Bush-Fire-Analysis.R

2025-04-16

```r
setwd("C:/H/W/Data science/New folder")
#Loading the data set
BFdata = read.csv("BushFireData.csv")
attach(BFdata)
#Data overview
head(BFdata)
```

```
##     ClaimID Fire_Intensity Distance_from_Fire Building_Age Property_Value
## 1 DQTA26862         5738.5               5.57           19           9.76
## 2 RDAQ32534        12247.9               5.49           27           5.89
## 3 WTLA41817         7316.6               5.12           16           3.98
## 4 YHZL16317        13479.2               4.89           30           4.91
## 5 LUKH77472        14226.0               6.13           21           9.31
## 6 YBOA62820         2592.2               7.66           27           6.41
##   Population_Density Emergency_Response_Time Mitigation_Measures
## 1                520                      16                   3
## 2                433                      18                   3
## 3                634                      17                   4
## 4                576                      14                   2
## 5                644                      12                   2
## 6                476                      10                   1
##   Construction_Quality Insurance_Coverage Wind_Speed Humidity
Damage_Claims
## 1                 Good              Fully       24.9    35.32
7.02
## 2                 Good               None       21.0    28.24
7.45
## 3                 Good          Partially       25.3    44.51
4.30
## 4                 Good          Partially       22.3    53.77
7.78
## 5                 Good               None       37.2    73.79
9.46
## 6                 Good              Fully       31.8    50.89
4.54
```

```r
dim(BFdata)
```

```
## [1] 600  13
```

```r
sum(is.na(BFdata))
```

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

```r
#Explore data structure
str(BFdata)
```

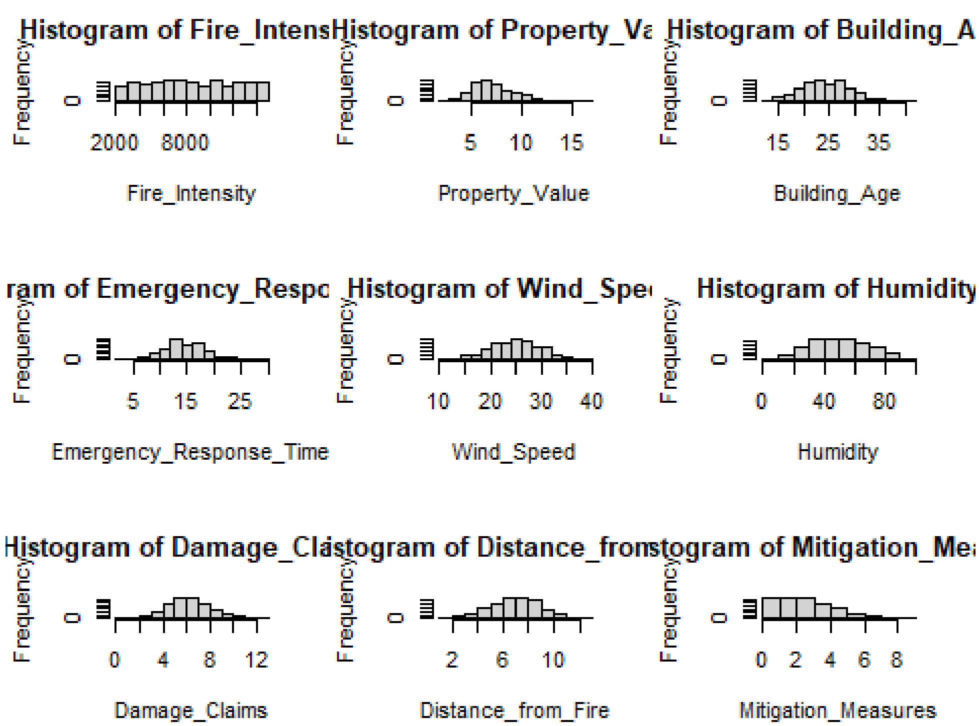
```
## 'data.frame':    600 obs. of  13 variables:
##  $ ClaimID               : chr  "DQTA26862" "RDAQ32534" "WTLA41817"
"YHZL16317" ...
##  $ Fire_Intensity        : num  5738 12248 7317 13479 14226 ...
##  $ Distance_from_Fire    : num  5.57 5.49 5.12 4.89 6.13 ...
##  $ Building_Age          : int  19 27 16 30 21 27 24 24 36 30 ...
##  $ Property_Value        : num  9.76 5.89 3.98 4.91 9.31 ...
##  $ Population_Density    : int  520 433 634 576 644 476 500 591 487 441
...
##  $ Emergency_Response_Time: int  16 18 17 14 12 10 16 19 15 18 ...
##  $ Mitigation_Measures   : int  3 3 4 2 2 1 5 7 2 3 ...
##  $ Construction_Quality  : chr  "Good" "Good" "Good" "Good" ...
##  $ Insurance_Coverage    : chr  "Fully" "None" "Partially" "Partially"
...
##  $ Wind_Speed            : num  24.9 21 25.3 22.3 37.2 31.8 27.8 22.5
32.2 20.6 ...
##  $ Humidity              : num  35.3 28.2 44.5 53.8 73.8 ...
##  $ Damage_Claims         : num  7.02 7.45 4.3 7.78 9.46 4.54 7.14 7.73
6.03 5.37 ...
```

```r
summary(BFdata)
```

```
##    ClaimID          Fire_Intensity  Distance_from_Fire  Building_Age
##  Length:600         Min.   : 2006   Min.   : 1.380     Min.   :12.00
##  Class :character   1st Qu.: 5379   1st Qu.: 5.710     1st Qu.:21.00
##  Mode  :character   Median : 8272   Median : 7.090     Median :25.00
##                     Mean   : 8490   Mean   : 7.026     Mean   :24.88
##                     3rd Qu.:11708   3rd Qu.: 8.410     3rd Qu.:28.00
##                     Max.   :14992   Max.   :12.380     Max.   :42.00
##  Property_Value   Population_Density Emergency_Response_Time
##  Min.   : 2.800   Min.   :372.0      Min.   : 2.00
##  1st Qu.: 5.737   1st Qu.:546.0      1st Qu.:13.00
##  Median : 6.920   Median :597.5      Median :15.00
##  Mean   : 7.278   Mean   :598.3      Mean   :14.97
##  3rd Qu.: 8.590   3rd Qu.:652.2      3rd Qu.:18.00
##  Max.   :16.290   Max.   :842.0      Max.   :29.00
##  Mitigation_Measures Construction_Quality Insurance_Coverage   Wind_Speed
##  Min.   :0.000       Length:600           Length:600         Min.   :10.00
##  1st Qu.:2.000       Class :character     Class :character   1st Qu.:21.40
##  Median :3.000       Mode  :character     Mode  :character   Median :24.95
##  Mean   :2.978                                               Mean   :24.99
##  3rd Qu.:4.000                                               3rd Qu.:28.52
##  Max.   :9.000                                               Max.   :39.50
##     Humidity      Damage_Claims
##  Min.   : 5.46   Min.   : 0.100
##  1st Qu.:35.54   1st Qu.: 4.978
##  Median :49.20   Median : 6.180
```

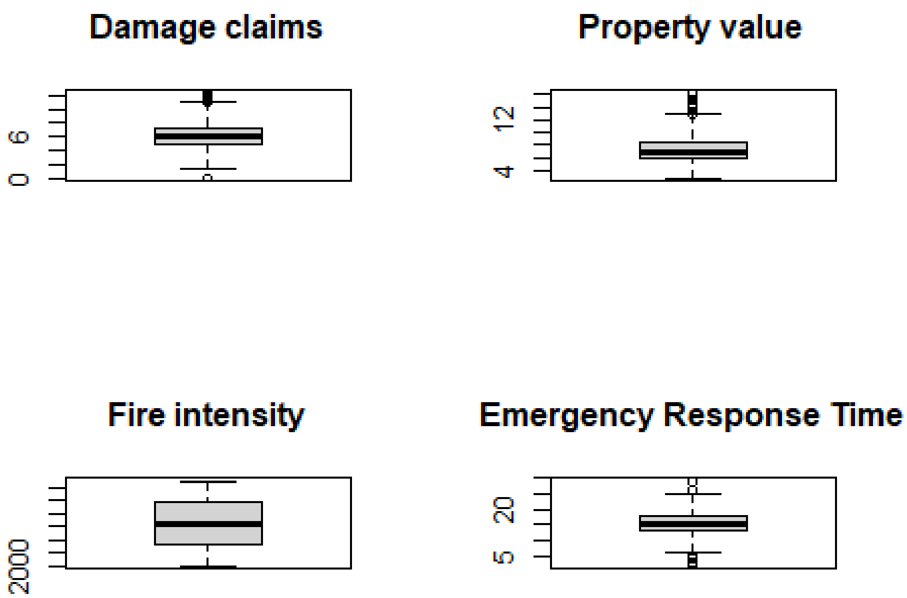
```
##   Mean   :49.77   Mean   : 6.250
##   3rd Qu.:63.83   3rd Qu.: 7.362
##   Max.   :98.63   Max.   :12.370

#Encoding construction quality Good and Bad to 1 and 0
BFdata$Construction_Quality = ifelse(BFdata$Construction_Quality ==
"Good",1,0)

#Encoding insurance coverage: 0 for none, 1 for partially and 2 for fully
IC_factor = factor(BFdata$Insurance_Coverage, levels = c("None", "Partially",
"Fully"))
BFdata$Insurance_Coverage = as.integer(IC_factor) - 1

#Divide 50% of the dataset into training and 50% for testing and remove
excess variable
set.seed(2)
tr.id = sample(1:nrow(BFdata),nrow(BFdata)/2)
training = BFdata[tr.id,]
training = training[,-1]
test = BFdata[-tr.id,]
test = test[,-1]
str(training)

## 'data.frame':    300 obs. of  12 variables:
##  $ Fire_Intensity         : num  4496 5852 2937 4980 8695 ...
##  $ Distance_from_Fire     : num  9.25 9.37 5.44 8.48 8.5 7.76 6.75 4.92
5.68 3.62 ...
##  $ Building_Age           : int  24 17 21 24 20 18 28 26 23 35 ...
##  $ Property_Value         : num  7.51 7.27 7.46 7.53 5.22 ...
##  $ Population_Density     : int  611 732 623 773 564 640 410 414 544 560
...
##  $ Emergency_Response_Time: int  14 11 12 16 16 15 9 21 17 16 ...
##  $ Mitigation_Measures    : int  5 2 1 4 1 2 3 2 4 1 ...
##  $ Construction_Quality   : num  1 1 1 1 1 1 1 1 1 0 ...
##  $ Insurance_Coverage     : num  2 2 2 2 2 2 2 1 1 0 ...
##  $ Wind_Speed             : num  32 31.7 25.8 21.3 21.4 25.6 30.4 24.3
27.4 29.1 ...
##  $ Humidity               : num  60.9 32.9 44.1 49.4 64.8 ...
##  $ Damage_Claims          : num  4.57 4.53 6.8 6.65 2.39 5.5 7.63 7.89
5.14 9.18 ...

str(test)

## 'data.frame':    300 obs. of  12 variables:
##  $ Fire_Intensity         : num  12248 7317 14226 7936 14439 ...
##  $ Distance_from_Fire     : num  5.49 5.12 6.13 11.08 9.6 ...
##  $ Building_Age           : int  27 16 21 30 32 22 28 31 24 25 ...
##  $ Property_Value         : num  5.89 3.98 9.31 8.49 5.47 5.46 9.13 3.91
7.01 8.3 ...
##  $ Population_Density     : int  433 634 644 441 663 518 509 625 530 538
...
```

```
##  $ Emergency_Response_Time: int  18 17 12 18 24 13 12 18 16 12 ...
##  $ Mitigation_Measures    : int  3 4 2 3 2 5 5 3 0 3 ...
##  $ Construction_Quality   : num  1 1 1 1 0 1 0 1 1 1 ...
##  $ Insurance_Coverage     : num  0 1 0 1 1 1 1 1 1 0 ...
##  $ Wind_Speed             : num  21 25.3 37.2 20.6 36.5 10 37.7 24.6 26.4
25.5 ...
##  $ Humidity               : num  28.2 44.5 73.8 76 61.1 ...
##  $ Damage_Claims          : num  7.45 4.3 9.46 5.37 5.42 6.55 5.86 4.02
5.43 7.34 ...

#Build histogram to explore the distribution of property value as well as
building age
par(mfrow = c(3,3))
hist(Fire_Intensity)
hist(Property_Value)
hist(Building_Age)
hist(Emergency_Response_Time)
hist(Wind_Speed)
hist(Humidity)
hist(Damage_Claims)
hist(Distance_from_Fire)
hist(Mitigation_Measures)
```



