CKME 136 Capstone Forest Fires

## Link for “Initial Results and Code” on Github

<https://github.com/ed209robo/Ryerson>

Contents:

Contents

[Link for “Initial Results and Code” on Github 1](#_Toc35864131)

[Load packages. 1](#_Toc35864132)

[Outlier detection 96](#_Toc35864133)

[17. Prepare packages for models 99](#_Toc35864134)

[18. 100](#_Toc35864135)

[Split the data into training and test set 100](#_Toc35864136)

[Set the seed to make your partition reproducible 100](#_Toc35864137)

[We want to make sure that the training set and the test set do not have any common data points. 100](#_Toc35864138)

[R built in function “Sample”" randomly selects samples 100](#_Toc35864139)

[19. 100](#_Toc35864140)

[Set up model 100](#_Toc35864141)

[Set up K-fold cross-validation 100](#_Toc35864142)

[Defining the training controls for multiple models 100](#_Toc35864143)

[20. 101](#_Toc35864144)

[Build the models with start time and end time for each model 101](#_Toc35864145)

[21. 153](#_Toc35864146)

[View the total amount of time taken to run each model. 153](#_Toc35864147)

[22. 154](#_Toc35864148)

[View summaries of the models. 154](#_Toc35864149)

[23. 174](#_Toc35864150)

[Evaluation of techniques 174](#_Toc35864151)

[View the results of the models 174](#_Toc35864152)

[24. 177](#_Toc35864153)

[Find the best results for each model. 177](#_Toc35864154)

[25. Predict on test set 185](#_Toc35864155)

[26. Time taken for prediction 199](#_Toc35864156)

[27. Compare correlation between actual and predicted 199](#_Toc35864157)

[27. RMSE between actual and predicted 201](#_Toc35864158)

[28. MAE between actual and predicted 203](#_Toc35864159)

[29. r squared between actual and predicted 204](#_Toc35864160)

[30. Combine predicted RMSE, MAE R squared, time 207](#_Toc35864161)

[31. Compare the two sets of RMSE, MAE, r squared, time 208](#_Toc35864162)

[32. RMSE, Rsquared MAE on training set 209](#_Toc35864163)

[32. 211](#_Toc35864164)

[Model below is separate from models above 211](#_Toc35864165)

[Additional for testing: Decision Tree 211](#_Toc35864166)

[32. 257](#_Toc35864167)

[Model below is separate from models above 257](#_Toc35864168)

[Additional for testing: Random Forest 257](#_Toc35864169)

[33. 264](#_Toc35864170)

[Model below is separate from models above 264](#_Toc35864171)

[Additional for testing: Linear Regression for Predicting Forest Fires. 264](#_Toc35864172)

[34. 271](#_Toc35864173)

[Model below is separate from models above 271](#_Toc35864174)

[Additional for testing: prediction 271](#_Toc35864175)

[35. 276](#_Toc35864176)

[RMSE Prediction for Years 276](#_Toc35864177)

[36. 279](#_Toc35864178)

[Prepare Time Series Analysis. 279](#_Toc35864179)

[37. 283](#_Toc35864180)

[Model: Time Series Analysis. 283](#_Toc35864181)

[38. 286](#_Toc35864182)

[Model: Forecasting Time Series ARIMA Analysis. 286](#_Toc35864183)

[39. 290](#_Toc35864184)

[Analysis of Stationarity 290](#_Toc35864185)

[Autocorrelation function (ACF) of the time series 290](#_Toc35864186)

[40. 291](#_Toc35864187)

[Plot of the differenced time series 291](#_Toc35864188)

[41. 291](#_Toc35864189)

[Autocorrelation function (ACF) of the differenced time series 291](#_Toc35864190)

[42. 292](#_Toc35864191)

[Partial autocorrelation function (PACF) of the differenced time series 292](#_Toc35864192)

[43. 293](#_Toc35864193)

[Ljung-Box test of autocorrelation 293](#_Toc35864194)

[44. 293](#_Toc35864195)

[Augmented Dickey-Fuller test of stationarity 293](#_Toc35864196)

[40. 294](#_Toc35864197)

[Additional testing 294](#_Toc35864198)

[Variable Selection for Multiple Linear Regression in R 294](#_Toc35864199)

[41. 297](#_Toc35864200)

[Additional testing 297](#_Toc35864201)

[Forward and Backward selection algorithm 297](#_Toc35864202)

[42. 302](#_Toc35864203)

[Additional testing 302](#_Toc35864204)

[Variable selection using automatic methods 302](#_Toc35864205)

[43. 304](#_Toc35864206)

[Additional testing 304](#_Toc35864207)

[Prediction using k Nearest Neighbor Regression 304](#_Toc35864208)

