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 time period, the loss of property was estimated as $3.2 trillion, while hail caused estimatedly total crop damage of $58 billion.

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",..: 272 287 270
5 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 1973 2387
3 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",..: 83
4 834 834 834 834 834 834 834 834 ...
##  $ 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 ...
```

```
# Let the unit of the damage value in columns "PROPDMGEXP" and "CROPD
MGEXP" 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     : 837
28
##  EST    :245558   1st Qu.: 31.0   WASHINGTON:  7603   KS     : 534
40
##  MST    : 68390   Median : 75.0   JACKSON   :  6660   OK     : 468
02
##  PST    : 28302   Mean   :100.6   FRANKLIN  :  6256   MO     : 356
48
##  AST    :  6360   3rd Qu.:131.0   LINCOLN   :  5937   IA     : 310
69
##  HST    :  2563   Max.   :873.0   MADISON   :  5632   NE     : 302
71
##  (Other):  3631                   (Other)   :862369   (Other):6213
39
##                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             :238
978
##  COUNTYWIDE   : 19680   4/27/2011 0:00:00:  1214   06:00:00 PM:  9
802
```

```
##  Countywide   :   993   5/25/2011 0:00:00:  1196   05:00:00 PM:  8
314
##  SPRINGFIELD  :   843   6/9/2011 0:00:00 :  1021   04:00:00 PM:  8
104
##  SOUTH PORTION:   810   4/4/2011 0:00:00 :  1007   12:00:00 PM:  7
483
##  NORTH PORTION:   784   5/30/2004 0:00:00:   998   11:59:00 PM:  7
184
##  (Other)      :591444   (Other)          :653450   (Other)    :622
432
##    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.   :170
0.0000
##  NA's   :843563
##     PROPDMG          PROPDMGEXP        CROPDMG          CROPDMGEXP
##  Min.   :   0.00          :465934   Min.   :  0.000          :6184
13
##  1st Qu.:   0.00   K      :424665   1st Qu.:  0.000   K      :2818
32
##  Median :   0.00   M      : 11330   Median :  0.000   M      :  19
94
```

```
94
##  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   :40
                                                    REMARKS           REFNU
M
##                                                          :287433   Min.   :
1
##                                                          : 24013   1st Qu.:2
25575
```

```
##  Trees down.\n                                    :  1110   Median :4
51149
##  Several trees were blown down.\n                :   568   Mean   :4
51149
##  Trees were downed.\n                            :   446   3rd Qu.:6
76723
##  Large trees and power lines were blown down.\n:   432   Max.   :9
02297
##  (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(NA)
  } 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(10^12)
  }

}
```

```
  }
raw$PROPDMG <- raw$PROPDMG*unit_fun(raw$PROPDMGEXP)
```

```
## Warning in if (unit == "") {: Bedingung hat Länge > 1 und nur das
erste Element
## wird benutzt
```

```
## Warning in if (unit %in% c("?", "-", "+")) {: Bedingung hat Länge
> 1 und nur
## das erste Element wird benutzt
```

```
## Warning in if (as.numeric(unit) %in% c(1:10)) {: Bedingung hat Län
ge > 1 und nur
## das erste Element wird benutzt
```

```
## Warning in if (unit %in% c("k", "K")) {: Bedingung hat Länge > 1 u
nd nur das
## erste Element wird benutzt
```

```
raw$CROPDMG <- raw$CROPDMG*unit_fun(raw$CROPDMGEXP)
```

```
## Warning in if (unit == "") {: Bedingung hat Länge > 1 und nur das
erste Element
## wird benutzt
```

```
raw$PROPDMGEXP <- c(1)
raw$CROPDMGEXP <- c(1)
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
```

```
## 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 COUNTY
ENDN
## 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 INJUR
IES 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          1       0          1                              3040
8812
## 2          1       0          1                              3042
8755
## 3          1       0          1                              3340
8742
## 4          1       0          1                              3458
8626
## 5          1       0          1                              3412
8642
## 6          1       0          1                              3450
8748
##   LATITUDE_E LONGITUDE_ REMARKS REFNUM
## 1       3051        8806               1
## 2          0           0               2
```

```
## 3          0          0          3
## 4          0          0          4
## 5          0          0          5
## 6          0          0          6
```

```
dim(raw)
```

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

Results

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

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