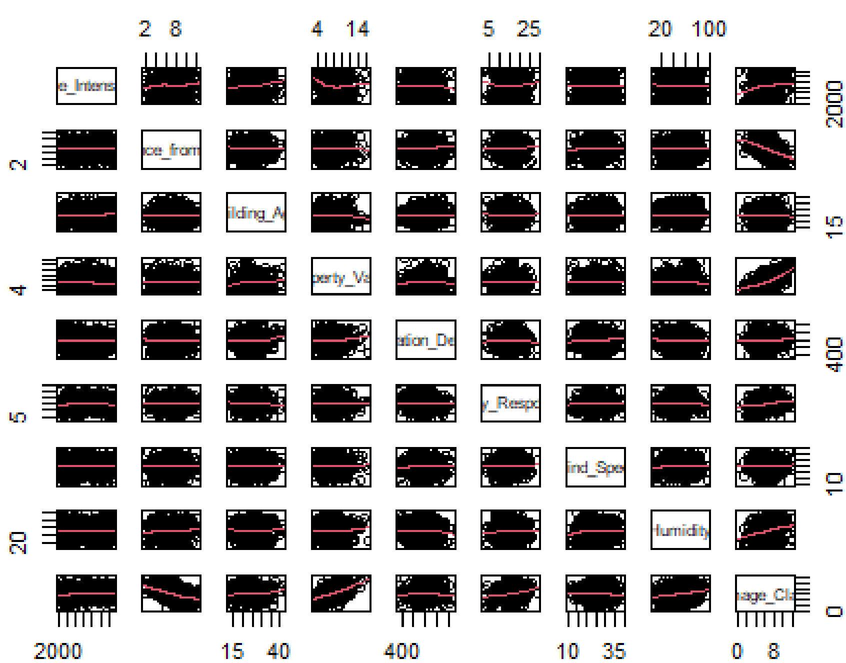

```
#Build box-plot to detect outliers and summarising the distribution of the
data set
par(mfrow = c(2,2))
boxplot(Damage_Claims, main = "Damage claims")
```

```
boxplot(Property_Value, main = "Property value")
boxplot(Fire_Intensity, main = "Fire intensity")
boxplot(Emergency_Response_Time, main = "Emergency Response Time")
```




```
#Correlation matrix for key numerical variables to explore the relationship
between them
cor_matrix =
BFdata[,c("Fire_Intensity","Distance_from_Fire","Building_Age","Property_Valu
e","Population_Density","Emergency_Response_Time","Wind_Speed","Humidity","Da
mage_Claims")]
cor(cor_matrix)

##                         Fire_Intensity Distance_from_Fire Building_Age
## Fire_Intensity             1.000000000         0.00430711   0.07932316
## Distance_from_Fire         0.004307110         1.00000000  -0.01747107
## Building_Age               0.079323163        -0.01747107   1.00000000
## Property_Value            -0.092373683         0.01046487   0.01011021
## Population_Density         0.005966024         0.03368348  -0.01500278
## Emergency_Response_Time    0.006990306         0.01909041  -0.02546560
## Wind_Speed                -0.026135802         0.04742770  -0.05554963
## Humidity                   0.002108686         0.03929606  -0.02762756
## Damage_Claims              0.094694540        -0.51972220   0.03508000
##                         Property_Value Population_Density
## Fire_Intensity            -0.092373683        0.005966024
## Distance_from_Fire         0.010464875        0.033683480
## Building_Age               0.010110213       -0.015002777
## Property_Value             1.000000000        0.013515053
```

```
## Population_Density          0.013515053        1.000000000
## Emergency_Response_Time    -0.007032240       -0.026580657
## Wind_Speed                  0.035542394        0.061671042
## Humidity                   -0.008731118       -0.016382216
## Damage_Claims               0.535456227       -0.005300330
##                         Emergency_Response_Time   Wind_Speed     Humidity
## Fire_Intensity                      0.006990306 -0.026135802  0.002108686
## Distance_from_Fire                  0.019090406  0.047427705  0.039296064
## Building_Age                       -0.025465605 -0.055549633 -0.027627558
## Property_Value                     -0.007032240  0.035542394 -0.008731118
## Population_Density                 -0.026580657  0.061671042 -0.016382216
## Emergency_Response_Time             1.000000000 -0.000547797  0.019014280
## Wind_Speed                         -0.000547797  1.000000000  0.042964276
## Humidity                            0.019014280  0.042964276  1.000000000
## Damage_Claims                       0.204320762 -0.029321620  0.264199332
##                         Damage_Claims
## Fire_Intensity             0.09469454
## Distance_from_Fire        -0.51972220
## Building_Age               0.03508000
## Property_Value             0.53545623
## Population_Density        -0.00530033
## Emergency_Response_Time    0.20432076
## Wind_Speed                -0.02932162
## Humidity                   0.26419933
## Damage_Claims              1.00000000

pairs(cor_matrix, panel = panel.smooth)
```



```r
#Build multiple linear regression
m1 = lm(Damage_Claims~.,data = training)
summary(m1)

##
## Call:
## lm(formula = Damage_Claims ~ ., data = training)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.95324 -0.72569  0.01252  0.72947  2.73626
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
## (Intercept)              2.270e+00  8.074e-01   2.811  0.00527 **
## Fire_Intensity           9.220e-05  1.657e-05   5.564 6.04e-08 ***
## Distance_from_Fire      -5.117e-01  3.155e-02 -16.221  < 2e-16 ***
## Building_Age            -7.918e-03  1.221e-02  -0.648  0.51721
## Property_Value           5.032e-01  2.856e-02  17.617  < 2e-16 ***
## Population_Density       5.097e-04  7.512e-04   0.679  0.49800
## Emergency_Response_Time  1.019e-01  1.499e-02   6.800 6.05e-11 ***
## Mitigation_Measures      1.062e-01  3.705e-02   2.865  0.00448 **
## Construction_Quality    -2.450e-01  1.600e-01  -1.532  0.12672
## Insurance_Coverage       1.417e-02  8.610e-02   0.165  0.86940
## Wind_Speed              -9.135e-03  1.211e-02  -0.754  0.45128
## Humidity                 3.124e-02  3.333e-03   9.374  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.027 on 288 degrees of freedom
## Multiple R-squared:  0.7214, Adjusted R-squared:  0.7108
## F-statistic:  67.8 on 11 and 288 DF,  p-value: < 2.2e-16

#New model with only significant variables
m2 = lm(Damage_Claims~Fire_Intensity + Distance_from_Fire + Property_Value +
Emergency_Response_Time + Mitigation_Measures + Humidity, data = training)
summary(m2)

##
## Call:
## lm(formula = Damage_Claims ~ Fire_Intensity + Distance_from_Fire +
##     Property_Value + Emergency_Response_Time + Mitigation_Measures +
##     Humidity, data = training)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.64443 -0.66589  0.00145  0.68283  2.68320
##
## Coefficients:
##                           Estimate Std. Error t value Pr(>|t|)
```

```
## (Intercept)             1.940e+00  4.560e-01   4.256 2.81e-05 ***
## Fire_Intensity          9.092e-05  1.632e-05   5.569 5.78e-08 ***
## Distance_from_Fire     -5.074e-01  3.095e-02 -16.394  < 2e-16 ***
## Property_Value          5.038e-01  2.846e-02  17.701  < 2e-16 ***
## Emergency_Response_Time  9.911e-02  1.478e-02   6.707 1.02e-10 ***
## Mitigation_Measures     1.138e-01  3.659e-02   3.109  0.00206 **
## Humidity                3.159e-02  3.310e-03   9.542  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.026 on 293 degrees of freedom
## Multiple R-squared:  0.7172, Adjusted R-squared:  0.7114
## F-statistic: 123.8 on 6 and 293 DF,  p-value: < 2.2e-16
```

```
anova(m2)
```

```
## Analysis of Variance Table
##
## Response: Damage_Claims
##                          Df  Sum Sq Mean Sq F value    Pr(>F)
## Fire_Intensity            1  14.579  14.579  13.846 0.0002379 ***
## Distance_from_Fire        1 296.739 296.739 281.802 < 2.2e-16 ***
## Property_Value            1 308.056 308.056 292.550 < 2.2e-16 ***
## Emergency_Response_Time   1  52.895  52.895  50.233 1.022e-11 ***
## Mitigation_Measures       1  14.143  14.143  13.431 0.0002938 ***
## Humidity                  1  95.881  95.881  91.055 < 2.2e-16 ***
## Residuals               293 308.530   1.053
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Checking correlation between pairs of variable
newdata = BFdata[,-1]
cor(training)
```

```
##                         Fire_Intensity Distance_from_Fire  Building_Age
## Fire_Intensity              1.00000000       -0.035130436  0.1485138507
## Distance_from_Fire         -0.03513044        1.000000000 -0.0161134463
## Building_Age                0.14851385       -0.016113446  1.0000000000
## Property_Value             -0.17214426       -0.023820894 -0.0171452193
## Population_Density         -0.02538997        0.086787272 -0.0692060492
## Emergency_Response_Time     0.05863044        0.044657527 -0.0009148271
## Mitigation_Measures         0.01526527       -0.026643380 -0.0479332316
## Construction_Quality       -0.03832640       -0.046775779 -0.0463700387
## Insurance_Coverage         -0.06565339        0.137742116 -0.0555359597
## Wind_Speed                  0.03641542        0.055297007 -0.0792001844
## Humidity                    0.01384675       -0.006683554 -0.0584046267
## Damage_Claims               0.11560952       -0.525306240 -0.0147362895
##                         Property_Value Population_Density
## Fire_Intensity             -0.17214426       -0.025389972
## Distance_from_Fire         -0.02382089        0.086787272
## Building_Age               -0.01714522       -0.069206049
```

```
## Property_Value              1.00000000       0.025901702
## Population_Density          0.02590170       1.000000000
## Emergency_Response_Time    -0.04334720      -0.087718406
## Mitigation_Measures         0.02048197       0.063686144
## Construction_Quality        0.01549979      -0.102322819
## Insurance_Coverage          0.07181407       0.038976909
## Wind_Speed                 -0.02831214       0.003703872
## Humidity                   -0.05192790      -0.018956106
## Damage_Claims               0.51893206      -0.025465268
##                           Emergency_Response_Time Mitigation_Measures
## Fire_Intensity                       0.0586304446          0.01526527
## Distance_from_Fire                   0.0446575271         -0.02664338
## Building_Age                        -0.0009148271         -0.04793323
## Property_Value                      -0.0433472014          0.02048197
## Population_Density                  -0.0877184057          0.06368614
## Emergency_Response_Time              1.0000000000         -0.06621487
## Mitigation_Measures                 -0.0662148722          1.00000000
## Construction_Quality                 0.0943203397         -0.05027369
## Insurance_Coverage                  -0.0702711129         -0.05920259
## Wind_Speed                          -0.0281850915         -0.09958924
## Humidity                             0.0601163065          0.05264768
## Damage_Claims                        0.1846742970          0.12658484
##                           Construction_Quality Insurance_Coverage
Wind_Speed
## Fire_Intensity                     -0.03832640       -0.065653389
0.036415422
## Distance_from_Fire                 -0.04677578        0.137742116
0.055297007
## Building_Age                       -0.04637004       -0.055535960 -
0.079200184
## Property_Value                      0.01549979        0.071814067 -
0.028312138
## Population_Density                 -0.10232282        0.038976909
0.003703872
## Emergency_Response_Time             0.09432034       -0.070271113 -
0.028185092
## Mitigation_Measures                -0.05027369       -0.059202594 -
0.099589243
## Construction_Quality                1.00000000        0.023503225
0.144957276
## Insurance_Coverage                  0.02350322        1.000000000 -
0.056819283
## Wind_Speed                          0.14495728       -0.056819283
1.000000000
## Humidity                           -0.06439629        0.002911288
0.034991268
## Damage_Claims                      -0.03088254       -0.054728683 -
0.072401102
##                               Humidity Damage_Claims
## Fire_Intensity            0.013846751    0.11560952
```

```
## Distance_from_Fire      -0.006683554   -0.52530624
## Building_Age            -0.058404627   -0.01473629
## Property_Value          -0.051927902    0.51893206
## Population_Density      -0.018956106   -0.02546527
## Emergency_Response_Time  0.060116306    0.18467430
## Mitigation_Measures      0.052647684    0.12658484
## Construction_Quality    -0.064396286   -0.03088254
## Insurance_Coverage       0.002911288   -0.05472868
## Wind_Speed               0.034991268   -0.07240110
## Humidity                 1.000000000    0.29240552
## Damage_Claims            0.292405519    1.00000000
```

```
#Evaluation using MSE
actual = test$Damage_Claims
predict1 = predict(m2,data = test)
MSE1 = mean((predict1-actual)^2)
MSE1
```

```
## [1] 6.479355
```

```
plot(predict1, actual, xlim =c(2,13),ylim = c(2,13))
abline(0,1)
```

```
#Interaction model
m3<-lm(Damage_Claims~(Fire_Intensity+ Distance_from_Fire+ Property_Value+
Emergency_Response_Time+ Mitigation_Measures+ Humidity)^2, data=training)
anova(m3)
```

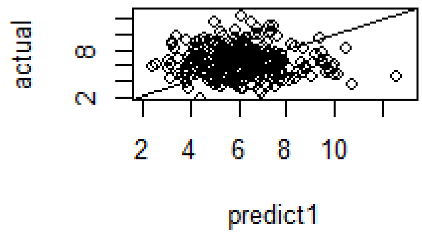
```
## Analysis of Variance Table
##
## Response: Damage_Claims
##                                             Df  Sum Sq Mean Sq  F value
## Fire_Intensity                               1  14.579  14.579  13.7251
## Distance_from_Fire                           1 296.739 296.739 279.3490
## Property_Value                               1 308.056 308.056 290.0031
## Emergency_Response_Time                      1  52.895  52.895  49.7954
## Mitigation_Measures                          1  14.143  14.143  13.3138
## Humidity                                     1  95.881  95.881  90.2620
## Fire_Intensity:Distance_from_Fire            1   0.452   0.452   0.4254
## Fire_Intensity:Property_Value                1   0.241   0.241   0.2269
## Fire_Intensity:Emergency_Response_Time       1   0.848   0.848   0.7985
## Fire_Intensity:Mitigation_Measures           1   0.336   0.336   0.3167
## Fire_Intensity:Humidity                      1   1.096   1.096   1.0315
## Distance_from_Fire:Property_Value            1   3.600   3.600   3.3888
## Distance_from_Fire:Emergency_Response_Time   1   0.010   0.010   0.0093
## Distance_from_Fire:Mitigation_Measures       1   1.392   1.392   1.3108
## Distance_from_Fire:Humidity                  1   0.022   0.022   0.0211
## Property_Value:Emergency_Response_Time       1   0.993   0.993   0.9352
## Property_Value:Mitigation_Measures           1   0.096   0.096   0.0905
## Property_Value:Humidity                      1   0.099   0.099   0.0933
## Emergency_Response_Time:Mitigation_Measures  1   1.815   1.815   1.7082
```

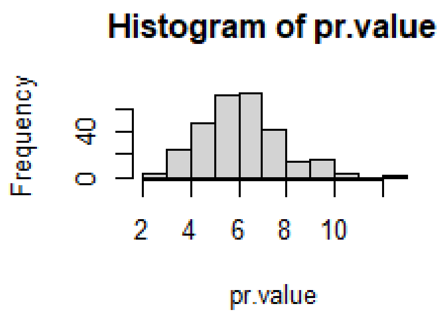
```
## Emergency_Response_Time:Humidity               1   1.829   1.829   1.7222
## Mitigation_Measures:Humidity                   1   0.394   0.394   0.3710
## Residuals                                    278 295.306   1.062
##                                                 Pr(>F)
## Fire_Intensity                               0.0002553 ***
## Distance_from_Fire                           < 2.2e-16 ***
## Property_Value                               < 2.2e-16 ***
## Emergency_Response_Time                      1.361e-11 ***
## Mitigation_Measures                          0.0003146 ***
## Humidity                                     < 2.2e-16 ***
## Fire_Intensity:Distance_from_Fire            0.5147704
## Fire_Intensity:Property_Value                0.6342111
## Fire_Intensity:Emergency_Response_Time       0.3723081
## Fire_Intensity:Mitigation_Measures           0.5740321
## Fire_Intensity:Humidity                      0.3106904
## Distance_from_Fire:Property_Value            0.0667050 .
## Distance_from_Fire:Emergency_Response_Time   0.9233060
## Distance_from_Fire:Mitigation_Measures       0.2532308
## Distance_from_Fire:Humidity                  0.8845165
## Property_Value:Emergency_Response_Time       0.3343606
## Property_Value:Mitigation_Measures           0.7637714
## Property_Value:Humidity                      0.7602486
## Emergency_Response_Time:Mitigation_Measures 0.1922973
## Emergency_Response_Time:Humidity             0.1904964
## Mitigation_Measures:Humidity                 0.5429587
## Residuals
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
#Polynomial model
m4<-lm(Damage_Claims~poly(Fire_Intensity,3) +poly(Distance_from_Fire,3) +
poly(Property_Value,3)+ poly(Emergency_Response_Time,3) +
poly(Mitigation_Measures,3)+ poly(Humidity,3), data=training)
summary(m4)
```

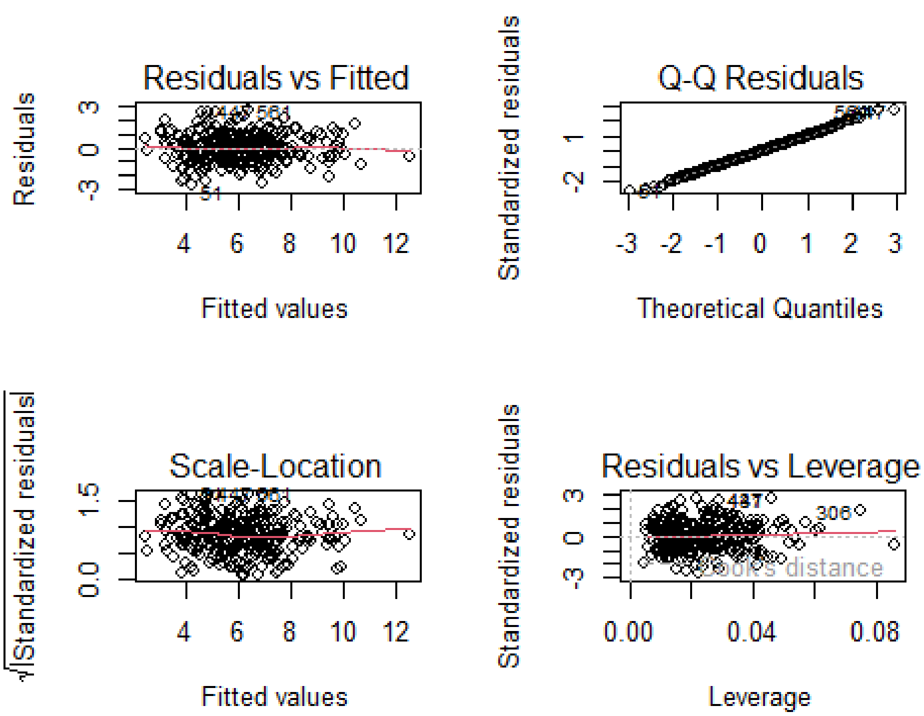
```
##
## Call:
## lm(formula = Damage_Claims ~ poly(Fire_Intensity, 3) +
poly(Distance_from_Fire,
##     3) + poly(Property_Value, 3) + poly(Emergency_Response_Time,
##     3) + poly(Mitigation_Measures, 3) + poly(Humidity, 3), data =
training)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2.44033 -0.68967 -0.01413  0.69111  2.94772
##
## Coefficients:
##                                      Estimate Std. Error t value Pr(>|t|)
## (Intercept)                           6.12797    0.05891 104.030  < 2e-16
```

```
***
## poly(Fire_Intensity, 3)1            5.58858    1.07321   5.207 3.71e-07
***
## poly(Fire_Intensity, 3)2           -0.96902    1.06177  -0.913  0.36221
## poly(Fire_Intensity, 3)3           -0.36473    1.05548  -0.346  0.72993
## poly(Distance_from_Fire, 3)1      -16.64112    1.03161 -16.131  < 2e-16
***
## poly(Distance_from_Fire, 3)2        1.99287    1.03862   1.919  0.05603 .
## poly(Distance_from_Fire, 3)3        1.57936    1.04451   1.512  0.13165
## poly(Property_Value, 3)1           18.65842    1.05140  17.746  < 2e-16
***
## poly(Property_Value, 3)2            1.15974    1.04877   1.106  0.26976
## poly(Property_Value, 3)3            1.04355    1.05320   0.991  0.32262
## poly(Emergency_Response_Time, 3)1   6.57656    1.06310   6.186 2.17e-09
***
## poly(Emergency_Response_Time, 3)2   0.67633    1.04246   0.649  0.51701
## poly(Emergency_Response_Time, 3)3   1.93567    1.04969   1.844  0.06623 .
## poly(Mitigation_Measures, 3)1       2.94396    1.03879   2.834  0.00493 **
## poly(Mitigation_Measures, 3)2      -0.97380    1.05124  -0.926  0.35506
## poly(Mitigation_Measures, 3)3       1.02174    1.04661   0.976  0.32979
## poly(Humidity, 3)1                  9.85806    1.04517   9.432  < 2e-16
***
## poly(Humidity, 3)2                 -0.09953    1.05815  -0.094  0.92513
## poly(Humidity, 3)3                  0.75487    1.05334   0.717  0.47419
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.02 on 281 degrees of freedom
## Multiple R-squared:  0.7318, Adjusted R-squared:  0.7147
## F-statistic: 42.61 on 18 and 281 DF,  p-value: < 2.2e-16

#Evaluation using Multivariate model
pr.value = predict(m2)
hist(pr.value)

par(mfrow = c(2,2))
```






```
plot(m2)
```