[Additional time series data 309](#_Toc35864209)

## Load packages.

#Make sure to use libraries below  
library(dplyr)

## Warning: package 'dplyr' was built under R version 3.5.3

##   
## Attaching package: 'dplyr'

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

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

#install.packages("ggplot2")  
library(ggplot2)

## Warning: package 'ggplot2' was built under R version 3.5.3

#install.packages("ggpubr")  
library(ggpubr)

## Loading required package: magrittr

#install.packages("tidyr")  
library(tidyr)

## Warning: package 'tidyr' was built under R version 3.5.3

##   
## Attaching package: 'tidyr'

## The following object is masked from 'package:magrittr':  
##   
## extract

#install.packages("scales")  
library(scales)

## Warning: package 'scales' was built under R version 3.5.3

#install.packages("wesanderson")  
#library(wesanderson)  
#install.packages("viridis") # Install  
library(viridis) # Load

## Warning: package 'viridis' was built under R version 3.5.3

## Loading required package: viridisLite

##   
## Attaching package: 'viridis'

## The following object is masked from 'package:scales':  
##   
## viridis\_pal

#theme\_set(theme\_pubclean())  
library(ggrepel)

## Warning: package 'ggrepel' was built under R version 3.5.3

#install.packages("janitor")  
library(janitor)

## Warning: package 'janitor' was built under R version 3.5.3

##   
## Attaching package: 'janitor'

## The following objects are masked from 'package:stats':  
##   
## chisq.test, fisher.test

#install.packages("PerformanceAnalytics")  
library(PerformanceAnalytics)

## Warning: package 'PerformanceAnalytics' was built under R version 3.5.3

## Loading required package: xts

## Warning: package 'xts' was built under R version 3.5.3

## Loading required package: zoo

## Warning: package 'zoo' was built under R version 3.5.3

##   
## Attaching package: 'zoo'

## The following objects are masked from 'package:base':  
##   
## as.Date, as.Date.numeric

##   
## Attaching package: 'xts'

## The following objects are masked from 'package:dplyr':  
##   
## first, last

##   
## Attaching package: 'PerformanceAnalytics'

## The following object is masked from 'package:graphics':  
##   
## legend

library(randomForest)

## Warning: package 'randomForest' was built under R version 3.5.3

## randomForest 4.6-14

## Type rfNews() to see new features/changes/bug fixes.

##   
## Attaching package: 'randomForest'

## The following object is masked from 'package:ggplot2':  
##   
## margin

## The following object is masked from 'package:dplyr':  
##   
## combine

#install.packages("e1071")  
library(e1071)

## Warning: package 'e1071' was built under R version 3.5.3

##   
## Attaching package: 'e1071'

## The following objects are masked from 'package:PerformanceAnalytics':  
##   
## kurtosis, skewness

library(caret)

## Warning: package 'caret' was built under R version 3.5.3

## Loading required package: lattice

#install.packages("caretEnsemble")  
library(caretEnsemble)

## Warning: package 'caretEnsemble' was built under R version 3.5.3

##   
## Attaching package: 'caretEnsemble'

## The following object is masked from 'package:ggplot2':  
##   
## autoplot

# install.packages("party")  
library(party)

## Warning: package 'party' was built under R version 3.5.3

## Loading required package: grid

## Loading required package: mvtnorm

## Loading required package: modeltools

## Loading required package: stats4

## Loading required package: strucchange

## Warning: package 'strucchange' was built under R version 3.5.3

## Loading required package: sandwich

## Warning: package 'sandwich' was built under R version 3.5.3

library(rpart)  
#install.packages("formattable")  
#detach(package:MASS, unload=TRUE)  
#library(formattable)  
#install.packages("DT")  
#library(DT)  
#install.packages("FSelector")  
library(FSelector)

## Warning: package 'FSelector' was built under R version 3.5.3

#??FSelector

1. Read the “fores fire .csv” file from the following website.

fires <-read.csv('CKME 136 Forest Fire Data.csv',header=T)

1. Have a look at the data set. View(train.data)

head(fires)

## Année Cause Data.qualifier Juridiction Jurisdiction  
## 1 1990 Forest industry a Alberta Alberta  
## 2 1991 Forest industry a Alberta Alberta  
## 3 1992 Forest industry a Alberta Alberta  
## 4 1993 Forest industry a Alberta Alberta  
## 5 1994 Forest industry a Alberta Alberta  
## 6 1995 Forest industry a Alberta Alberta  
## Niveau.d.intervention Number Origine Protection.zone  
## 1 Normale 22 Industrie forestiere Intensive  
## 2 Normale 14 Industrie forestiere Intensive  
## 3 Normale 12 Industrie forestiere Intensive  
## 4 Normale 11 Industrie forestiere Intensive  
## 5 Normale 13 Industrie forestiere Intensive  
## 6 Normale 14 Industrie forestiere Intensive  
## Response.category Year Zone.de.protection  
## 1 Full 1990 Intensive  
## 2 Full 1991 Intensive  
## 3 Full 1992 Intensive  
## 4 Full 1993 Intensive  
## 5 Full 1994 Intensive  
## 6 Full 1995 Intensive

tail(fires)

