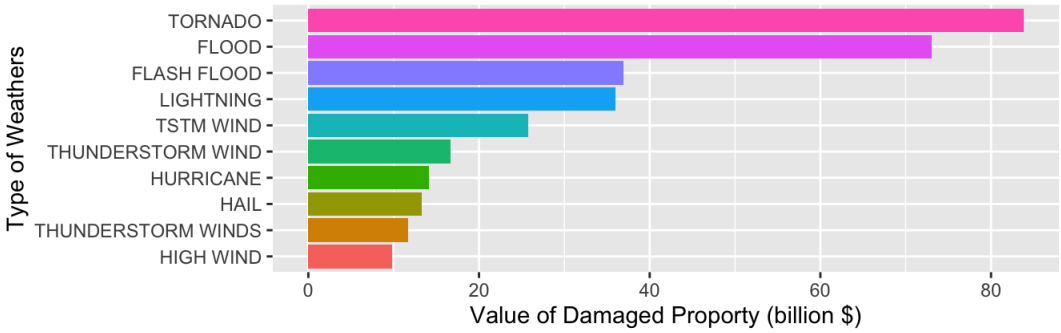
```
crop_damage <- raw %>% group_by(EVTYPE) %>%
      summarise(damage_c=sum(CROPDMG_BIO,na.rm=T)) %>%
      arrange(desc(damage_c))
```

```
## `summarise()` ungrouping output (override with `.groups` argument)
```

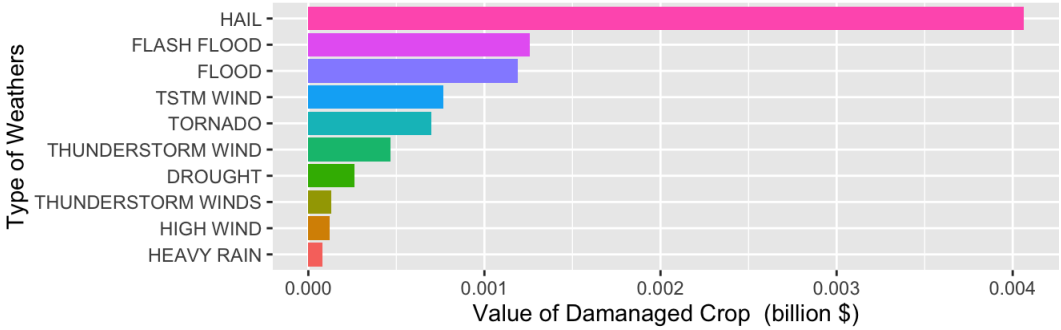
```
crop_damage_top10 <- crop_damage %>% top_n(10)
```

```
## Selecting by damage_c
```

C


Damage of Proporty due to Extreme Weathers
Type of Weathers
TORNADO
FLOOD
FLASH FLOOD
LIGHTNING
TSTM WIND
THUNDERSTORM WIND
HURRICANE
HAIL
THUNDERSTORM WINDS
HIGH WIND
0
20
40
60
80
Value of Damaged Proporty (billion $)

D


Damage of Crop Damage due to Extreme Weathers
Type of Weathers
HAIL
FLASH FLOOD
FLOOD
TSTM WIND
TORNADO
THUNDERSTORM WIND
DROUGHT
THUNDERSTORM WINDS
HIGH WIND
HEAVY RAIN
0.000
0.001
0.002
0.003
0.004
Value of Damanaged Crop (billion $)