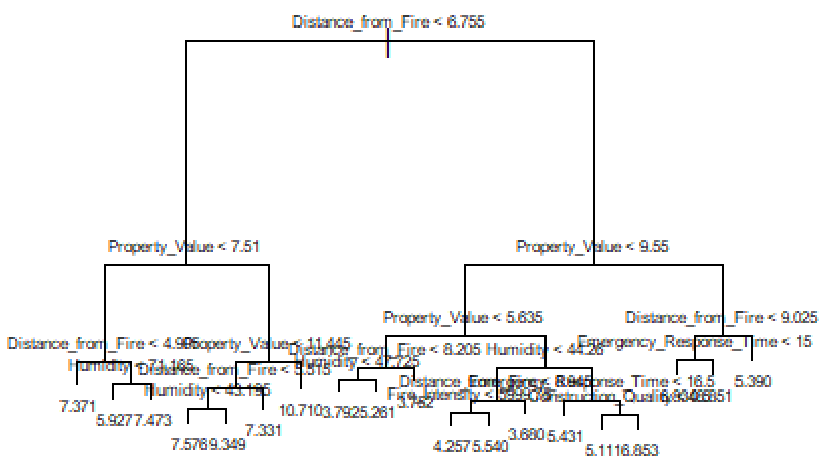

```
library(tree)
```

```
## Warning: package 'tree' was built under R version 4.4.1
```

```
#Build the regression tree model
tree = tree(Damage_Claims~.,newdata,subset = tr.id)
summary(tree)
```

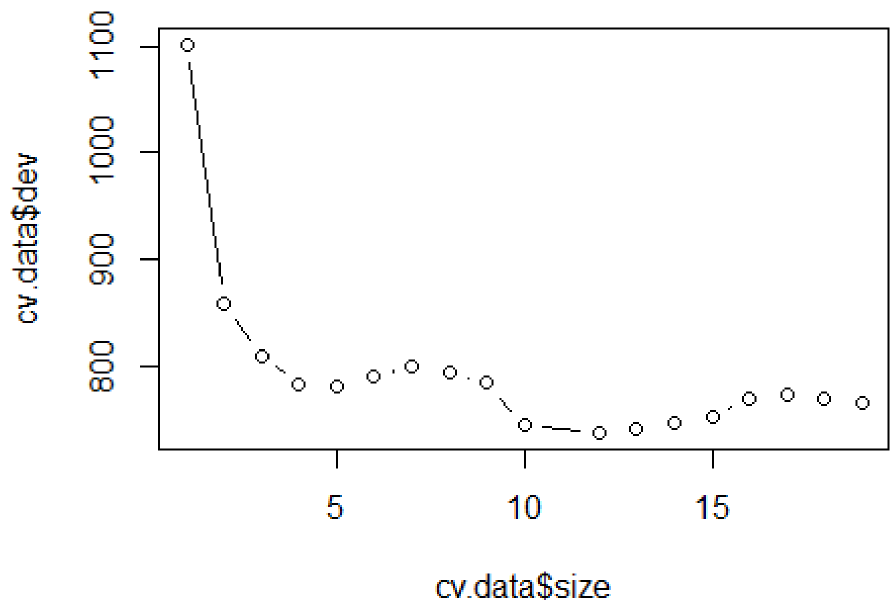
```
##
## Regression tree:
## tree(formula = Damage_Claims ~ ., data = newdata, subset = tr.id)
## Variables actually used in tree construction:
## [1] "Distance_from_Fire"      "Property_Value"
## [3] "Humidity"                "Fire_Intensity"
## [5] "Emergency_Response_Time" "Construction_Quality"
## Number of terminal nodes:  19
## Residual mean deviance:  1.221 = 343 / 281
## Distribution of residuals:
##     Min.  1st Qu.   Median     Mean  3rd Qu.     Max.
## -4.42700 -0.72700  0.08313  0.00000  0.71290  2.82900
```

```
#Visualise the tree
par(mfrow = c(1,1))
plot(tree)
text(tree,pretty = 0,cex =0.5)
```

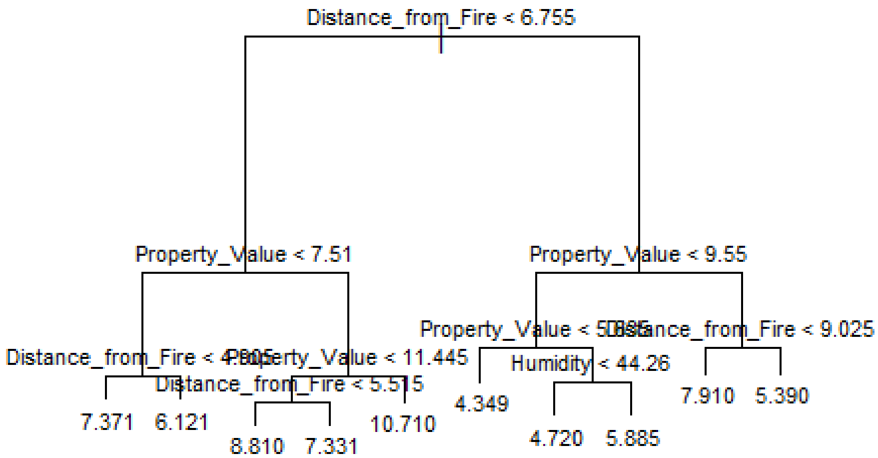



```
#Improve the model
set.seed(1)
cv.data = cv.tree(tree)
```

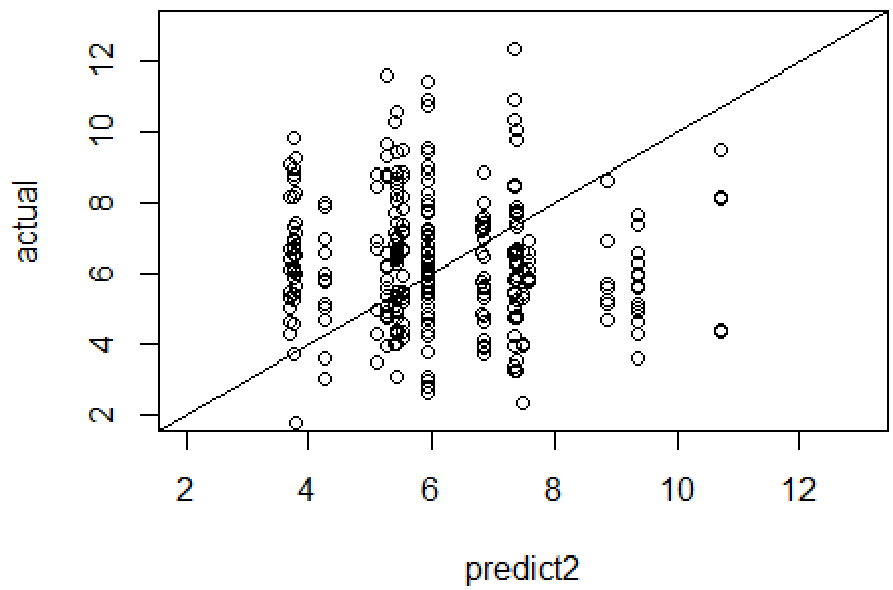
```r
#Plot to choose the best tree size
plot(cv.data$size,cv.data$dev, type = "b")
```



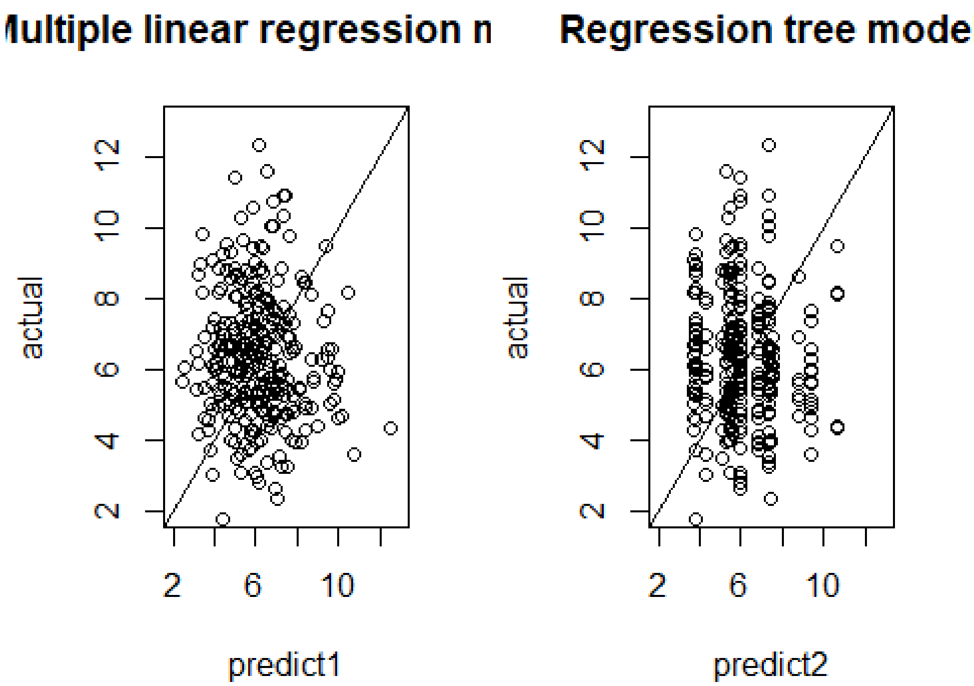

```r
#Prune the tree
pruned.model = prune.tree(tree, best = 10)
plot(pruned.model)
text(pruned.model,pretty = 0, cex = 0.7)
```




```r
#Calculate MSE and RMSE
predict2 = predict(tree, data = test)
MSE2 = mean((predict2-actual)^2)
RMSE2 = sqrt(MSE2)
MSE2

## [1] 6.413686

RMSE2

## [1] 2.532526

#Plot the predict and actual value for testing data set
plot(predict2,actual, xlim =c(2,13),ylim = c(2,13))
abline(0,1)
```

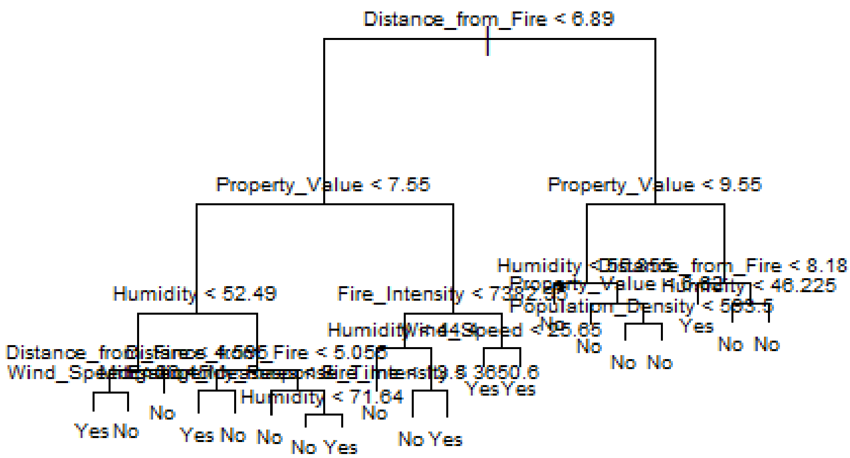



```
#Compare two model using MSE
MSE1

## [1] 6.479355

MSE2

## [1] 6.413686

#Compare two model using residual plot
par(mfrow = c(1,2))
plot(predict1, actual, xlim =c(2,13),ylim = c(2,13), main = "Multiple linear
regression model")
abline(0,1)
plot(predict2,actual, xlim =c(2,13),ylim = c(2,13), main = "Regression tree
model")
abline(0,1)
```



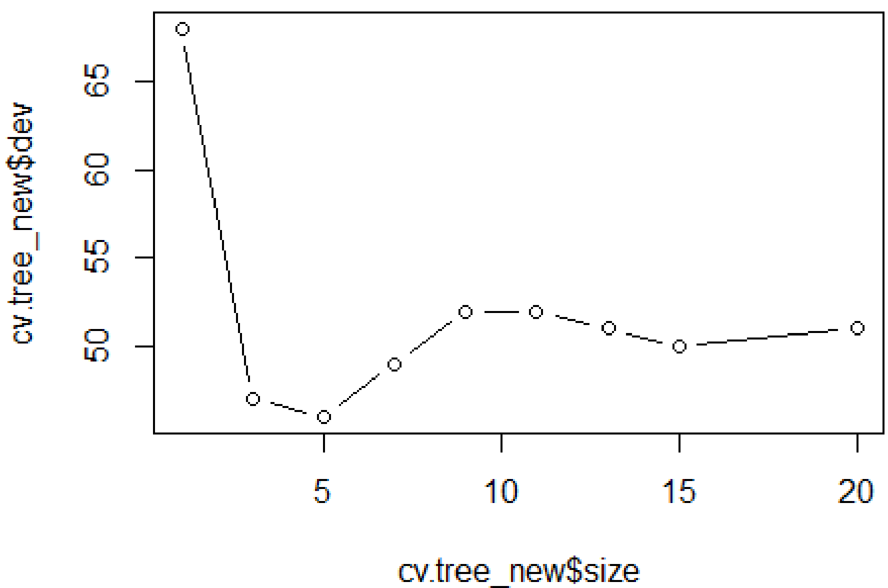

```
#Modify the target variable
Highdamage = ifelse(newdata$Damage_Claims>7.5,"Yes","No")
Highdamage = as.factor(Highdamage)
newdata2 = data.frame(newdata,Highdamage)
newdata2 = newdata2[,-12]
str(newdata2)

## 'data.frame':    600 obs. of  12 variables:
##  $ Fire_Intensity          : num  5738 12248 7317 13479 14226 ...
##  $ Distance_from_Fire      : num  5.57 5.49 5.12 4.89 6.13 ...
##  $ Building_Age            : int  19 27 16 30 21 27 24 24 36 30 ...
##  $ Property_Value          : num  9.76 5.89 3.98 4.91 9.31 ...
##  $ Population_Density      : int  520 433 634 576 644 476 500 591 487 441
...
##  $ Emergency_Response_Time: int  16 18 17 14 12 10 16 19 15 18 ...
##  $ Mitigation_Measures     : int  3 3 4 2 2 1 5 7 2 3 ...
##  $ Construction_Quality    : num  1 1 1 1 1 1 1 1 1 1 ...
##  $ Insurance_Coverage      : num  2 0 1 1 0 2 1 2 2 1 ...
##  $ Wind_Speed              : num  24.9 21 25.3 22.3 37.2 31.8 27.8 22.5
32.2 20.6 ...
##  $ Humidity                : num  35.3 28.2 44.5 53.8 73.8 ...
##  $ Highdamage              : Factor w/ 2 levels "No","Yes": 1 1 1 2 2 1 1 2
1 1 ...

#Build classification tree
training2 = newdata2[tr.id,]
testing2 = newdata2[-tr.id,]
```

```r
tree_new = tree(Highdamage~.,training2)

#visualise the tree
par(mfrow = c(1,1))
plot(tree_new)
text(tree_new,pretty=0,cex = 0.6)
```