## Année Cause Data.qualifier  
## 19866 2018 Unspecified human activities p  
## 19867 2018 Unspecified human activities p  
## 19868 2018 Unspecified human activities p  
## 19869 2018 Unspecified human activities p  
## 19870 2018 Unspecified human activities p  
## 19871 2018 Unspecified human activities p  
## Juridiction Jurisdiction Niveau.d.intervention  
## 19866 Nouvelle-Écosse Nova Scotia Modulée  
## 19867 Ontario Ontario Modulée  
## 19868 Île-du-Prince-Édouard Prince Edward Island Modulée  
## 19869 Québec Quebec Modulée  
## 19870 Saskatchewan Saskatchewan Modulée  
## 19871 Yukon Yukon Modulée  
## Number Origine Protection.zone  
## 19866 0 Activités humaines indéterminées Unspecified  
## 19867 11 Activités humaines indéterminées Unspecified  
## 19868 0 Activités humaines indéterminées Unspecified  
## 19869 6 Activités humaines indéterminées Unspecified  
## 19870 13 Activités humaines indéterminées Unspecified  
## 19871 6 Activités humaines indéterminées Unspecified  
## Response.category Year Zone.de.protection  
## 19866 Modified 2018 Indéterminée  
## 19867 Modified 2018 Indéterminée  
## 19868 Modified 2018 Indéterminée  
## 19869 Modified 2018 Indéterminée  
## 19870 Modified 2018 Indéterminée  
## 19871 Modified 2018 Indéterminée

str(fires) #properties and elements of (fires)

## 'data.frame': 19871 obs. of 12 variables:  
## $ Année : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Data.qualifier : Factor w/ 8 levels "a","e","E","n",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Juridiction : Factor w/ 13 levels "Alberta","Colombie-Britannique",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Niveau.d.intervention: Factor w/ 4 levels "Aucune","Indéterminée",..: 4 4 4 4 4 4 4 4 4 4 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Origine : Factor w/ 10 levels "Activités humaines indéterminées",..: 8 8 8 8 8 8 8 8 8 8 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category : Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Zone.de.protection : Factor w/ 3 levels "Indéterminée",..: 2 2 2 2 2 2 2 2 2 2 ...

# Check data types of attributes  
sapply(fires, class)

## Année Cause Data.qualifier   
## "integer" "factor" "factor"   
## Juridiction Jurisdiction Niveau.d.intervention   
## "factor" "factor" "factor"   
## Number Origine Protection.zone   
## "integer" "factor" "factor"   
## Response.category Year Zone.de.protection   
## "factor" "integer" "factor"

sapply(fires, typeof)

## Année Cause Data.qualifier   
## "integer" "integer" "integer"   
## Juridiction Jurisdiction Niveau.d.intervention   
## "integer" "integer" "integer"   
## Number Origine Protection.zone   
## "integer" "integer" "integer"   
## Response.category Year Zone.de.protection   
## "integer" "integer" "integer"

1. Extract relevant columns.

new\_fire <- fires[, c("Cause", "Jurisdiction", "Number", "Protection.zone", "Response.category", "Year")]

1. Check for missing values.

sum(is.na(new\_fire$Cause) == TRUE) # 0 Missing values.

## [1] 0

length(new\_fire$Cause)

## [1] 19871

sum(is.na(new\_fire$Jurisdiction) == TRUE) # 0 Missing values.

## [1] 0

length(new\_fire$Jurisdiction)

## [1] 19871

sum(is.na(new\_fire$Number) == TRUE) # 8352 initial missing values for "Number" field.

## [1] 8352

length(new\_fire$Number)

## [1] 19871

sum(is.na(new\_fire$Protection.zone) == TRUE) # 0 Missing values.

## [1] 0

length(new\_fire$Protection.zone)

## [1] 19871

sum(is.na(new\_fire$Response.category) == TRUE) # 0 Missing values.

## [1] 0

length(new\_fire$Response.category)

## [1] 19871

sum(is.na(new\_fire$Year) == TRUE) # 0 Missing values.