```
## `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)) %>%
        ungroup()
```

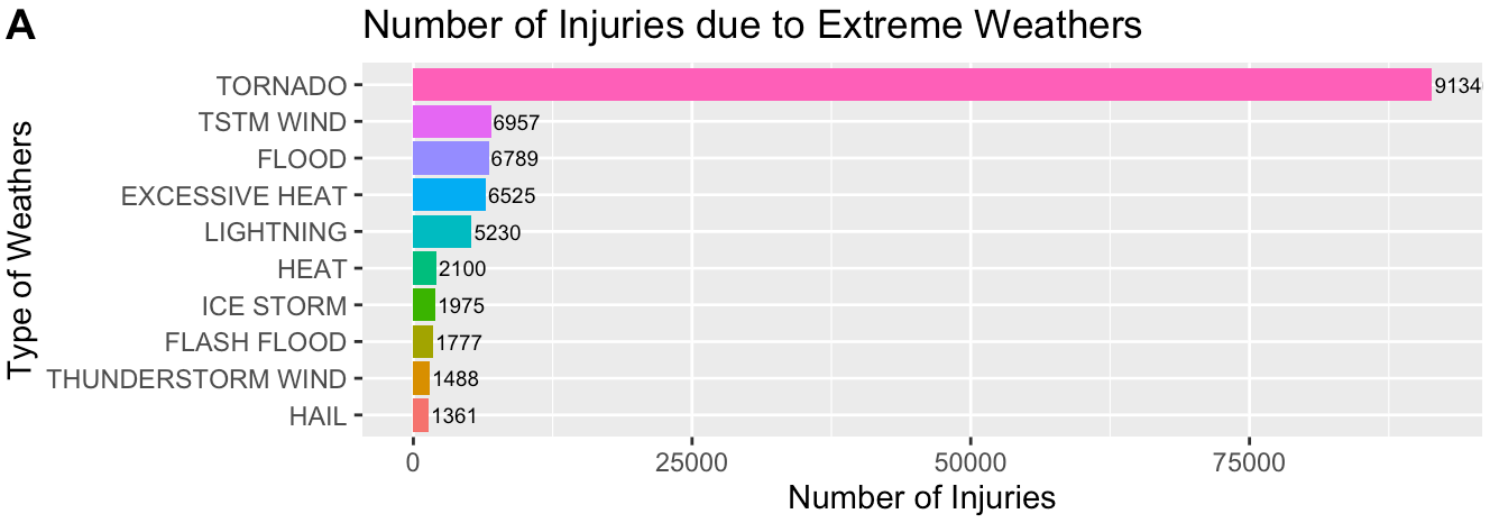


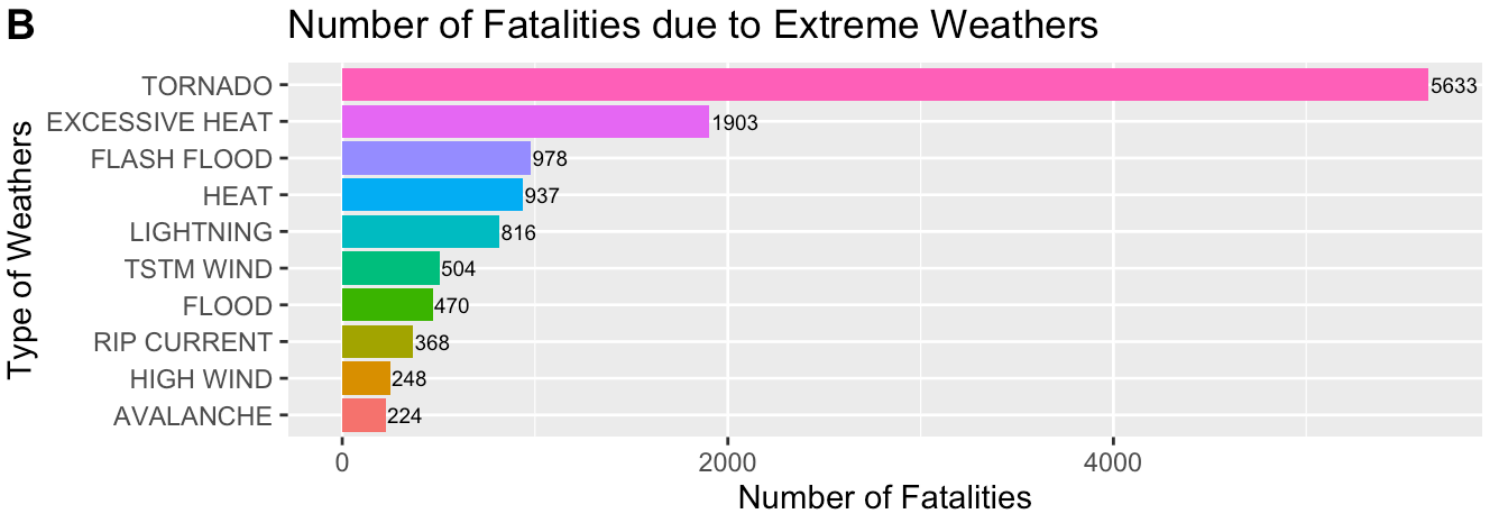
```
## `summarise()` ungrouping output (override with `.groups` argument)
```

```
# 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//RtmpaG1z7O/down
loaded_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,na.rm=T))%>%
        arrange(desc(damage_p)) %>%
        ungroup()
```



```
## `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,na.rm=T)) %>%
        arrange(desc(damage_c)) %>%
        ungroup()
```

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

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

```
## Selecting by damage_c
```