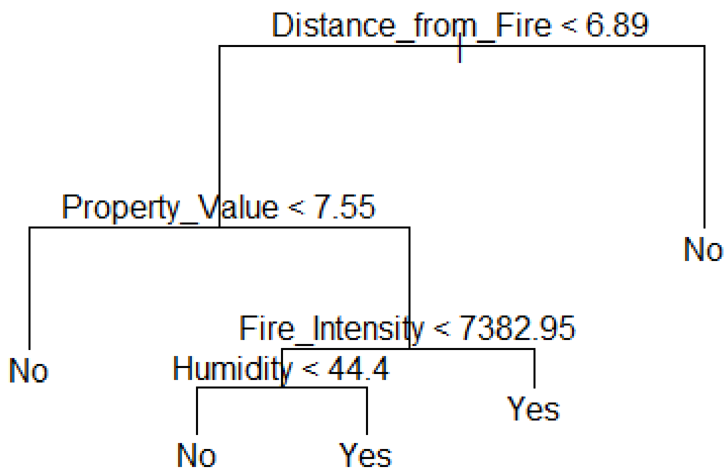



```r
summary(tree_new)

##
## Classification tree:
## tree(formula = Highdamage ~ ., data = training2)
## Variables actually used in tree construction:
## [1] "Distance_from_Fire"      "Property_Value"
## [3] "Humidity"                "Wind_Speed"
## [5] "Mitigation_Measures"     "Emergency_Response_Time"
## [7] "Fire_Intensity"          "Population_Density"
## Number of terminal nodes:  20
## Residual mean deviance:  0.3108 = 87.02 / 280
## Misclassification error rate: 0.07 = 21 / 300

#Calculate misclassification rate
tree_pred1=predict(tree_new,testing2,type="class")
table = table(tree_pred1,testing2$Highdamage)
misrate1 <- (table[1,2]+table[2,1])/sum(table)
misrate1
```

```
## [1] 0.21

#Prunning tree
set.seed(12)
cv.tree_new=cv.tree(tree_new,FUN=prune.misclass)
names(cv.tree_new)

## [1] "size"   "dev"    "k"      "method"

plot(cv.tree_new$size, cv.tree_new$dev, type = "b")
```




```
prune.tree_new=prune.misclass(tree_new,best=5)
plot(prune.tree_new)
text(prune.tree_new,pretty=0)
```




```r
#Calculate misclassification rate
tree.pred2=predict(prune.tree_new,testing2,type='class')
table(tree.pred2,testing2$Highdamage)

##
## tree.pred2  No Yes
##        No  217  35
##        Yes  11  37

tab3 <- table(tree.pred2,testing2$Highdamage)
mis_rate2 <- (tab3[1,2]+tab3[2,1])/sum(tab3)
mis_rate2

## [1] 0.1533333

BFD = read.csv("BushFireData.csv")
#Encoding variables
Highdamage = ifelse(Damage_Claims>7.5, "1","0")
new_BFD = data.frame(BFD,Highdamage)
new_BFD$Highdamage = as.factor(new_BFD$Highdamage)
new_BFD$Construction_Quality = ifelse(new_BFD$Construction_Quality ==
"Good",1,0)
IC_factor = factor(new_BFD$Insurance_Coverage, levels = c("None",
"Partially", "Fully"))
new_BFD$Insurance_Coverage = as.integer(IC_factor)-1
#Remove excess variables
new_BFD = new_BFD[,-13]
```

```r
new_BFD = new_BFD[,-1]

#Divide data set into training and testing set, 70% training, 30% testing
set.seed(1)
tr.id = sample(1:nrow(BFD),nrow(BFD)*0.7)
training = new_BFD[tr.id,]
testing = new_BFD[-tr.id,]

#Build support vector machines
library(e1071)

## Warning: package 'e1071' was built under R version 4.4.2

#linear kernel model
set.seed(1)
linear_svm = tune(svm,Highdamage~., data = training, kernel = "linear",
                  scale = TRUE, ranges = list(cost =
c(0.001,0.01,0.1,1,10,100)))
summary(linear_svm)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost
##   0.1
##
## - best performance: 0.08809524
##
## - Detailed performance results:
##    cost      error dispersion
## 1 1e-03 0.21904762 0.05810478
## 2 1e-02 0.17142857 0.05475615
## 3 1e-01 0.08809524 0.05728598
## 4 1e+00 0.09047619 0.04994328
## 5 1e+01 0.09523810 0.04761905
## 6 1e+02 0.09285714 0.04821061

linear_bm = linear_svm$best.model
summary(linear_bm)

##
## Call:
## best.tune(METHOD = svm, train.x = Highdamage ~ ., data = training,
##     ranges = list(cost = c(0.001, 0.01, 0.1, 1, 10, 100)), kernel =
"linear",
##     scale = TRUE)
##
##
```

```
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  linear
##        cost:  0.1
##
## Number of Support Vectors:  128
##
##  ( 62 66 )
##
##
## Number of Classes:  2
##
## Levels:
##  0 1
```

```
#prediction for linear model
actual = testing$Highdamage
actual
```

```
##   [1] 1 0 0 0 0 0 0 0 1 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 1 0 1 0 0 0 1 1 1
0 0 0
##  [38] 0 0 1 0 1 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
0 0 0
##  [75] 0 0 0 1 0 0 1 0 1 1 1 0 0 0 0 0 1 0 1 0 1 1 0 1 0 0 1 0 0 0 0 1 0 0
0 1 0
## [112] 0 0 0 1 0 0 0 0 1 1 0 0 0 0 0 0 1 0 1 1 0 1 0 0 0 0 0 0 1 0 0 0 0 0
0 1 1
## [149] 0 0 0 0 0 1 1 0 0 1 0 0 0 1 0 0 0 0 1 1 0 0 0 0 0 0 1 0 0 1 0 0
## Levels: 0 1
```

```
pred1 = predict(linear_bm, newdata = testing)
pred1
```

```
##   4   6   9  10  11  12  13  17  23  24  52  54  55  57  59  61  63  66
67  68
##   0   0   0   0   0   0   0   0   1   1   1   0   0   0   0   1   0   0
0   1
##  70  76  80  82  85  87  88  90  94  95  96 100 101 107 118 120 125 128
142 144
##   1   1   0   0   0   1   0   0   0   0   0   1   0   0   0   1   0   0
0   1
## 146 149 151 154 155 158 165 166 170 171 172 175 178 182 184 186 188 191
196 200
##   0   1   0   0   0   0   1   0   0   0   0   0   1   0   0   0   0   0
0   0
## 206 210 211 213 215 216 225 226 227 228 232 240 243 244 245 250 251 257
258 259
##   0   0   1   0   0   0   0   0   0   0   1   0   0   0   0   0   0   1
0   0
## 261 262 263 267 272 278 281 283 289 301 302 303 308 312 318 319 320 322
332 340
```

```
##   1   0   1   1   1   1   0   0   0   0   1   0   0   0   1   0   0   0
0   0
## 341 342 347 348 350 351 353 354 357 360 366 367 370 374 376 384 387 389
392 394
##   1   0   0   0   0   0   0   0   0   1   0   0   0   0   1   0   0   0
0   0
## 395 398 401 407 417 420 424 431 432 433 444 445 447 449 450 452 455 456
457 458
##   1   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0
0   1
## 462 469 473 476 479 481 486 489 493 496 497 503 505 507 510 512 517 520
523 524
##   0   0   0   0   0   0   1   1   0   0   0   0   0   0   1   0   0   0
0   0
## 529 535 539 543 544 547 552 557 560 562 565 568 569 571 573 580 581 583
593 595
##   0   1   0   0   0   0   0   1   0   0   0   0   0   1   1   0   0   1
0   0
## Levels: 0 1
```

```
tab1 = table(pred1,actual)
tab1
```

```
##      actual
## pred1   0   1
##     0 124  18
##     1   8  30
```

```
misrate_linear = (tab1[1,2]+tab1[2,1])/sum(tab1)

#Polynomial kernel model
set.seed(1)
poly_svm = tune(svm,Highdamage~., data = training, kernel = "polynomial",
                scale = TRUE, ranges = list(cost =
c(0.001,0.01,0.1,1,10,100), d =c(2:5)))
summary(poly_svm)
```

```
##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost d
##     1 3
##
## - best performance: 0.1261905
##
## - Detailed performance results:
##     cost d     error dispersion
## 1  1e-03 2 0.2190476 0.05810478
```

```
## 2  1e-02 2 0.2190476 0.05810478
## 3  1e-01 2 0.2190476 0.05810478
## 4  1e+00 2 0.2071429 0.04768514
## 5  1e+01 2 0.2428571 0.08078102
## 6  1e+02 2 0.2547619 0.07780207
## 7  1e-03 3 0.2190476 0.05810478
## 8  1e-02 3 0.2190476 0.05810478
## 9  1e-01 3 0.2023810 0.05639949
## 10 1e+00 3 0.1261905 0.05270463
## 11 1e+01 3 0.1595238 0.06644900
## 12 1e+02 3 0.2214286 0.03731003
## 13 1e-03 4 0.2190476 0.05810478
## 14 1e-02 4 0.2190476 0.05810478
## 15 1e-01 4 0.2047619 0.05634362
## 16 1e+00 4 0.2095238 0.05810478
## 17 1e+01 4 0.2214286 0.07103064
## 18 1e+02 4 0.2666667 0.04994328
## 19 1e-03 5 0.2190476 0.05810478
## 20 1e-02 5 0.2190476 0.05810478
## 21 1e-01 5 0.1928571 0.05549884
## 22 1e+00 5 0.1809524 0.05745067
## 23 1e+01 5 0.1547619 0.07876759
## 24 1e+02 5 0.1952381 0.07342878
```

```
poly_bm = poly_svm$best.model
summary(poly_bm)
```

```
##
## Call:
## best.tune(METHOD = svm, train.x = Highdamage ~ ., data = training,
##     ranges = list(cost = c(0.001, 0.01, 0.1, 1, 10, 100), d = c(2:5)),
##     kernel = "polynomial", scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  polynomial
##        cost:  1
##      degree:  3
##      coef.0:  0
##
## Number of Support Vectors:  179
##
##  ( 75 104 )
##
##
## Number of Classes:  2
##
## Levels:
##  0 1
```

```r
#Prediction for polynomial kernel model
pred2 = predict(poly_bm, newdata = testing)
pred2
```

```
##   4   6   9  10  11  12  13  17  23  24  52  54  55  57  59  61  63  66 
67  68 
##   0   0   0   0   0   0   0   0   1   1   0   0   0   0   1   0   0   0 
0   1 
##  70  76  80  82  85  87  88  90  94  95  96 100 101 107 118 120 125 128 
142 144 
##   0   0   0   0   0   0   0   0   0   0   0   1   0   0   0   1   0   0 
0   0 
## 146 149 151 154 155 158 165 166 170 171 172 175 178 182 184 186 188 191 
196 200 
##   0   1   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0 
0   0 
## 206 210 211 213 215 216 225 226 227 228 232 240 243 244 245 250 251 257 
258 259 
##   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   1 
0   0 
## 261 262 263 267 272 278 281 283 289 301 302 303 308 312 318 319 320 322 
332 340 
##   1   0   1   1   0   1   0   0   0   0   1   0   0   0   0   0   0   0 
0   0 
## 341 342 347 348 350 351 353 354 357 360 366 367 370 374 376 384 387 389 
392 394 
##   0   0   0   0   0   0   0   0   0   1   0   0   0   0   1   0   0   0 
0   1 
## 395 398 401 407 417 420 424 431 432 433 444 445 447 449 450 452 455 456 
457 458 
##   1   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0 
0   0 
## 462 469 473 476 479 481 486 489 493 496 497 503 505 507 510 512 517 520 
523 524 
##   0   0   0   0   0   0   0   1   0   0   0   0   0   0   1   0   0   0 
0   0 
## 529 535 539 543 544 547 552 557 560 562 565 568 569 571 573 580 581 583 
593 595 
##   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0 
0   0 
## Levels: 0 1
```

```r
tab2 = table(pred2,actual)
tab2
```

```
##      actual
## pred2   0   1
##     0 127  30
##     1   5  18
```

```
misrate_poly = (tab2[1,2]+tab2[2,1])/sum(tab2)

#Radial kernel model
set.seed(1)
ra_svm = tune(svm,Highdamage~., data = training, kernel = "radial",
              scale = TRUE, ranges = list(cost = c(0.001,0.01,0.1,1,10,100),
gamma = c(0.5, 1, 2, 3,4)))
summary(ra_svm)

##
## Parameter tuning of 'svm':
##
## - sampling method: 10-fold cross validation
##
## - best parameters:
##  cost gamma
##    10   0.5
##
## - best performance: 0.197619
##
## - Detailed performance results:
##     cost gamma     error dispersion
## 1  1e-03   0.5 0.2190476 0.05810478
## 2  1e-02   0.5 0.2190476 0.05810478
## 3  1e-01   0.5 0.2190476 0.05810478
## 4  1e+00   0.5 0.2119048 0.05772412
## 5  1e+01   0.5 0.1976190 0.05388649
## 6  1e+02   0.5 0.1976190 0.05388649
## 7  1e-03   1.0 0.2190476 0.05810478
## 8  1e-02   1.0 0.2190476 0.05810478
## 9  1e-01   1.0 0.2190476 0.05810478
## 10 1e+00   1.0 0.2190476 0.05810478
## 11 1e+01   1.0 0.2190476 0.06023386
## 12 1e+02   1.0 0.2190476 0.06023386
## 13 1e-03   2.0 0.2190476 0.05810478
## 14 1e-02   2.0 0.2190476 0.05810478
## 15 1e-01   2.0 0.2190476 0.05810478
## 16 1e+00   2.0 0.2190476 0.05810478
## 17 1e+01   2.0 0.2190476 0.05810478
## 18 1e+02   2.0 0.2190476 0.05810478
## 19 1e-03   3.0 0.2190476 0.05810478
## 20 1e-02   3.0 0.2190476 0.05810478
## 21 1e-01   3.0 0.2190476 0.05810478
## 22 1e+00   3.0 0.2190476 0.05810478
## 23 1e+01   3.0 0.2190476 0.05810478
## 24 1e+02   3.0 0.2190476 0.05810478
## 25 1e-03   4.0 0.2190476 0.05810478
## 26 1e-02   4.0 0.2190476 0.05810478
## 27 1e-01   4.0 0.2190476 0.05810478
## 28 1e+00   4.0 0.2190476 0.05810478
```

```
## 29 1e+01   4.0 0.2190476 0.05810478
## 30 1e+02   4.0 0.2190476 0.05810478
```

```
ra_bm = ra_svm$best.model
summary(ra_bm)
```

```
##
## Call:
## best.tune(METHOD = svm, train.x = Highdamage ~ ., data = training,
##     ranges = list(cost = c(0.001, 0.01, 0.1, 1, 10, 100), gamma = c(0.5,
##         1, 2, 3, 4)), kernel = "radial", scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  10
##
## Number of Support Vectors:  406
##
##  ( 92 314 )
##
##
## Number of Classes:  2
##
## Levels:
##  0 1
```

```
#Prediction for radial kernel model
pred3 = predict(ra_bm, newdata = testing)
pred3
```

```
##   4   6   9  10  11  12  13  17  23  24  52  54  55  57  59  61  63  66
67  68
##   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0   0   0
0   0
##  70  76  80  82  85  87  88  90  94  95  96 100 101 107 118 120 125 128
142 144
##   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   1
## 146 149 151 154 155 158 165 166 170 171 172 175 178 182 184 186 188 191
196 200
##   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0
## 206 210 211 213 215 216 225 226 227 228 232 240 243 244 245 250 251 257
258 259
##   0   0   0   0   0   0   0   1   0   0   1   0   0   0   0   0   0   0
0   0
## 261 262 263 267 272 278 281 283 289 301 302 303 308 312 318 319 320 322
332 340
##   0   0   0   0   1   0   0   0   0   0   0   0   0   0   0   0   0   0
```

```
0   0
## 341 342 347 348 350 351 353 354 357 360 366 367 370 374 376 384 387 389
392 394
##   1   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0
## 395 398 401 407 417 420 424 431 432 433 444 445 447 449 450 452 455 456
457 458
##   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0
## 462 469 473 476 479 481 486 489 493 496 497 503 505 507 510 512 517 520
523 524
##   0   0   0   0   0   0   0   0   0   0   1   0   0   0   0   0   0   0
0   0
## 529 535 539 543 544 547 552 557 560 562 565 568 569 571 573 580 581 583
593 595
##   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0
0   0
## Levels: 0 1
```

```
tab3 = table(pred3,actual)
tab3
```

```
##      actual
## pred3   0   1
##     0 130  42
##     1   2   6
```

```
misrate_ra = (tab3[1,2]+tab3[2,1])/sum(tab3)


#compare misclassification rate between the three kernels
misrate_linear
```

```
## [1] 0.1444444
```

```
misrate_poly
```

```
## [1] 0.1944444
```

```
misrate_ra
```

```
## [1] 0.2444444
```

```
#PCA
PCA_BFD = BFD[,-c(1,9,10,13)]
PCA_BFD
```

```
##     Fire_Intensity Distance_from_Fire Building_Age Property_Value
## 1           5738.5               5.57           19           9.76
## 2          12247.9               5.49           27           5.89
## 3           7316.6               5.12           16           3.98
## 4          13479.2               4.89           30           4.91
```

```
## 5          14226.0              6.13          21          9.31
## 6           2592.2              7.66          27          6.41
## 7           8865.3              2.97          24          3.65
## 8          13601.4              7.42          24          6.63
## 9           9168.6              9.47          36         10.68
## 10          7935.9             11.08          30          8.49
## 11         14438.8              9.60          32          5.47
## 12          7893.3              8.51          15          4.40
## 13         10808.4              3.55          22          5.46
## 14          9444.2              5.80          22          7.07
## 15          3338.0              6.30          28          9.13
## 16         13697.7              8.41          31          3.91
## 17          5199.1              6.79          31          9.51
## 18          2546.7              4.48          24          7.01
## 19          6262.9             10.37          25          8.30
## 20         14408.5              8.82          37          4.26
## 21         13564.0              7.47          27          5.73
## 22         11006.4              9.44          25          6.11
## 23         10326.5              4.32          18          9.57
## 24         14925.5              8.32          21          9.52
## 25         10524.1              5.95          24          7.97
## 26         11210.8              8.37          22         11.32
## 27          9072.8              6.88          23          5.99
## 28          9723.8              8.27          32          9.48
## 29          5759.0              9.67          19          6.92
## 30          3912.4              7.01          30          5.72
## 31         14519.3              9.04          23          9.23
## 32         13729.8              4.62          16         10.59
## 33         10979.1              5.56          23          9.11
## 34         12341.0             10.04          26          6.00
## 35          2319.9              7.75          36          6.07
## 36          8211.3              2.90          28         10.58
## 37         11859.9              4.27          25          7.78
## 38          4813.3              6.60          29          8.97
## 39          6136.3              8.73          25          6.32
## 40          5011.1              6.80          21         10.21
## 41          3856.4              8.25          25          5.49
## 42          7389.1              8.92          26          8.44
## 43          7378.4             10.34          26          5.47
## 44          6794.9              7.11          16          3.34
## 45          3981.7              6.90          26          4.67
## 46          3804.4              3.49          18          7.29
## 47          5029.4              7.20          29          9.12
## 48          8057.5              5.86          28          4.13
## 49          5457.6              5.05          36          4.80
## 50         13151.7              6.64          25         11.88
## 51          2595.8              9.03          25          6.14
## 52          7748.6              3.01          25          8.14
## 53         12386.0              6.15          25          5.97
## 54          3584.6              7.23          25          6.40
```

```
## 55          9292.3              5.21          29          7.18
## 56          4684.9              7.67          28          7.02
## 57          3657.9              7.82          22          6.60
## 58         11793.0              6.93          17          6.07
## 59         13635.5              2.07          27          2.80
## 60          6868.0             12.14          21         12.26
## 61         10646.4              6.59          21         11.97
## 62          3232.9              8.30          24          5.03
## 63          6991.6              7.55          28          6.65
## 64          5566.9              9.05          19         10.57
## 65         12590.3              8.64          19          9.44
## 66          7830.7              6.58          23         10.26
## 67         12530.8              7.76          16          5.07
## 68         12561.0              5.11          21         15.16
## 69         12326.4              8.71          25          4.98
## 70          7717.8              6.08          26          8.77
## 71         11808.1             11.83          22          7.30
## 72         10179.8              3.70          28          6.20
## 73         11232.3              6.07          19          6.24
## 74          2008.1              8.65          19          5.19
## 75          8179.1              8.02          26         11.38
## 76          4861.5              5.82          24          7.19
## 77          6937.6              5.01          30          7.56
## 78          9966.0              7.29          18          7.45
## 79          6573.3              6.97          28          6.25
## 80          3444.7              3.42          24          4.98
## 81          5167.0              7.07          19          7.55
## 82         10684.7              7.38          24          3.73
## 83          7429.4              7.35          24          4.57
## 84         12246.5              4.89          12          5.06
## 85          3337.2              7.95          21          5.06
## 86          7653.6              9.76          37          7.22
## 87         14804.4              7.91          28         11.30
## 88         13609.6              4.73          22          4.44
## 89         13524.0              6.13          24          7.97
## 90          4275.6              7.69          20          9.16
## 91          3699.0              5.71          27          5.20
## 92         10490.3              2.68          23          6.88
## 93          6465.7              8.77          25          8.96
## 94         10537.8              5.34          26          6.48
## 95          6164.8              5.85          18          6.55
## 96          4439.9             10.01          33          7.67
## 97         12169.8              5.45          28          6.87
## 98          3216.7              8.69          20          5.92
## 99          8068.1              4.48          31          6.71
## 100         8649.5              6.29          29         12.31
## 101         9799.8              6.85          16          9.09
## 102         6326.7              4.66          18          5.32
## 103         8351.9              5.73          32          4.81
## 104        14408.1              6.94          27          6.28
```

```
## 105          8277.7                   8.34            28             10.42
## 106         13574.5                   3.70            19              7.64
## 107         13887.6                   6.30            29              5.67
## 108          9913.5                   8.51            32              9.12
## 109          7338.9                   5.92            27              6.72
## 110          3912.2                   7.45            25              5.00
## 111         14158.8                   7.98            34              8.03
## 112          5915.9                   7.54            19             11.05
## 113          2789.3                   8.31            18              7.97
## 114         14320.4                   6.75            23              7.41
## 115         11367.7                   6.17            27              5.74
## 116          3849.8                   1.71            19              8.30
## 117          9140.7                   6.81            15              5.07
## 118         14403.1                   7.86            33              4.26
## 119          9611.2                   8.07            25              6.90
## 120          7258.6                   5.89            26              6.92
## 121         10422.6                  10.56            24             14.23
## 122          6157.6                   7.57            27              4.85
## 123          6000.3                   7.25            20              7.36
## 124          4856.9                   9.54            29              8.91
## 125          6803.3                   5.56            22              9.59
## 126         14794.8                   6.10            25              6.97
## 127          4004.6                  11.79            28              5.60
## 128          3183.5                   7.02            27              6.86
## 129          3844.7                  10.27            32             12.52
## 130         10970.0                   4.12            21              8.09
## 131         10050.3                   6.62            15              3.79
## 132         13588.1                   7.76            24             10.72
## 133         10748.9                   7.60            20              8.23
## 134         11582.0                   4.99            19              6.92
## 135          8774.7                   7.04            24              6.96
## 136         10577.8                   4.85            33              6.69
## 137         12683.4                   8.43            27              7.56
## 138         12221.6                   9.17            23              6.01
## 139         14737.6                   2.55            19              7.60
## 140          7712.6                   9.47            23              5.29
## 141          6052.1                   4.52            27              7.43
## 142          7323.1                   7.91            34              9.75
## 143          2136.0                   8.32            20              8.15
## 144          4390.0                   6.60            24              9.54
## 145         12955.4                   5.71            21              5.04
## 146          5005.1                   7.33            19              7.11
## 147          5108.2                   7.88            26              8.42
## 148          2996.9                   8.77            16              5.08
## 149          5194.4                   2.90            24             11.19
## 150         11517.7                   3.73            24              5.13
## 151         13016.8                   9.86            24              7.35
## 152          8467.8                   9.09            16              7.32
## 153          7042.8                   7.87            16              7.26
## 154          5203.8                   8.43            27              6.57
```

```
## 155         3444.2                 8.83          24          8.01
## 156         7069.9                 1.68          15          5.13
## 157         9435.1                 9.22          21          4.75
## 158         4819.6                 6.03          20          5.75
## 159         7781.9                 7.46          30          6.88
## 160         4833.8                 6.41          27         10.20
## 161         8529.8                 8.74          23         11.27
## 162         6600.7                 6.30          29          7.70
## 163        10449.8                 8.04          29          7.84
## 164         6871.2                 6.22          20          6.50
## 165         6620.7                 4.81          27          7.10
## 166         8937.9                 9.42          22          4.59
## 167        11624.3                 8.48          20          7.63
## 168         4874.3                10.45          18          5.96
## 169         7365.6                 7.13          25          7.73
## 170         5453.9                 9.25          21          6.30
## 171        10189.6                10.95          24          5.73
## 172         4389.7                 6.44          30          6.55
## 173        13227.3                 4.35          29          6.27
## 174        11705.3                 6.52          24          9.72
## 175        10687.7                 6.57          22          7.45
## 176        10034.2                 7.30          21          7.96
## 177         6839.0                10.42          21          4.82
## 178         8887.8                 6.35          34         10.96
## 179        13370.8                 7.75          30          7.34
## 180         9562.7                 6.54          28          5.41
## 181        12916.9                 7.04          22          7.68
## 182         6061.8                 7.63          24          9.08
## 183        11207.7                 9.66          22          4.62
## 184         5445.2                 7.24          22         11.62
## 185         9726.4                 8.43          27          6.67
## 186         8256.7                 8.56          24          9.79
## 187         5445.4                 8.83          27          7.15
## 188         9339.6                 5.85          20          6.33
## 189        13871.4                10.25          21          4.03
## 190        13724.3                 6.24          21          5.03
## 191         5564.1                 6.79          33          6.91
## 192         6179.2                 9.81          24          8.97
## 193        14813.3                 9.59          16          3.98
## 194        10059.9                 4.82          23         10.57
## 195        14185.0                 5.25          25         10.65
## 196         8064.9                 4.28          25          4.96
## 197         7288.8                 7.36          26          8.06
## 198        10569.9                 7.33          21          5.13
## 199         3980.5                 7.73          24          6.74
## 200         9447.2                 8.10          21          9.24
## 201         5103.4                 5.80          26          9.08
## 202        14510.6                 5.01          24          5.42
## 203         9817.7                 9.05          20          6.23
## 204         8695.3                 8.50          20          5.22
```

```
## 205          7233.4              3.98            31           7.75
## 206         13443.2              6.81            25           4.38
## 207          6733.1              5.21            23           3.18
## 208          5747.1              2.86            26          10.87
## 209          4218.3              7.30            19          13.84
## 210          4238.2              6.84            26           6.10
## 211          8266.5              6.81            25           8.79
## 212          5288.5              7.43            27           6.98
## 213          4811.3              8.76            21          10.89
## 214         10766.8              7.41            21           8.26
## 215          2619.6              5.77            20           7.44
## 216         11111.0              5.53            28           4.08
## 217          6574.5              6.74            18           9.68
## 218          7316.2              7.62            32           6.30
## 219         12672.3              4.92            19           4.59
## 220         13945.1              6.63            20           6.58
## 221          5672.8              8.93            23           6.73
## 222         14494.3              6.78            24           9.61
## 223         11469.1              5.60            29           4.93
## 224         10922.8              6.45            28           5.92
## 225          2686.9              9.23            17          10.93
## 226          7137.8              8.10            21          10.52
## 227          8211.9              9.47            27           9.92
## 228          9283.2              7.28            31          11.52
## 229         11077.4              7.82            21           7.44
## 230         13903.8              5.88            28           5.87
## 231         10038.5              8.21            30           8.26
## 232          7569.4              5.99            20           9.61
## 233          9047.0              4.16            21          14.43
## 234          2760.2              7.26            14           3.88
## 235          5391.1             10.89            33           7.59
## 236          7162.9              8.60            27           8.51
## 237          4570.6              9.33            13           6.88
## 238         12815.0              7.72            32           4.38
## 239          3987.5              5.78            20           8.74
## 240         12444.4              6.60            31           5.54
## 241          9108.7              6.45            26           8.14
## 242         10610.1              6.06            31           9.19
## 243          4232.0              8.41            22          10.28
## 244         10229.7              4.61            28           4.38
## 245          6054.3              8.73            30           9.68
## 246         11419.2              8.73            20           5.57
## 247          7186.2              4.60            18           4.75
## 248         14601.6              8.28            26          10.38
## 249         14576.1             11.86            26           9.87
## 250         11447.1              5.89            22           6.50
## 251          5343.8              8.69            24           8.79
## 252          4883.2              5.44            30           5.40
## 253          9709.5              9.22            28           6.68
## 254          5477.7              7.50            23           6.80
```

```
## 255           8903.9             10.30          28           6.43
## 256          12208.7              4.08          25           8.72
## 257           4184.7              6.90          27          11.10
## 258           7257.1              5.95          29           6.10
## 259           8130.4              6.61          21           6.93
## 260          13285.3              5.74          36          11.43
## 261          14034.2              5.33          36           6.34
## 262          13465.7              8.16          21           3.20
## 263          10764.4              4.82          20           8.16
## 264          14352.1              9.97          20           5.36
## 265           8713.7              4.63          15           5.18
## 266           9494.7              7.20          40          10.72
## 267           6372.3              8.07          22          14.58
## 268           6515.2              8.17          20           5.12
## 269           2260.3              6.40          21           9.53
## 270           8536.5              7.16          21           6.80
## 271          13323.5              8.92          21           7.30
## 272           2081.9              4.09          27          10.10
## 273           2936.7              5.44          21           7.46
## 274           4134.7              7.64          27           5.42
## 275          12014.3              6.11          32           6.07
## 276          11557.3              9.74          26           8.59
## 277          14634.3              8.35          30           3.47
## 278           8064.1              7.14          28           9.72
## 279           2966.9              3.98          27           4.37
## 280          10434.6              7.05          26           7.04
## 281          11861.7              6.37          31           6.61
## 282           3782.3              6.80          19          10.31
## 283           7155.5              4.64          21           7.40
## 284           4924.8              8.00          24           7.21
## 285           2753.4              4.92          25           8.63
## 286           7146.6              6.55          28           5.46
## 287           2844.0              7.76          28           6.60
## 288           4936.5              5.43          23           9.96
## 289           2710.1              8.17          23           8.59
## 290          10713.6              4.37          25           4.77
## 291           5870.6              1.38          30           8.47
## 292           3309.3              7.93          27           4.63
## 293           2934.7              8.68          32           5.84
## 294          13445.7              6.43          24          10.06
## 295          11805.2              8.01          30           3.56
## 296          12615.8              4.69          29           4.10
## 297          14767.8              6.75          28          10.34
## 298           3346.7              3.12          27           5.48
## 299           3287.5              9.36          23          10.16
## 300          12384.8             10.72          24           6.65
## 301          12199.4              9.15          26           7.95
## 302           2122.5              6.95          25           8.93
## 303          12127.8              6.93          29           5.75
## 304          11482.0              3.97          24           6.38
```

```
## 305       10191.7          8.58       24       6.18
## 306        8251.8          6.58       22      16.29
## 307        4036.2          5.69       24       7.26
## 308        2106.8          4.18       29       8.06
## 309        7881.9          6.40       22       6.31
## 310        8399.8          5.30       24       6.51
## 311        7064.6          6.21       23      10.58
## 312        8040.6          4.56       36       6.32
## 313       11272.6         10.38       18       7.04
## 314        2718.9          6.97       24       7.83
## 315        6612.1          9.15       32       6.14
## 316       12436.5          1.80       25      12.59
## 317       12864.2          6.09       25       4.56
## 318        5090.7          5.65       26      12.79
## 319        6601.8          4.55       20       6.29
## 320       13139.5         10.09       28      10.51
## 321       13098.9          4.17       22       3.84
## 322        5846.6          7.64       23       9.32
## 323        3911.6          8.69       19       9.10
## 324       11151.8          7.36       20       4.78
## 325        3349.4          5.25       28       5.55
## 326        2438.4          8.88       18       7.41
## 327       14992.2          7.34       28       9.86
## 328        2453.3          4.87       26       5.56
## 329        6399.0          4.22       32       6.54
## 330       13895.8         11.17       19      11.21
## 331       10024.0          5.64       28       4.99
## 332        5721.7          3.29       21       9.30
## 333       11591.3          8.07       16       8.00
## 334       12842.7          7.62       21       5.02
## 335        6085.5          4.29       18       5.72
## 336        8403.3          3.11       26       8.85
## 337       11065.8          6.77       22       7.54
## 338       10339.0          9.28       20      10.73
## 339       10370.9          8.27       41       5.84
## 340       14712.0          6.01       26       4.18
## 341        7391.5          5.33       29       9.58
## 342        3552.2          7.54       31       5.83
## 343        8838.3          7.31       21       7.25
## 344        4925.9          8.26       27      11.72
## 345        8323.3          6.21       27       6.49
## 346        6812.7          8.80       21      11.14
## 347       14783.5          5.34       23       5.03
## 348        7048.1          6.34       23       9.24
## 349        4980.1          8.48       24       7.53
## 350       10102.8          8.98       15       5.61
## 351        3775.0          3.12       28       4.76
## 352       14577.1          7.21       23       7.16
## 353        8695.9          8.22       32       7.55
## 354        4119.9          4.10       22       7.60
```