## [1] 0

length(new\_fire$Year)

## [1] 19871

1. Only “Number” has missing rows. Remove all rows with missing values.

# Remove remaining records with missing values.  
FireClean <- new\_fire[complete.cases(new\_fire),]  
  
nrow(FireClean) #11519 rows remaining

## [1] 11519

1. Check attributes after missing rows have been removed.

#attach(FireClean)  
  
head(FireClean)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry Alberta 22 Intensive Full  
## 2 Forest industry Alberta 14 Intensive Full  
## 3 Forest industry Alberta 12 Intensive Full  
## 4 Forest industry Alberta 11 Intensive Full  
## 5 Forest industry Alberta 13 Intensive Full  
## 6 Forest industry Alberta 14 Intensive Full  
## Year  
## 1 1990  
## 2 1991  
## 3 1992  
## 4 1993  
## 5 1994  
## 6 1995

tail(FireClean)

## Cause Jurisdiction Number  
## 19866 Unspecified human activities Nova Scotia 0  
## 19867 Unspecified human activities Ontario 11  
## 19868 Unspecified human activities Prince Edward Island 0  
## 19869 Unspecified human activities Quebec 6  
## 19870 Unspecified human activities Saskatchewan 13  
## 19871 Unspecified human activities Yukon 6  
## Protection.zone Response.category Year  
## 19866 Unspecified Modified 2018  
## 19867 Unspecified Modified 2018  
## 19868 Unspecified Modified 2018  
## 19869 Unspecified Modified 2018  
## 19870 Unspecified Modified 2018  
## 19871 Unspecified Modified 2018

str(FireClean)

## 'data.frame': 11519 obs. of 6 variables:  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...

dim(FireClean) # 11519 rows, 6 columns

## [1] 11519 6

# Check data types of attributes  
sapply(FireClean, class)

## Cause Jurisdiction Number Protection.zone   
## "factor" "factor" "integer" "factor"   
## Response.category Year   
## "factor" "integer"

levels(FireClean$Cause)

## [1] "Forest industry" "Incendiary"   
## [3] "Lightning" "Miscellaneous known causes"   
## [5] "Other industry" "Railways"   
## [7] "Recreation" "Residents"   
## [9] "Unspecified" "Unspecified human activities"

levels(FireClean$Jurisdiction)

## [1] "Alberta" "British Columbia"   
## [3] "Manitoba" "National parks"   
## [5] "New Brunswick" "Newfoundland and Labrador"  
## [7] "Northwest Territories" "Nova Scotia"   
## [9] "Ontario" "Prince Edward Island"   
## [11] "Quebec" "Saskatchewan"   
## [13] "Yukon"

levels(FireClean$Protection.zone)

## [1] "Intensive" "Limited" "Unspecified"

levels(FireClean$Response.category)

## [1] "Full" "Modified" "None" "Unspecified"

levels(FireClean$Year)

## NULL

summary(FireClean) # Only the "number" attribute maybe usefull with the summary

## Cause Jurisdiction   
## Lightning :1325 Quebec :1516   
## Unspecified :1290 Newfoundland and Labrador:1486   
## Miscellaneous known causes:1279 Ontario :1368   
## Recreation :1274 Manitoba :1304   
## Incendiary :1271 Yukon :1059   
## Residents :1268 Northwest Territories : 773   
## (Other) :3812 (Other) :4013   
## Number Protection.zone Response.category Year   
## Min. : 0.00 Intensive :8190 Full :4204 Min. :1990   
## 1st Qu.: 0.00 Limited :3281 Modified :3521 1st Qu.:1997   
## Median : 0.00 Unspecified: 48 None :3681 Median :2004   
## Mean : 18.64 Unspecified: 113 Mean :2004   
## 3rd Qu.: 4.00 3rd Qu.:2011   
## Max. :2913.00 Max. :2018   
##

1. Shorten “Jurisdiction” name

FireClean$Juris\_Long <- FireClean$Jurisdiction # Duplicate Jurisdiction column  
  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "British Columbia"] <- "BC"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Alberta"] <- "AB"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "National parks"] <- "NP"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Northwest Territories"] <- "NT"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Prince Edward Island"] <- "PE"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Yukon"] <- "YT"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "New Brunswick"] <- "NB"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Nova Scotia"] <- "NS"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Quebec"] <- "QC"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Manitoba"] <- "MB"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Newfoundland and Labrador"] <- "NL"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Ontario"] <- "ON"  
levels(FireClean$Jurisdiction)[levels(FireClean$Jurisdiction) == "Saskatchewan"] <- "SK"  
levels(FireClean$Jurisdiction)

## [1] "AB" "BC" "MB" "NP" "NB" "NL" "NT" "NS" "ON" "PE" "QC" "SK" "YT"

1. create new column: Cause\_Grouped People vs Lightning

# Group Human causes together  
# Lightning is a stand alone cause  
FireClean <- FireClean %>%  
 mutate(Cause\_Grouped = case\_when(  
 Cause == "Lightning" ~ "Lightning",  
 TRUE ~ "People"  
 )  
 )