```
## 355        10084.7            7.96         32          8.22
## 356        14817.4            5.34         36          6.09
## 357        10694.0            9.04         22          6.00
## 358         7445.9            8.08         27          7.51
## 359         6203.4            8.54         20          5.95
## 360        12858.3            7.24         35         10.09
## 361         3869.6            8.73         27          7.37
## 362         4506.6            9.76         26          5.82
## 363        13657.6           10.93         31          4.07
## 364         6005.5            6.94         30          5.77
## 365         6722.9            2.50         23         12.93
## 366        12191.3            7.06         24          5.91
## 367         4513.9            7.41         22          5.44
## 368         2230.9            6.69         21          8.51
## 369         7285.9            8.14         25          7.99
## 370         8281.1            9.02         18          8.77
## 371         7483.9            5.96         30          6.43
## 372         6456.5            6.41         28          9.80
## 373        13264.2            7.80         19          4.92
## 374         7916.4            5.90         28          6.89
## 375         8938.9            7.18         24          5.66
## 376        14529.9            3.08         24          8.58
## 377        12069.6            4.76         28          7.27
## 378         4715.3            4.34         30          9.76
## 379         6014.2            5.29         42         12.98
## 380        14627.4            5.61         28          7.30
## 381         9603.7            7.76         18          5.96
## 382        11890.7            8.96         24          5.46
## 383         6845.2            5.55         32          6.46
## 384        11999.5            5.01         24          6.85
## 385         8989.8            4.92         22         12.72
## 386        13881.9            6.17         27          4.98
## 387         4408.8            6.52         27          5.04
## 388         5668.8            7.97         28          6.19
## 389         3234.5            6.36         15          8.34
## 390         4736.3            2.84         23          8.95
## 391        14702.2            6.82         30          5.33
## 392         5851.9            9.37         17          7.27
## 393        11437.7            9.38         22          6.91
## 394        12213.9            5.42         35         10.01
## 395         3370.4            3.90         26          9.70
## 396         5114.7           11.92         13          6.37
## 397         5517.0            6.68         18          7.09
## 398         3313.7            6.81         24          8.51
## 399         3532.8            7.84         23          4.26
## 400        14886.0            3.77         26          6.37
## 401        14818.7            5.54         31          8.31
## 402         3781.8            3.92         25          5.98
## 403        13769.0            5.61         17          6.87
## 404         9491.9            7.24         22          6.95
```

```
## 405          7140.8                4.27           33             5.63
## 406          7847.4                8.18           23             5.19
## 407         11184.5                7.58           29             6.59
## 408          3072.5                5.19           19             6.30
## 409          6411.0                7.45           23             8.99
## 410         10850.2                8.50           25            11.07
## 411          6120.3                9.12           27             6.97
## 412         12810.3                6.57           19             7.88
## 413          4797.2                6.81           21             6.85
## 414          8473.3                6.83           26             8.38
## 415          5588.6                9.88           27             7.47
## 416          4496.3                9.25           24             7.51
## 417         14358.0                8.67           29             9.77
## 418          6182.4                6.43           28             5.20
## 419          8219.9                7.75           24            10.80
## 420          2363.9                7.81           30             7.77
## 421          9116.9                4.92           26             7.39
## 422         10375.1                3.54           28             5.91
## 423          9751.4                8.28           22             6.66
## 424          6185.1                3.94           21             7.83
## 425         13584.4                7.00           29             3.76
## 426         10141.3                7.50           24             5.84
## 427          5937.7                8.13           23             8.34
## 428          7046.6                7.38           28             6.40
## 429          4086.1                5.53           17             5.50
## 430         13213.1                8.97           28             5.78
## 431         14390.3               10.48           32             7.51
## 432          9327.3                8.76           23             4.28
## 433          6284.1                3.11           18             9.09
## 434         14956.0                9.80           28             3.65
## 435          5052.6                6.89           22             6.01
## 436          9964.7                8.05           33             5.52
## 437          3406.3                8.24           27             4.81
## 438          8331.4                6.81           26             5.06
## 439          3292.7                6.85           31             7.54
## 440          4095.1                9.04           16             6.75
## 441          5678.9                8.42           40             6.39
## 442          9590.3                8.98           27             3.48
## 443         11512.1               11.77           17             4.70
## 444          4151.7                8.33           27             6.72
## 445         13264.0                7.41           29             5.37
## 446         11211.4                2.58           31             5.51
## 447         11885.1               12.38           22             9.59
## 448          3912.0                6.03           24             7.37
## 449          6654.7               11.75           22             5.11
## 450         10753.3                7.75           28             6.08
## 451          8809.6               10.08           27             6.42
## 452          6547.4                6.78           20             5.70
## 453          5126.8                8.02           21             5.24
## 454          2756.4                7.43           28             6.89
```

```
## 455          5076.0                6.63           27             8.74
## 456         13571.0                6.76           23             7.49
## 457         12553.7                9.03           24             6.59
## 458         11717.7                6.60           28             7.86
## 459          4013.8                2.92           25             8.88
## 460          3621.6                6.61           20             6.71
## 461         14671.4                8.08           30             8.02
## 462          7669.6                8.23           17             4.96
## 463          8032.2                8.23           24             6.49
## 464          4148.8                3.62           35             6.17
## 465          9604.1                7.74           20             7.42
## 466          5520.1                8.94           15             7.79
## 467          4991.2                9.55           17             6.74
## 468         10985.7                6.55           28             5.56
## 469          5677.0                6.36           27             5.29
## 470         12535.1                9.98           30             7.61
## 471          3220.9                3.66           21            10.51
## 472         12686.3                6.13           23             5.52
## 473          7556.5                7.91           17             6.23
## 474         11826.5                3.76           36             7.73
## 475         10611.0                7.56           29             5.92
## 476          7778.8               10.76           28             7.26
## 477         10152.9                6.99           19             6.90
## 478          2006.0                6.44           32             5.54
## 479          4824.1                7.95           22             8.98
## 480         11163.3                6.44           26             9.02
## 481          4797.1                8.63           29             9.51
## 482         12581.1                8.81           30            10.24
## 483          6000.9                7.01           30             6.01
## 484         10940.6                4.65           24             6.08
## 485         14124.8                4.36           20             7.57
## 486          3505.1                5.81           26             8.45
## 487          3660.1                8.59           27             6.32
## 488         10816.9                3.08           24             6.16
## 489          7576.3                3.23           29             5.81
## 490         12847.2                5.69           27            10.91
## 491         14628.6                7.79           32             3.29
## 492          2916.3                5.17           23             6.65
## 493          7977.2                8.77           17             7.08
## 494         11120.6                7.67           29             5.09
## 495          3130.2                6.66           33             7.85
## 496         14908.2                8.64           33             3.87
## 497          5290.2                7.78           24             9.32
## 498          2643.9                6.11           20             4.24
## 499         10922.2                7.46           24             3.61
## 500         12230.0                8.30           23             5.56
## 501          6596.8                7.71           25             7.34
## 502          6763.7                5.68           23             5.75
## 503          5732.3                8.71           22             5.91
## 504          3039.6                9.31           26             7.73
```

```
## 505        6750.9              7.55          29           5.09
## 506        4314.1              7.29          20           6.82
## 507        8968.6              6.85          18           8.12
## 508        8551.3             11.32          27          11.42
## 509       14285.4              7.55          36           8.08
## 510        6437.1              6.68          38          11.70
## 511        8041.2              1.98          24           8.01
## 512        3072.9              3.87          29           6.99
## 513       13181.3              6.84          22           3.55
## 514        7143.5              7.41          26           4.84
## 515       11566.6              7.55          28           6.36
## 516        4232.6              8.64          30           8.66
## 517        7911.9              6.61          26           6.35
## 518       12012.6              9.43          24           8.24
## 519        2814.4              5.16          31           5.08
## 520       12596.0              4.58          25           6.44
## 521        5914.8              4.54          32           7.47
## 522        6740.7              8.48          24           6.28
## 523        6057.4              6.83          28           7.24
## 524        2485.8              8.58          17           5.72
## 525        8744.4              6.46          20           7.83
## 526       10827.1              5.82          21           6.83
## 527       13742.0              6.26          25           6.90
## 528        2331.8              3.29          19           3.90
## 529       14858.0              4.66          18           5.71
## 530        5937.5              4.12          27           4.47
## 531       14208.7              9.11          35           4.32
## 532       10938.8              5.81          32           6.03
## 533        7811.4              8.58          25           6.67
## 534       12614.2             10.03          22           7.62
## 535        2513.4              6.62          25           9.71
## 536       11607.4              7.57          27           7.99
## 537        6533.3              3.50          22           9.48
## 538       12780.2              5.36          27           5.97
## 539        8962.0              7.11          21           6.38
## 540        5569.0              7.60          23           9.69
## 541       12412.3              5.48          25           7.00
## 542        3191.3             12.37          31           4.22
## 543       12817.4              6.08          21           5.43
## 544        5599.1              7.13          19           9.47
## 545       11790.4              8.30          17           5.82
## 546       14533.9              6.95          29           7.73
## 547        3059.0              5.71          21           7.02
## 548       13106.7              9.09          24           6.03
## 549       12429.0             10.23          22           6.30
## 550        7007.2              6.94          23           7.87
## 551        6258.7              8.12          21           7.45
## 552        4664.2              6.81          27          10.13
## 553        9401.9              9.03          21           6.59
## 554       13544.7              4.69          16           5.30
```

```
## 555        8886.2               11.64           22            7.35
## 556        9630.4                5.79           18            8.64
## 557       10654.5                4.08           14           13.88
## 558        8888.6                6.30           22            6.09
## 559        8627.9                7.29           19            6.34
## 560        2210.0               10.25           28            9.12
## 561        2620.2                8.82           27           10.28
## 562       14081.5                7.28           31            5.74
## 563       12000.7                4.22           28            8.54
## 564        4614.0                5.27           25            5.90
## 565       10453.3                6.67           20            5.24
## 566       10498.9               12.11           28            8.43
## 567        7138.2                3.28           22            7.22
## 568       12559.9                9.26           26            7.86
## 569        9111.3                5.95           26            5.88
## 570       13506.7               10.33           16           11.99
## 571        9193.0                4.72           29            8.54
## 572       13778.6                7.29           33            6.25
## 573        9636.9                4.80           29            8.64
## 574        7505.0                8.81           30            4.86
## 575       14344.6                9.97           29            6.71
## 576       11217.4               10.90           27           10.66
## 577        7372.9                8.60           22            6.61
## 578        2238.7               10.69           25            9.19
## 579        9367.5                9.49           23            6.54
## 580        8370.8                6.74           25            3.51
## 581       13422.7                7.95           25            5.37
## 582       12567.0                5.06           26            7.48
## 583       13103.2                6.63           26           10.80
## 584        6782.6                9.44           25            5.85
## 585       13361.3                8.08           32            7.60
## 586        3967.3                7.91           30            5.24
## 587        5663.5                4.92           26            5.16
## 588       10667.1                5.79           28            5.54
## 589       14705.9                5.47           37           10.55
## 590        9575.6                7.79           32            9.28
## 591        8845.6                5.02           34            8.36
## 592        2790.1                8.12           22            9.78
## 593       14597.5                4.77           23            6.16
## 594        3563.0               10.66           31            8.79
## 595        3148.7                7.92           30            7.45
## 596       13449.9                5.60           20            5.10
## 597        8608.8                7.48           24            5.45
## 598        6387.4                6.30           19            7.10
## 599       13626.3                7.74           33            7.44
## 600        2415.6                7.49           32            6.35
##     Population_Density Emergency_Response_Time Mitigation_Measures
Wind_Speed
## 1                  520                      16                   3
24.9
```

```
## 2                  433                    18                    3
21.0
## 3                  634                    17                    4
25.3
## 4                  576                    14                    2
22.3
## 5                  644                    12                    2
37.2
## 6                  476                    10                    1
31.8
## 7                  500                    16                    5
27.8
## 8                  591                    19                    7
22.5
## 9                  487                    15                    2
32.2
## 10                 441                    18                    3
20.6
## 11                 663                    24                    2
36.5
## 12                 672                    23                    1
30.1
## 13                 518                    13                    5
10.0
## 14                 578                    17                    2
26.1
## 15                 509                    12                    5
37.7
## 16                 625                    18                    3
24.6
## 17                 598                    15                    4
22.9
## 18                 530                    16                    0
26.4
## 19                 538                    12                    3
25.5
## 20                 515                    20                    0
33.4
## 21                 635                    15                    6
19.2
## 22                 646                    13                    3
32.0
## 23                 630                    15                    1
25.6
## 24                 533                    15                    3
30.9
## 25                 457                    22                    5
18.3
## 26                 642                    11                    1
18.1
```

```
## 27                   586                       25                     6
23.4
## 28                   597                       12                     5
20.1
## 29                   683                       16                     3
26.1
## 30                   529                        7                     5
26.0
## 31                   692                       12                     4
24.0
## 32                   567                       18                     9
24.9
## 33                   543                       17                     4
25.0
## 34                   584                       17                     3
24.2
## 35                   631                       13                     5
16.9
## 36                   583                        8                     1
24.3
## 37                   528                       11                     1
25.7
## 38                   577                       14                     1
27.0
## 39                   397                       17                     4
25.7
## 40                   559                       18                     4
29.0
## 41                   636                       14                     0
23.1
## 42                   586                       14                     6
20.3
## 43                   655                       14                     7
32.4
## 44                   639                       15                     5
22.4
## 45                   652                       21                     2
31.3
## 46                   652                       12                     3
28.3
## 47                   461                       14                     2
32.7
## 48                   600                       15                     1
17.0
## 49                   730                       10                     3
20.5
## 50                   562                       11                     2
26.0
## 51                   636                       16                     1
29.3
```

```
## 52                     611                       17                       0
21.0
## 53                     645                       20                       2
21.5
## 54                     578                       13                       2
25.3
## 55                     548                       21                       3
26.7
## 56                     606                       12                       2
24.5
## 57                     617                        9                       2
33.8
## 58                     585                        7                       0
20.5
## 59                     603                       19                       7
16.8
## 60                     633                       16                       3
24.5
## 61                     538                       14                       0
29.1
## 62                     691                       14                       3
30.4
## 63                     776                       21                       3
19.3
## 64                     718                       20                       3
19.3
## 65                     564                       11                       5
21.1
## 66                     454                        9                       0
22.8
## 67                     604                       19                       2
24.4
## 68                     670                       17                       1
25.3
## 69                     662                       13                       3
28.3
## 70                     502                       17                       1
17.1
## 71                     511                        7                       7
24.1
## 72                     611                       12                       1
29.4
## 73                     650                       17                       0
22.9
## 74                     670                       15                       3
21.7
## 75                     665                       10                       2
25.2
## 76                     523                       19                       3
19.0
```

```
## 77                      495                       20                     1
21.4
## 78                      439                       11                     2
31.2
## 79                      640                       14                     4
22.8
## 80                      666                       18                     2
20.5
## 81                      627                       18                     1
22.8
## 82                      515                       13                     1
29.0
## 83                      725                       11                     4
21.1
## 84                      570                       16                     2
32.0
## 85                      742                        7                     2
29.3
## 86                      644                       11                     1
27.8
## 87                      695                       18                     3
14.7
## 88                      626                        8                     4
25.5
## 89                      595                       10                     4
14.3
## 90                      519                       14                     6
24.3
## 91                      555                       14                     3
25.3
## 92                      596                        8                     4
26.5
## 93                      623                       17                     0
24.3
## 94                      597                       11                     5
19.4
## 95                      586                       14                     2
27.3
## 96                      615                       14                     2
24.0
## 97                      558                       18                     4
25.3
## 98                      557                       15                     1
27.7
## 99                      484                       14                     7
26.5
## 100                     668                       22                     5
29.5
## 101                     604                       16                     1
34.1
```

```
## 102                    593                      17                     1
28.7
## 103                    541                      17                     2
25.7
## 104                    580                      17                     1
28.0
## 105                    513                      20                     3
26.1
## 106                    516                      15                     4
20.0
## 107                    446                      16                     2
26.1
## 108                    679                      23                     2
29.0
## 109                    610                      13                     1
15.0
## 110                    511                      20                     1
20.4
## 111                    693                      13                     7
20.2
## 112                    650                      22                     4
31.8
## 113                    659                      12                     6
25.6
## 114                    582                      12                     3
24.9
## 115                    566                      19                     1
28.1
## 116                    592                      19                     5
27.7
## 117                    632                      17                     0
17.4
## 118                    664                      16                     4
20.3
## 119                    727                      16                     2
27.8
## 120                    559                      23                     1
14.7
## 121                    519                       9                     4
13.4
## 122                    608                      11                     3
19.8
## 123                    842                      10                     3
36.2
## 124                    566                      19                     4
15.2
## 125                    692                      14                     5
24.1
## 126                    581                      14                     7
23.1
```

```
## 127               562              22              2
22.4
## 128               543              13              2
26.7
## 129               583              23              1
23.9
## 130               731               9              8
22.9
## 131               624              20              6
35.3
## 132               639              16              6
17.0
## 133               667              13              2
32.1
## 134               766              14              4
19.0
## 135               662              20              2
26.0
## 136               486              22              0
23.2
## 137               517               8              2
27.8
## 138               473              29              6
30.4
## 139               372              25              3
20.2
## 140               703              13              4
30.6
## 141               561              15              0
25.0
## 142               632              12              3
25.9
## 143               695              15              4
28.8
## 144               559              18              3
24.3
## 145               589              15              4
19.5
## 146               628              16              3
34.5
## 147               618              21              4
23.0
## 148               538               6              4
24.5
## 149               658              13              2
22.9
## 150               644              16              4
14.8
## 151               577              12              3
33.7
```

```
## 152                502                 19                  5
23.0
## 153                651                 13                  1
29.1
## 154                714                 13                  2
19.4
## 155                710                 20                  3
29.0
## 156                670                 18                  0
27.3
## 157                561                 14                  2
26.0
## 158                557                 14                  3
13.6
## 159                553                  9                  5
16.3
## 160                567                 12                  3
28.9
## 161                657                 25                  1
25.2
## 162                621                 15                  4
23.9
## 163                451                 19                  0
33.7
## 164                451                 14                  3
28.1
## 165                598                 17                  3
20.2
## 166                612                 15                  1
19.5
## 167                415                 20                  1
23.9
## 168                535                 13                  0
21.2
## 169                602                  8                  1
27.9
## 170                717                 19                  2
26.8
## 171                439                 14                  4
23.3
## 172                500                 21                  1
15.1
## 173                514                 15                  7
23.7
## 174                614                 21                  3
29.0
## 175                626                 16                  2
26.0
## 176                574                 14                  3
26.7
```

```
## 177                  471                      18                     5
24.3
## 178                  550                      13                     1
17.3
## 179                  555                      22                     1
33.4
## 180                  584                      16                     6
24.9
## 181                  730                       7                     6
14.1
## 182                  546                      13                     2
18.5
## 183                  606                       8                     3
27.4
## 184                  544                       6                     2
29.5
## 185                  501                      15                     2
30.5
## 186                  651                      18                     4
27.6
## 187                  516                      12                     4
18.4
## 188                  819                      10                     3
26.3
## 189                  607                      13                     2
23.0
## 190                  605                       9                     4
19.7
## 191                  595                      18                     3
24.2
## 192                  747                      17                     1
30.2
## 193                  653                       9                     3
32.9
## 194                  580                      13                     2
23.6
## 195                  507                      19                     5
19.9
## 196                  517                      14                     5
25.3
## 197                  537                      15                     2
20.7
## 198                  697                      17                     2
22.2
## 199                  585                      18                     2
27.8
## 200                  539                      20                     3
27.0
## 201                  663                      18                     3
16.7
```

```
## 202                     708                         9                    3
19.7
## 203                     544                        14                    4
22.7
## 204                     564                        16                    1
21.4
## 205                     628                        15                    7
25.8
## 206                     600                         6                    3
29.0
## 207                     633                        12                    6
21.7
## 208                     737                        19                    3
20.8
## 209                     595                        16                    5
34.5
## 210                     578                         9                    7
19.2
## 211                     639                        16                    0
28.3
## 212                     596                        14                    1
25.7
## 213                     650                        18                    5
31.3
## 214                     582                        23                    3
25.1
## 215                     635                         9                    4
19.2
## 216                     475                        13                    4
27.1
## 217                     601                        14                    2
27.4
## 218                     559                         6                    2
21.9
## 219                     505                        15                    2
17.3
## 220                     567                        13                    1
18.9
## 221                     630                        24                    1
26.0
## 222                     607                         3                    3
23.5
## 223                     655                        21                    3
24.1
## 224                     675                        19                    2
29.1
## 225                     666                        18                    3
21.0
## 226                     574                        16                    3
26.3
```

```
## 227                494                     12                   0
22.2
## 228                578                     19                   3
20.0
## 229                694                     11                   1
30.4
## 230                590                     18                   2
21.8
## 231                469                     17                   3
19.2
## 232                639                     19                   1
24.9
## 233                623                     13                   1
29.7
## 234                568                     13                   2
23.8
## 235                614                     16                   2
20.3
## 236                710                     16                   2
21.1
## 237                704                     20                   5
20.7
## 238                563                     17                   2
27.1
## 239                601                     16                   2
28.7
## 240                484                     18                   4
18.6
## 241                542                     13                   3
30.8
## 242                761                     19                   1
15.7
## 243                720                     11                   4
31.8
## 244                582                     16                   2
34.4
## 245                545                      8                   1
29.5
## 246                491                     16                   4
21.3
## 247                770                      9                   5
23.7
## 248                609                     14                   6
28.7
## 249                552                      8                   5
21.2
## 250                686                     12                   3
31.5
## 251                512                     12                   5
28.1
```

```
## 252                    658                     17                     2
23.1
## 253                    715                     13                     2
24.2
## 254                    583                     12                     4
32.0
## 255                    716                     20                     1
27.1
## 256                    651                     22                     3
21.7
## 257                    546                     19                     4
37.9