1. Create new column: Time1 Group Years

# Create new column "Time1" and group years into time periods  
FireClean <- FireClean %>%  
 mutate(Time1 = case\_when(  
 Year <= 1995 ~ "Early 90s",  
 Year >= 1996 & Year <= 2000 ~ "Late 90s",  
 Year >= 2001 & Year <= 2005 ~ "Early 10s",  
 Year >= 2006 & Year <= 2010 ~ "Late 10s",  
 Year >= 2011 & Year <= 2015 ~ "Early 20s",  
 Year >= 2016 ~ "Late 20s"  
 )  
 )

1. Create new column: Time2 Group Years

# Create new column "Time2" and group years into time periods  
FireClean <- FireClean %>%  
 mutate(Time2 = case\_when(  
 Year >= 1990 & Year <= 1999 ~ "1990s",  
 Year >= 2000 & Year <= 2009 ~ "2000s",  
 Year >= 2010 & Year <= 2018 ~ "2010s"  
 )  
 )

1. Group Provinces into regions

# Create new column "Region" and group provinces into regions  
FireClean <- FireClean %>%   
 mutate(Region = case\_when(  
 Jurisdiction %in% c("AB", "MB", "SK") ~ "Prairie Region",  
 Jurisdiction %in% c("BC") ~ "Pacific Region",  
 Jurisdiction %in% c("NP") ~ "National Parks",  
 Jurisdiction %in% c("NB", "NL", "NS", "PE") ~ "Atlantic Region",  
 Jurisdiction %in% c("ON", "QC") ~ "Central Region",  
 Jurisdiction %in% c("YT", "NT") ~ "North Region"  
 )  
 )

1. Check structure of attributes again.

#attach(FireClean)  
  
head(FireClean)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 22 Intensive Full  
## 2 Forest industry AB 14 Intensive Full  
## 3 Forest industry AB 12 Intensive Full  
## 4 Forest industry AB 11 Intensive Full  
## 5 Forest industry AB 13 Intensive Full  
## 6 Forest industry AB 14 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1990 Alberta People Early 90s 1990s Prairie Region  
## 2 1991 Alberta People Early 90s 1990s Prairie Region  
## 3 1992 Alberta People Early 90s 1990s Prairie Region  
## 4 1993 Alberta People Early 90s 1990s Prairie Region  
## 5 1994 Alberta People Early 90s 1990s Prairie Region  
## 6 1995 Alberta People Early 90s 1990s Prairie Region

tail(FireClean)

## Cause Jurisdiction Number Protection.zone  
## 11514 Unspecified human activities NS 0 Unspecified  
## 11515 Unspecified human activities ON 11 Unspecified  
## 11516 Unspecified human activities PE 0 Unspecified  
## 11517 Unspecified human activities QC 6 Unspecified  
## 11518 Unspecified human activities SK 13 Unspecified  
## 11519 Unspecified human activities YT 6 Unspecified  
## Response.category Year Juris\_Long Cause\_Grouped Time1  
## 11514 Modified 2018 Nova Scotia People Late 20s  
## 11515 Modified 2018 Ontario People Late 20s  
## 11516 Modified 2018 Prince Edward Island People Late 20s  
## 11517 Modified 2018 Quebec People Late 20s  
## 11518 Modified 2018 Saskatchewan People Late 20s  
## 11519 Modified 2018 Yukon People Late 20s  
## Time2 Region  
## 11514 2010s Atlantic Region  
## 11515 2010s Central Region  
## 11516 2010s Atlantic Region  
## 11517 2010s Central Region  
## 11518 2010s Prairie Region  
## 11519 2010s North Region

str(FireClean)

## 'data.frame': 11519 obs. of 11 variables:  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "AB","BC","MB",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Cause\_Grouped : chr "People" "People" "People" "People" ...  
## $ Time1 : chr "Early 90s" "Early 90s" "Early 90s" "Early 90s" ...  
## $ Time2 : chr "1990s" "1990s" "1990s" "1990s" ...  
## $ Region : chr "Prairie Region" "Prairie Region" "Prairie Region" "Prairie Region" ...

dim(FireClean) # 11519 rows, 6 columns

## [1] 11519 11

# Check data types of attributes  
sapply(FireClean, class)

## Cause Jurisdiction Number Protection.zone   
## "factor" "factor" "integer" "factor"   
## Response.category Year Juris\_Long Cause\_Grouped   
## "factor" "integer" "factor" "character"   
## Time1 Time2 Region   
## "character" "character" "character"

levels(FireClean$Cause)