## 258                    646                      9                     4
18.9
## 259                    544                     20                     4
26.9
## 260                    557                     10                     6
21.5
## 261                    662                     15                     8
27.5
## 262                    562                     18                     2
21.4
## 263                    598                     14                     6
26.0
## 264                    682                     14                     3
30.1
## 265                    504                     16                     2
20.6
## 266                    728                     17                     1
29.4
## 267                    763                     17                     1
33.4
## 268                    649                      8                     1
14.2
## 269                    634                     14                     4
24.6
## 270                    560                     16                     2
19.6
## 271                    639                     17                     7
14.6
## 272                    560                     14                     2
24.6
## 273                    623                     12                     1
25.8
## 274                    545                     10                     1
24.9
## 275                    663                     12                     2
30.2
## 276                    655                     15                     5
18.4
```

```
## 277                   699                      12                     6
22.0
## 278                   759                      17                     1
23.7
## 279                   548                      16                     7
14.8
## 280                   677                       9                     2
21.8
## 281                   486                      16                     3
25.9
## 282                   563                      17                     1
14.5
## 283                   676                      14                     1
23.3
## 284                   541                      15                     3
26.1
## 285                   628                      13                     2
20.7
## 286                   528                      14                     2
27.5
## 287                   570                      11                     5
23.5
## 288                   597                      17                     4
23.1
## 289                   551                      10                     7
26.9
## 290                   444                      13                     0
26.1
## 291                   619                      11                     3
16.4
## 292                   638                      12                     2
23.1
## 293                   611                      14                     2
13.2
## 294                   561                      13                     2
33.8
## 295                   672                      12                     3
32.6
## 296                   686                      14                     5
22.9
## 297                   410                       9                     3
30.4
## 298                   690                      15                     1
21.0
## 299                   458                      18                     1
19.4
## 300                   572                      10                     1
25.4
## 301                   511                       9                     4
26.0
```

```
## 302                550                     24                    6
32.8
## 303                705                     16                    6
21.5
## 304                643                     15                    3
27.5
## 305                640                     14                    3
24.9
## 306                434                     17                    4
22.7
## 307                616                     15                    4
26.7
## 308                650                     13                    3
28.0
## 309                669                     13                    3
31.9
## 310                522                     14                    6
24.9
## 311                675                     14                    4
21.0
## 312                488                     12                    2
23.8
## 313                739                     19                    2
23.4
## 314                536                     15                    1
28.5
## 315                661                     12                    5
25.7
## 316                625                     17                    7
24.6
## 317                515                     16                    3
30.9
## 318                692                     14                    5
12.5
## 319                603                     17                    2
18.7
## 320                665                     11                    4
34.6
## 321                617                     14                    4
33.0
## 322                669                     11                    2
19.1
## 323                602                     10                    5
26.1
## 324                689                     14                    3
24.5
## 325                572                     16                    3
27.1
## 326                642                     11                    1
26.4
```

```
## 327                630                     14                      0
26.1
## 328                668                      8                      6
39.2
## 329                550                     13                      6
27.5
## 330                614                     20                      3
26.4
## 331                554                     10                      2
23.5
## 332                673                     10                      5
30.7
## 333                549                     14                      2
15.4
## 334                739                     17                      3
31.5
## 335                663                     20                      6
32.9
## 336                599                     26                      3
20.9
## 337                696                     18                      0
18.7
## 338                593                     18                      5
26.7
## 339                645                     23                      1
31.5
## 340                642                     14                      2
22.7
## 341                634                     14                      2
20.8
## 342                552                     16                      1
34.8
## 343                500                      9                      1
27.0
## 344                465                      8                      3
27.5
## 345                563                     22                      5
27.7
## 346                655                     13                      0
31.0
## 347                581                     13                      5
22.7
## 348                504                     11                      5
31.6
## 349                773                     16                      4
21.3
## 350                656                     17                      4
28.9
## 351                756                     14                      2
28.9
```

```
## 352                 697                   15                   1
19.4
## 353                 551                   19                   2
26.6
## 354                 567                   15                   3
16.6
## 355                 485                   13                   2
18.7
## 356                 659                   15                   3
30.5
## 357                 730                   12                   2
20.5
## 358                 526                   15                   3
29.1
## 359                 504                   11                   4
20.8
## 360                 671                   21                   0
33.2
## 361                 479                    5                   5
31.5
## 362                 754                   17                   1
28.3
## 363                 646                   13                   2
21.3
## 364                 463                   23                   4
22.8
## 365                 628                   14                   3
36.5
## 366                 608                   17                   5
28.4
## 367                 403                   17                   0
26.6
## 368                 597                   16                   5
14.8
## 369                 553                   17                   3
23.6
## 370                 529                   23                   2
24.3
## 371                 619                   19                   1
27.5
## 372                 668                   16                   3
38.1
## 373                 738                   22                   5
25.4
## 374                 389                   17                   4
15.1
## 375                 659                   18                   5
27.4
## 376                 524                   20                   1
30.0
```

```
## 377                    693                      16                      0
27.8
## 378                    628                      18                      2
30.2
## 379                    716                      14                      5
24.1
## 380                    481                      15                      2
24.0
## 381                    640                      15                      2
25.6
## 382                    624                      12                      1
23.2
## 383                    684                      23                      3
20.2
## 384                    582                      13                      5
32.6
## 385                    692                      14                      5
33.0
## 386                    564                      20                      3
33.5
## 387                    566                      15                      4
27.8
## 388                    602                      20                      4
24.8
## 389                    514                      13                      2
31.3
## 390                    563                      15                      2
27.2
## 391                    689                      14                      3
31.9
## 392                    732                      11                      2
31.7
## 393                    689                      14                      2
28.4
## 394                    566                      12                      1
25.7
## 395                    625                      18                      5
22.8
## 396                    608                      14                      4
29.4
## 397                    499                      15                      1
29.7
## 398                    621                      12                      3
29.2
## 399                    534                      16                      4
19.6
## 400                    515                       9                      3
12.3
## 401                    658                       3                      6
31.3
```

```
## 402                    543                       23                    3
22.8
## 403                    588                       18                    0
30.5
## 404                    522                       18                    4
29.4
## 405                    604                        6                    4
18.6
## 406                    639                       18                    3
33.5
## 407                    640                       17                    2
15.6
## 408                    514                       15                    2
27.2
## 409                    701                       18                    3
29.5
## 410                    719                       19                    2
25.6
## 411                    630                       15                    2
25.7
## 412                    613                       23                    2
32.0
## 413                    606                       19                    4
19.1
## 414                    621                       20                    1
24.4
## 415                    630                       14                    5
29.9
## 416                    611                       14                    5
32.0
## 417                    652                       11                    4
26.7
## 418                    573                       17                    1
23.6
## 419                    690                       16                    3
18.1
## 420                    597                       15                    2
27.1
## 421                    460                       12                    2
18.4
## 422                    592                       14                    1
35.3
## 423                    636                       23                    3
24.1
## 424                    698                       11                    4
26.1
## 425                    605                       13                    2
20.7
## 426                    445                        9                    3
25.4
```

```
## 427                 600                  10                  3
23.9
## 428                 504                  14                  4
35.1
## 429                 522                  13                  2
26.8
## 430                 518                  13                  5
18.4
## 431                 536                  12                  4
27.1
## 432                 691                  14                  2
25.5
## 433                 533                  20                  1
26.6
## 434                 565                  14                  3
31.2
## 435                 615                  10                  1
32.7
## 436                 671                  11                  2
23.5
## 437                 547                   7                  3
27.6
## 438                 534                   8                  1
19.9
## 439                 559                  12                  4
21.7
## 440                 506                  11                  3
19.0
## 441                 674                  10                  5
26.6
## 442                 425                  23                  2
20.9
## 443                 558                  22                  4
23.2
## 444                 485                  25                  6
18.3
## 445                 443                  18                  3
20.3
## 446                 602                  14                  7
11.8
## 447                 723                  11                  4
16.3
## 448                 731                  11                  7
31.2
## 449                 555                  13                  1
31.5
## 450                 544                  20                  4
23.2
## 451                 557                  18                  1
18.9
```

```
## 452                 657                      19                      2
24.3
## 453                 395                      14                      1
22.6
## 454                 620                       9                      4
22.5
## 455                 568                      16                      3
36.5
## 456                 540                      14                      4
34.0
## 457                 440                      14                      4
28.5
## 458                 584                      24                      5
28.6
## 459                 468                      18                      5
23.5
## 460                 599                      14                      4
30.0
## 461                 528                       7                      6
26.0
## 462                 604                      14                      3
20.5
## 463                 637                      19                      3
25.4
## 464                 560                      16                      1
29.1
## 465                 518                      16                      3
24.9
## 466                 551                      19                      5
16.2
## 467                 547                      14                      2
24.6
## 468                 481                      14                      5
23.8
## 469                 538                      14                      3
20.1
## 470                 585                      18                      1
23.2
## 471                 582                      14                      3
24.6
## 472                 626                      18                      4
21.9
## 473                 703                      10                      2
23.5
## 474                 627                      10                      2
25.5
## 475                 718                      16                      2
24.9
## 476                 548                      18                      2
20.2
```

```
## 477                 708                 13                 1
21.5
## 478                 647                 13                 2
27.4
## 479                 505                  4                 1
23.9
## 480                 632                 16                 6
21.4
## 481                 501                 11                 6
23.3
## 482                 676                 17                 3
29.4
## 483                 557                 21                 3
21.6
## 484                 581                 13                 3
23.9
## 485                 546                 18                 2
21.7
## 486                 532                 14                 4
17.7
## 487                 736                 16                 1
23.3
## 488                 679                 10                 1
26.7
## 489                 654                 17                 3
29.8
## 490                 606                 20                 1
20.2
## 491                 659                 22                 2
25.3
## 492                 653                 10                 0
20.4
## 493                 728                 17                 3
31.0
## 494                 668                 13                 3
21.8
## 495                 584                 17                 2
33.8
## 496                 583                 14                 4
21.7
## 497                 563                 14                 4
25.3
## 498                 571                 18                 3
36.1
## 499                 581                 18                 3
22.2
## 500                 698                 16                 4
18.6
## 501                 414                 17                 3
20.8
```

```
## 502                 544                      17                    4
27.4
## 503                 589                      16                    8
21.0
## 504                 497                      15                    3
29.4
## 505                 730                      19                    5
22.6
## 506                 581                      18                    5
18.5
## 507                 511                      18                    3
26.7
## 508                 529                      19                    3
25.9
## 509                 670                      17                    2
17.8
## 510                 750                      14                    3
20.3
## 511                 590                      11                    5
23.3
## 512                 609                      13                    3
20.8
## 513                 524                      12                    1
30.3
## 514                 705                      14                    1
26.7
## 515                 658                      13                    3
32.1
## 516                 414                      14                    2
10.6
## 517                 548                      11                    4
22.5
## 518                 581                      13                    1
28.4
## 519                 511                      16                    2
27.9
## 520                 578                      16                    2
26.4
## 521                 509                      13                    2
22.8
## 522                 629                      19                    4
24.3
## 523                 627                       8                    4
24.6
## 524                 665                      17                    1
27.0
## 525                 633                      21                    3
22.2
## 526                 728                      13                    2
20.0
```

```
## 527                569                  17                2
20.6
## 528                428                  13                3
30.0
## 529                602                  15                2
28.9
## 530                652                  18                1
28.1
## 531                568                  11                3
28.1
## 532                712                  13                2
31.1
## 533                688                  17                4
26.1
## 534                643                  17                2
39.5
## 535                606                  18                5
26.4
## 536                556                  20                5
32.3
## 537                586                  18                2
30.8
## 538                638                  11                6
25.4
## 539                677                  16                5
32.0
## 540                576                  13                0
30.7
## 541                542                  15                1
26.0
## 542                798                  19                4
30.4
## 543                641                  16                2
21.5
## 544                528                  16                1
19.1
## 545                674                  15                1
32.0
## 546                605                  17                4
15.8
## 547                666                  10                3
24.2
## 548                604                  13                2
31.3
## 549                595                  21                4
31.3
## 550                607                  17                4
30.9
## 551                633                  11                1
29.1
```

```
## 552                    551                         10                        1
25.1
## 553                    548                         11                        3
20.5
## 554                    585                         17                        6
11.7
## 555                    614                         17                        1
21.7
## 556                    575                         13                        3
25.5
## 557                    625                         14                        4
24.3
## 558                    512                         19                        0
23.3
## 559                    486                         14                        1
35.2
## 560                    751                         15                        3
27.9
## 561                    632                         16                        4
23.9
## 562                    568                         14                        8
22.2
## 563                    578                         12                        3
29.5
## 564                    663                         13                        6
21.1
## 565                    583                         11                        1
30.8
## 566                    615                         17                        6
17.7
## 567                    579                         20                        3
24.7
## 568                    560                         16                        1
27.6
## 569                    648                         18                        2
28.7
## 570                    611                         12                        4
25.1
## 571                    704                         14                        2
33.5
## 572                    510                         14                        7
31.6
## 573                    589                          9                        1
21.4
## 574                    583                         15                        4
15.2
## 575                    514                         17                        2
26.2
## 576                    680                         18                        2
19.3
```

```
## 577                 591                        20                    3
27.4
## 578                 489                         9                    4
29.8
## 579                 553                        17                    1
27.8
## 580                 512                        18                    5
16.1
## 581                 683                        14                    3
27.9
## 582                 803                        17                    2
23.3
## 583                 546                         9                    5
23.6
## 584                 593                        16                    4
17.6
## 585                 622                         2                    4
23.6
## 586                 817                        16                    2
21.4
## 587                 414                        21                    2
24.3
## 588                 559                        21                    5
25.0
## 589                 504                         4                    2
20.3
## 590                 582                        17                    4
25.6
## 591                 578                        14                    2
21.0
## 592                 542                        15                    4
35.8
## 593                 747                         6                    4
30.1
## 594                 621                        17                    3
24.9
## 595                 791                        13                    3
17.9
## 596                 666                        16                    1
22.0
## 597                 499                        14                    1
23.3
## 598                 540                        11                    5
15.4
## 599                 622                        16                    1
21.7
## 600                 554                        17                    6
28.6
##     Humidity
## 1      35.32
```

```
## 2       28.24
## 3       44.51
## 4       53.77
## 5       73.79
## 6       50.89
## 7       47.07
## 8       74.57
## 9       48.03
## 10      76.02
## 11      61.13
## 12      48.25
## 13      11.29
## 14      28.31
## 15      37.28
## 16      25.35
## 17      24.32
## 18      40.53
## 19      71.36
## 20      29.31
## 21      52.72
## 22      45.33
## 23      67.95
## 24      50.89
## 25      46.13
## 26      36.67
## 27      70.09
## 28      75.24
## 29      50.45
## 30      49.93
## 31      46.92
## 32      19.26
## 33      81.71
## 34      85.49
## 35      59.12
## 36      57.09
## 37      37.73
## 38      34.61
## 39      33.69
## 40      30.37
## 41      37.66
## 42      35.81
## 43      62.08
## 44      67.47
## 45      61.33
## 46      42.68
## 47      43.88
## 48      15.50
## 49      49.24
## 50      32.42
## 51      58.17
```

```
## 52      25.30
## 53      32.29
## 54      43.51
## 55      22.98
## 56      42.53
## 57      41.12
## 58      63.92
## 59      28.89
## 60      82.76
## 61      60.73
## 62      33.72
## 63      55.30
## 64      41.12
## 65      61.64
## 66      31.69
## 67      60.61
## 68      83.53
## 69      77.69
## 70      57.01
## 71      57.66
## 72      59.66
## 73      70.23
## 74      58.85
## 75      63.82
## 76      64.53
## 77      55.24
## 78      51.33
## 79      72.61
## 80      40.18
## 81      54.46
## 82      50.75
## 83      26.09
## 84      76.43
## 85      24.29
## 86      78.50
## 87      26.20
## 88      69.42
## 89      48.12
## 90      82.15
## 91      34.25
## 92      17.55
## 93      37.03
## 94      52.04
## 95      42.34
## 96      36.79
## 97      46.23
## 98      56.19
## 99      30.69
## 100     29.19
## 101     64.48
```

```
## 102    24.64
## 103    30.05
## 104    30.26
## 105    67.85
## 106    50.72
## 107    61.19
## 108    67.48
## 109    55.70
## 110    60.26
## 111    24.29
## 112    48.58
## 113    35.95
## 114    21.50
## 115    24.16
## 116    21.59
## 117    40.73
## 118    72.01
## 119    57.56
## 120    64.85
## 121    57.61
## 122    46.57
## 123     7.87
## 124    36.11
## 125    41.32
## 126    90.44
## 127    53.18
## 128    33.67
## 129    70.02
## 130    61.25
## 131    48.15
## 132    44.76
## 133    46.65
## 134    48.36
## 135    64.12
## 136    52.94
## 137    35.70
## 138    68.85
## 139    34.12
## 140    78.58
## 141    28.04
## 142    66.97
## 143    77.59
## 144    76.89
## 145    47.42
## 146    65.74
## 147     8.56
## 148    60.18
## 149    47.48
## 150    63.68
## 151    52.50
```

```
## 152    78.30
## 153    46.07
## 154    66.65
## 155    47.56
## 156    64.93
## 157    22.93
## 158    63.83
## 159    41.06
## 160    59.06
## 161    30.27
## 162    62.38
## 163    82.80
## 164    71.96
## 165    35.89
## 166    57.46
## 167    46.36
## 168    44.48
## 169    42.73
## 170    47.94
## 171    37.84
## 172    64.84
## 173    88.68
## 174    65.03
## 175    51.27
## 176    51.74
## 177    75.61
## 178    78.05
## 179    36.49
## 180    71.32
## 181    23.88
## 182    23.69
## 183    83.74
## 184    50.85
## 185    50.78
## 186    45.47
## 187    30.89
## 188    53.19
## 189    14.42
## 190    39.18
## 191    46.39
## 192    18.94
## 193    54.25
## 194    33.37
## 195    74.73
## 196    43.54
## 197    25.74
## 198    55.50
## 199    48.77
## 200    50.93
## 201    54.96
```

```
## 202    40.96
## 203    42.50
## 204    64.76
## 205    84.26
## 206    46.88
## 207    71.95
## 208    23.96
## 209    75.79
## 210    41.30
## 211    66.08
## 212    81.62
## 213    70.23
## 214     7.78
## 215    22.11
## 216    63.27
## 217    29.51
## 218    37.39
## 219    79.99
## 220    52.68
## 221    51.04
## 222    44.35
## 223    16.23
## 224    11.85
## 225    44.99
## 226    58.14
## 227    21.23
## 228    12.90
## 229    77.93
## 230    61.60
## 231    61.04
## 232    70.63
## 233    62.67
## 234    26.47
## 235    77.44
## 236    22.03
## 237    39.04
## 238    57.66
## 239    56.46
## 240    63.45
## 241    69.76
## 242    31.69
## 243    21.84
## 244    24.19
## 245    63.12
## 246    39.40
## 247    59.47
## 248    76.12
## 249    34.72
## 250    70.79
## 251    35.31
```

```
## 252    64.06
## 253    50.78
## 254    30.80
## 255    71.28
## 256    66.41
## 257    30.41
## 258    50.87
## 259    32.95
## 260    46.16
## 261    80.34
## 262    25.28
## 263    93.92
## 264    34.81
## 265    38.08
## 266    49.11
## 267    73.92
## 268    98.63
## 269    61.06
## 270    64.13
## 271    20.21
## 272    53.25
## 273    44.06
## 274    81.40
## 275    45.44
## 276    48.67
## 277    50.90
## 278    47.15
## 279    52.30
## 280    17.71
## 281    38.99
## 282    42.16
## 283    63.01
## 284    54.77
## 285    32.80
## 286    69.17
## 287    76.98
## 288    21.99
## 289    54.23
## 290    33.01
## 291    36.13
## 292    59.63
## 293    58.72
## 294    37.77
## 295    75.05
## 296    73.04
## 297    27.85
## 298    57.20
## 299    24.35
## 300    81.50
## 301    56.21
```

```
## 302    73.77
## 303    58.91
## 304    47.51
## 305    67.02
## 306    25.49
## 307    35.62
## 308    56.06
## 309    40.51
## 310    39.35
## 311    70.70
## 312    38.51
## 313    71.84
## 314    32.49
## 315    44.10
## 316    31.33
## 317    40.23
## 318    24.31
## 319    60.24
## 320    76.10
## 321    56.51
## 322    85.64
## 323    15.52
## 324    32.96
## 325    62.00
## 326    64.43
## 327    57.51
## 328    86.16
## 329    85.05
## 330    18.64
## 331    40.43
## 332    19.09
## 333    26.98
## 334    55.71
## 335    58.07
## 336    32.32
## 337    56.93
## 338    33.48
## 339    55.74
## 340    52.61
## 341    43.47
## 342    28.46
## 343    39.34
## 344    61.24
## 345    38.69
## 346    42.52
## 347    26.18
## 348    40.05
## 349    49.43
## 350    33.45
## 351    41.22
```

```
## 352    25.54
## 353    66.99
## 354    40.25
## 355    60.69
## 356    83.51
## 357    41.18
## 358    41.07
## 359    64.74
## 360    28.63
## 361    46.02
## 362    37.36
## 363    59.65
## 364    46.80
## 365    64.70
## 366    31.43
## 367    43.42
## 368    25.79
## 369    63.20
## 370    61.20
## 371    29.49
## 372    46.23
## 373    54.11
## 374    48.87
## 375    45.04
## 376    51.86
## 377    26.99
## 378    75.52
## 379    64.72
## 380    51.82
## 381    71.23
## 382    23.11
## 383    74.14
## 384    54.88
## 385    61.51
## 386    39.56
## 387    32.28
## 388    37.52
## 389    73.13
## 390    74.25
## 391    48.57
## 392    32.86
## 393    81.60
## 394    17.01
## 395    46.34
## 396    63.76
## 397    24.30
## 398    61.20
## 399    84.16
## 400    33.76
## 401    34.38
```

```
## 402    28.85
## 403    81.82
## 404    33.91
## 405    31.08
## 406    36.58
## 407    36.36
## 408    63.83
## 409    56.93
## 410    60.87
## 411    35.64
## 412    66.45
## 413    75.01
## 414    54.60
## 415    40.71
## 416    60.89
## 417    23.09
## 418    35.58
## 419    52.51
## 420    16.82
## 421    49.07
## 422    49.16
## 423    43.59
## 424    21.73
## 425    75.79
## 426    18.17
## 427    18.32
## 428    36.70
## 429    82.95
## 430    52.46
## 431    55.97
## 432    45.03
## 433    56.23
## 434    64.43
## 435    66.08
## 436    79.74
## 437    32.38
## 438    46.36
## 439    59.48
## 440    68.65
## 441    42.35
## 442    64.82
## 443    37.47
## 444    42.16
## 445    72.63
## 446    11.82
## 447    55.10
## 448    70.81
## 449    42.08
## 450    64.24
## 451    33.95
```

```
## 452     53.94
## 453     50.23
## 454     49.34
## 455     22.06
## 456     46.26
## 457     31.59
## 458     41.74
## 459     72.88
## 460     37.06
## 461     49.25
## 462     52.37
## 463     45.64
## 464     68.24
## 465     49.02
## 466     53.57
## 467     29.95
## 468     41.23
## 469     35.26
## 470     60.86
## 471     75.49
## 472     39.45
## 473      7.70
## 474     30.91
## 475     29.01
## 476     53.29
## 477     83.21
## 478     59.20
## 479     17.08
## 480     61.33
## 481     33.04
## 482     50.01
## 483     47.66
## 484     46.68
## 485     42.39
## 486     88.71
## 487     29.97
## 488     54.57
## 489     75.48
## 490     74.49
## 491     29.84
## 492     80.46
## 493     33.99
## 494     52.92
## 495     53.88
## 496     11.30
## 497     46.93
## 498     10.68
## 499     57.36
## 500     57.84
## 501     71.84
```

```
## 502    58.71
## 503    34.67
## 504    31.88
## 505    68.20
## 506    81.22
## 507    68.08
## 508    54.99
## 509    48.41
## 510    72.23
## 511    46.14
## 512    25.01
## 513    68.90
## 514    28.04
## 515    57.90
## 516    54.27
## 517    53.25
## 518    53.74
## 519    38.71
## 520    34.01
## 521    23.87
## 522    24.77
## 523    30.91
## 524    77.38
## 525    65.80
## 526    56.32
## 527    85.70
## 528    84.01
## 529    70.32
## 530    23.87
## 531    80.89
## 532    45.35
## 533    44.42
## 534    55.46
## 535    51.45
## 536    38.70
## 537    65.58
## 538    38.96
## 539    37.10
## 540    44.15
## 541    32.78
## 542    53.54
## 543    47.76
## 544    43.20
## 545    60.62
## 546    12.65
## 547    55.81
## 548    70.29
## 549    69.84
## 550    35.42
## 551    28.04
```

```
## 552    57.49
## 553    76.67
## 554    26.64
## 555    60.05
## 556    42.24
## 557    55.96
## 558    25.50
## 559    70.74
## 560     5.46
## 561    46.98
## 562    26.51
## 563    33.48
## 564    71.01
## 565    39.28
## 566    52.99
## 567    81.42
## 568    34.48
## 569    72.09
## 570    78.11
## 571    46.12
## 572    18.50
## 573    67.21
## 574    76.90
## 575    35.92
## 576    38.29
## 577    67.91
## 578    81.40
## 579    12.83
## 580    75.34
## 581    79.33
## 582    58.53
## 583    55.57
## 584    35.84
## 585    57.79
## 586    39.64
## 587    90.31
## 588    39.70
## 589    61.44
## 590    68.60
## 591    17.11
## 592    44.05
## 593    58.96
## 594    45.46
## 595    19.21
## 596    30.80
## 597    84.22
## 598    47.08
## 599    77.93
## 600    54.13
```

```r
#Perform PCA
obj = prcomp(PCA_BFD,center = TRUE, scale = TRUE)
summary(obj)
```

```
## Importance of components:
##                           PC1    PC2    PC3    PC4    PC5    PC6    PC7
PC8
## Standard deviation     1.1032 1.0420 1.0295 1.0070 0.9978 0.9800 0.9696
0.94216
## Proportion of Variance 0.1352 0.1206 0.1178 0.1127 0.1106 0.1067 0.1045
0.09863
## Cumulative Proportion  0.1352 0.2559 0.3736 0.4863 0.5969 0.7036 0.8081
0.90672
##                            PC9
## Standard deviation     0.91624
## Proportion of Variance 0.09328
## Cumulative Proportion  1.00000
```

```r
#Loadings
obj$rotation
```