## [1] "Forest industry" "Incendiary"   
## [3] "Lightning" "Miscellaneous known causes"   
## [5] "Other industry" "Railways"   
## [7] "Recreation" "Residents"   
## [9] "Unspecified" "Unspecified human activities"

levels(FireClean$Jurisdiction)

## [1] "AB" "BC" "MB" "NP" "NB" "NL" "NT" "NS" "ON" "PE" "QC" "SK" "YT"

levels(FireClean$Protection.zone)

## [1] "Intensive" "Limited" "Unspecified"

levels(FireClean$Response.category)

## [1] "Full" "Modified" "None" "Unspecified"

levels(FireClean$Year)

## NULL

summary(FireClean) # Only the "number" attribute maybe usefull with the summary

## Cause Jurisdiction Number   
## Lightning :1325 QC :1516 Min. : 0.00   
## Unspecified :1290 NL :1486 1st Qu.: 0.00   
## Miscellaneous known causes:1279 ON :1368 Median : 0.00   
## Recreation :1274 MB :1304 Mean : 18.64   
## Incendiary :1271 YT :1059 3rd Qu.: 4.00   
## Residents :1268 NT : 773 Max. :2913.00   
## (Other) :3812 (Other):4013   
## Protection.zone Response.category Year   
## Intensive :8190 Full :4204 Min. :1990   
## Limited :3281 Modified :3521 1st Qu.:1997   
## Unspecified: 48 None :3681 Median :2004   
## Unspecified: 113 Mean :2004   
## 3rd Qu.:2011   
## Max. :2018   
##   
## Juris\_Long Cause\_Grouped Time1   
## Quebec :1516 Length:11519 Length:11519   
## Newfoundland and Labrador:1486 Class :character Class :character   
## Ontario :1368 Mode :character Mode :character   
## Manitoba :1304   
## Yukon :1059   
## Northwest Territories : 773   
## (Other) :4013   
## Time2 Region   
## Length:11519 Length:11519   
## Class :character Class :character   
## Mode :character Mode :character   
##   
##   
##   
##

summary(FireClean$Number)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 0.00 0.00 0.00 18.64 4.00 2913.00

summary(FireClean$Year)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 1990 1997 2004 2004 2011 2018

1. Feature selection using FSelector Use information gain to find best attributes.

data <- tbl\_df(FireClean)  
  
head(data)

## # A tibble: 6 x 11  
## Cause Jurisdiction Number Protection.zone Response.catego~ Year  
## <fct> <fct> <int> <fct> <fct> <int>  
## 1 Fore~ AB 22 Intensive Full 1990  
## 2 Fore~ AB 14 Intensive Full 1991  
## 3 Fore~ AB 12 Intensive Full 1992  
## 4 Fore~ AB 11 Intensive Full 1993  
## 5 Fore~ AB 13 Intensive Full 1994  
## 6 Fore~ AB 14 Intensive Full 1995  
## # ... with 5 more variables: Juris\_Long <fct>, Cause\_Grouped <chr>,  
## # Time1 <chr>, Time2 <chr>, Region <chr>

weights <- information.gain(Number~., data)  
print(weights)

## attr\_importance  
## Cause 0.062070964  
## Jurisdiction 0.150794057  
## Protection.zone 0.308965544  
## Response.category 0.392000009  
## Year 0.006340241  
## Juris\_Long 0.150794057  
## Cause\_Grouped 0.023934581  
## Time1 0.005551252  
## Time2 0.004146064  
## Region 0.056031029

subset <- cutoff.k(weights, 12)  
  
f <- as.simple.formula(subset, "Number")  
print(f)

## Number ~ Response.category + Protection.zone + Jurisdiction +   
## Juris\_Long + Cause + Region + Cause\_Grouped + Year + Time1 +   
## Time2  
## <environment: 0x000000001ed2ce58>

1. Check structure of data

head(data)

## # A tibble: 6 x 11  
## Cause Jurisdiction Number Protection.zone Response.catego~ Year  
## <fct> <fct> <int> <fct> <fct> <int>  
## 1 Fore~ AB 22 Intensive Full 1990  
## 2 Fore~ AB 14 Intensive Full 1991  
## 3 Fore~ AB 12 Intensive Full 1992  
## 4 Fore~ AB 11 Intensive Full 1993  
## 5 Fore~ AB 13 Intensive Full 1994  
## 6 Fore~ AB 14 Intensive Full 1995  
## # ... with 5 more variables: Juris\_Long <fct>, Cause\_Grouped <chr>,  
## # Time1 <chr>, Time2 <chr>, Region <chr>

tail(data)