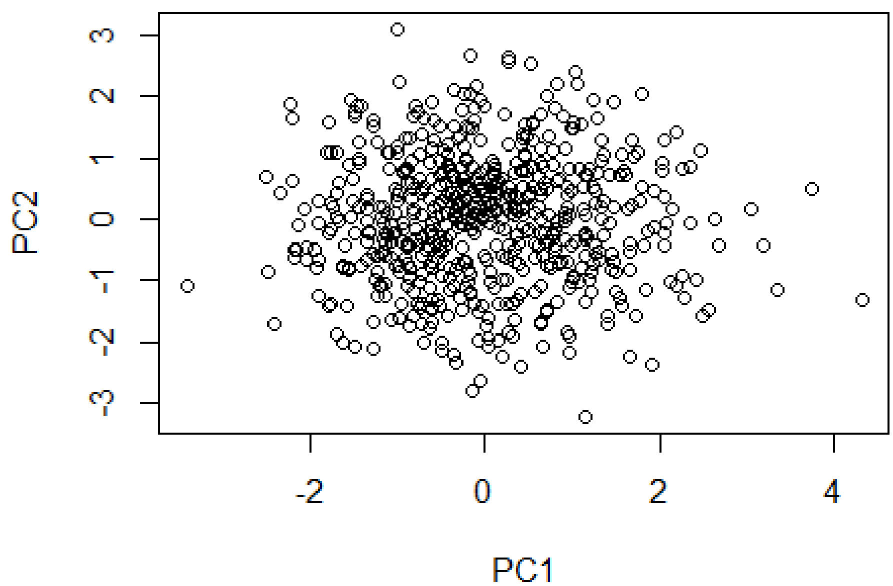
```
##                               PC1         PC2          PC3        PC4
## Fire_Intensity          0.3879646  0.53114764  0.277551664 -0.1241035
## Distance_from_Fire     -0.2886636  0.31299597  0.283544133  0.1461189
## Building_Age            0.3992121  0.01092616  0.188956016 -0.2397889
## Property_Value         -0.2343575 -0.56694049  0.046357169  0.1135330
## Population_Density     -0.1844550 -0.03471533  0.665073999 -0.2027555
## Emergency_Response_Time -0.1559268  0.36447621 -0.481160270 -0.1691881
## Mitigation_Measures     0.4326790 -0.18691331  0.233395512  0.5172214
## Wind_Speed             -0.5238593  0.11616106  0.276349250 -0.1083837
## Humidity               -0.1785676  0.34043615 -0.005782125  0.7374684
##                                PC5         PC6         PC7         PC8
## Fire_Intensity          0.06774495  0.05978999  0.17105479 -0.46566106
## Distance_from_Fire      0.39809326 -0.39041991 -0.63245462 -0.04322718
## Building_Age            0.63950630  0.32255633  0.06747088  0.33870550
## Property_Value          0.55375337 -0.06649410  0.24063293 -0.27686720
## Population_Density     -0.19223228 -0.34593910  0.37214303  0.42027466
## Emergency_Response_Time  0.26021220 -0.48561646  0.48327720 -0.01756541
## Mitigation_Measures    -0.06798850 -0.34429795  0.17163800 -0.30500609
## Wind_Speed             -0.03133774  0.41519685  0.19695159 -0.45038549
## Humidity                0.10513399  0.29850745  0.26074521  0.34219758
##                                PC9
## Fire_Intensity         -0.46974977
## Distance_from_Fire      0.06469508
## Building_Age            0.33914973
## Property_Value         -0.40372316
## Population_Density     -0.09792678
## Emergency_Response_Time  0.21284964
## Mitigation_Measures     0.45848552
```

```
## Wind_Speed                 0.45711549
## Humidity                  -0.15190984
```