## # A tibble: 6 x 11  
## Cause Jurisdiction Number Protection.zone Response.catego~ Year  
## <fct> <fct> <int> <fct> <fct> <int>  
## 1 Unsp~ NS 0 Unspecified Modified 2018  
## 2 Unsp~ ON 11 Unspecified Modified 2018  
## 3 Unsp~ PE 0 Unspecified Modified 2018  
## 4 Unsp~ QC 6 Unspecified Modified 2018  
## 5 Unsp~ SK 13 Unspecified Modified 2018  
## 6 Unsp~ YT 6 Unspecified Modified 2018  
## # ... with 5 more variables: Juris\_Long <fct>, Cause\_Grouped <chr>,  
## # Time1 <chr>, Time2 <chr>, Region <chr>

str(data)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 11519 obs. of 11 variables:  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "AB","BC","MB",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Cause\_Grouped : chr "People" "People" "People" "People" ...  
## $ Time1 : chr "Early 90s" "Early 90s" "Early 90s" "Early 90s" ...  
## $ Time2 : chr "1990s" "1990s" "1990s" "1990s" ...  
## $ Region : chr "Prairie Region" "Prairie Region" "Prairie Region" "Prairie Region" ...

dim(data) # 11519 rows, 6 columns

## [1] 11519 11

# Check data types of attributes  
sapply(data, class)

## Cause Jurisdiction Number Protection.zone   
## "factor" "factor" "integer" "factor"   
## Response.category Year Juris\_Long Cause\_Grouped   
## "factor" "integer" "factor" "character"   
## Time1 Time2 Region   
## "character" "character" "character"

levels(data$Cause)

## [1] "Forest industry" "Incendiary"   
## [3] "Lightning" "Miscellaneous known causes"   
## [5] "Other industry" "Railways"   
## [7] "Recreation" "Residents"   
## [9] "Unspecified" "Unspecified human activities"

levels(data$Jurisdiction)

## [1] "AB" "BC" "MB" "NP" "NB" "NL" "NT" "NS" "ON" "PE" "QC" "SK" "YT"

levels(data$Protection.zone)

## [1] "Intensive" "Limited" "Unspecified"

levels(data$Response.category)

## [1] "Full" "Modified" "None" "Unspecified"

levels(data$Year)

## NULL

summary(data) # Only the "number" attribute maybe usefull with the summary

## Cause Jurisdiction Number   
## Lightning :1325 QC :1516 Min. : 0.00   
## Unspecified :1290 NL :1486 1st Qu.: 0.00   
## Miscellaneous known causes:1279 ON :1368 Median : 0.00   
## Recreation :1274 MB :1304 Mean : 18.64   
## Incendiary :1271 YT :1059 3rd Qu.: 4.00   
## Residents :1268 NT : 773 Max. :2913.00   
## (Other) :3812 (Other):4013   
## Protection.zone Response.category Year   
## Intensive :8190 Full :4204 Min. :1990   
## Limited :3281 Modified :3521 1st Qu.:1997   
## Unspecified: 48 None :3681 Median :2004   
## Unspecified: 113 Mean :2004   
## 3rd Qu.:2011   
## Max. :2018   
##   
## Juris\_Long Cause\_Grouped Time1   
## Quebec :1516 Length:11519 Length:11519   
## Newfoundland and Labrador:1486 Class :character Class :character   
## Ontario :1368 Mode :character Mode :character   
## Manitoba :1304   
## Yukon :1059   
## Northwest Territories : 773   
## (Other) :4013   
## Time2 Region   
## Length:11519 Length:11519   
## Class :character Class :character   
## Mode :character Mode :character   
##   
##   
##   
##

summary(data$Number)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 0.00 0.00 0.00 18.64 4.00 2913.00

summary(data$Year)

## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 1990 1997 2004 2004 2011 2018

1. Visulization, Barplot, Boxplot, Exploratory Data Analysis, Outliers

########################################################################################################################################  
#11 STACKED BAR CHART (STACKED BY CAUSE) FOR FOREST FIRES IN BC 1990 - 2018  
pivot3 <- data %>%  
dplyr::select(Year, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Year Number Cause\_Grouped  
## <int> <int> <chr>   
## 1 1990 22 People   
## 2 1991 14 People   
## 3 1992 12 People   
## 4 1993 11 People   
## 5 1994 13 People   
## 6 1995 14 People

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Cause\_Grouped, Number, Year, Jurisdiction) %>%   
 filter(Jurisdiction == "BC") %>%   
 group\_by(Year, Cause\_Grouped) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
  
# Matrix with Cause-Grouped (Lightning & Human), Total number of fires for each year.  
pivot3 %>%   
 spread(Year, sum\_Number)