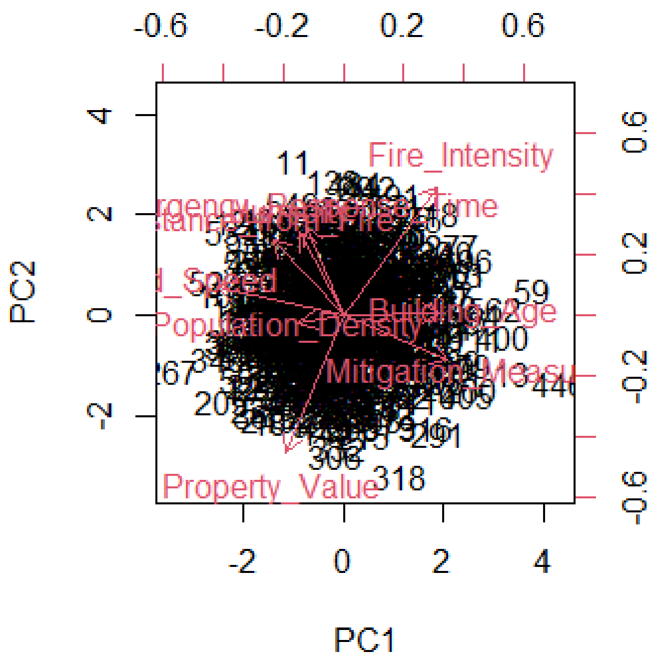
```r
#Principal components
head(obj$x)
```

```
##             PC1        PC2        PC3          PC4         PC5        PC6
## [1,] -0.5245971 -1.4173303 -1.3564853 -0.004936077 -0.28599453 -0.2470297
## [2,]  1.8103159  0.5301982 -1.8342258 -0.875235087  0.18356445  0.2213466
## [3,] -0.0967987  0.3485307 -0.5527159  0.069854381 -2.40385667 -0.7887507
## [4,]  1.5715451  1.0495303 -0.1293591 -0.669977650 -0.20716960  1.1520080
## [5,] -1.4997559  0.6674983  1.4491181  0.446020777 -0.25751187  1.6647432
## [6,] -1.1547775 -0.5263678 -0.6187590 -0.068258525  0.08416854  2.0334067
##              PC7        PC8         PC9
## [1,]  0.07927102 -1.0187599 -0.29485698
## [2,] -0.32898494 -1.0543512  0.07111559
## [3,]  0.50830477 -0.1184211  0.49628723
## [4,]  0.34139370  0.4354578 -0.46122443
## [5,]  1.27443050 -1.4171480 -0.98520328
## [6,] -1.62895108  0.1303434  1.02821475
```

```r
#First two principal components
plot(obj$x[,1:2])
```




```r
#biplot
biplot(obj,scale = 0)
```



PC1
PC2
Fire_Intensity
Property_Value
Mitigation_Measu
Population_Density
Building_Age