## # A tibble: 2 x 30  
## Cause\_Grouped `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <chr> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 Lightning 2015 759 2344 609 2913 342 723 675  
## 2 People 1240 1254 1461 888 1175 1132 623 486  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

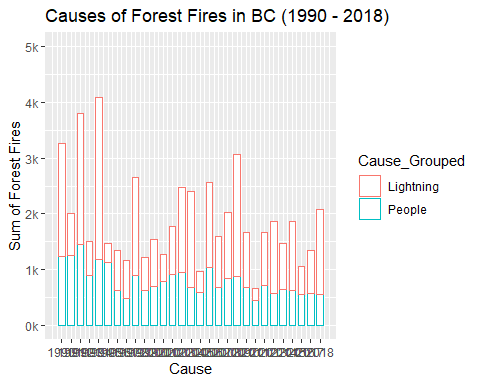
############  
#SUMMING COLUMNS AND ROWS  
pivot4 <- pivot3 %>%   
 spread(Year, sum\_Number)  
  
pivot4 # Matrix with Cause-Grouped (Lightning & Human), Total number of fires for each year.

## # A tibble: 2 x 30  
## Cause\_Grouped `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <chr> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 Lightning 2015 759 2344 609 2913 342 723 675  
## 2 People 1240 1254 1461 888 1175 1132 623 486  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

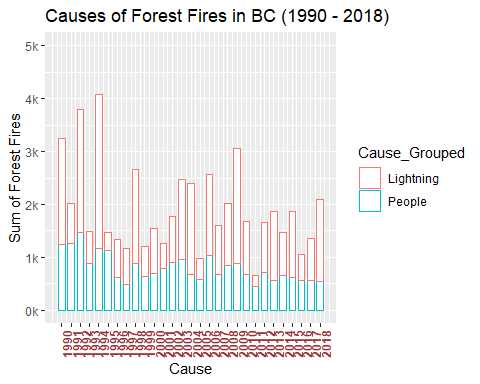
pivot5 <- pivot4 %>%  
 adorn\_totals("row") %>%   
 adorn\_totals("col")   
  
pivot5 # Matrix WITH TOTALS for Cause-Grouped (Lightning & Human), Total number of fires for each year.

## Cause\_Grouped 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001  
## Lightning 2015 759 2344 609 2913 342 723 675 1773 585 842 479  
## People 1240 1254 1461 888 1175 1132 623 486 889 629 697 785  
## Total 3255 2013 3805 1497 4088 1474 1346 1161 2662 1214 1539 1264  
## 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015  
## 870 1513 1716 384 1536 912 1175 2184 992 209 944 1296 816 1237  
## 911 959 682 587 1033 682 848 880 681 446 718 569 649 621  
## 1781 2472 2398 971 2569 1594 2023 3064 1673 655 1662 1865 1465 1858  
## 2016 2017 2018 Total  
## 486 782 1537 32648  
## 563 569 549 23206  
## 1049 1351 2086 55854

##################################################  
# Function to make number scale easier to read on x-axis  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = pivot3, aes(x = Year,  
 y = sum\_Number,  
 color = Cause\_Grouped)) +  
 geom\_bar(stat="identity", width = 0.7, fill="white") +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 scale\_x\_continuous(breaks=1990:2018)+  
 #stat\_summary(fun.y = sum, aes(label = ..y.., group = Year), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 5000))+  
 labs(title = "Causes of Forest Fires in BC (1990 - 2018)")  
  
p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 0 ,size = 9, angle = 90))



########################################################################################################################################  
#10B Matrix WITH TOTALS for Regions and total number of fires for each cause (Lightning & Human) in the region.  
pivot3 <- data %>%  
dplyr::select(Region, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Region Number Cause\_Grouped  
## <chr> <int> <chr>   
## 1 Prairie Region 22 People   
## 2 Prairie Region 14 People   
## 3 Prairie Region 12 People   
## 4 Prairie Region 11 People   
## 5 Prairie Region 13 People   
## 6 Prairie Region 14 People

pivot3 <- data %>% #Groups Cause and Regions together, sums Number  
 dplyr::select(Region, Number, Cause\_Grouped) %>%   
 group\_by(Cause\_Grouped, Region) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))  
   
# Matrix WITH TOTALS for Regions and total number of fires for each cause (Lightning & Human) in the region.  
pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)

## # A tibble: 6 x 3  
## Region Lightning People  
## <chr> <int> <int>  
## 1 Atlantic Region 2120 21073  
## 2 Central Region 25023 30116  
## 3 National Parks 1421 1096  
## 4 North Region 8549 2163  
## 5 Pacific Region 32648 23206  
## 6 Prairie Region 31234 36116

############  
#SUMMING COLUMNS AND ROWS  
pivot4 <- pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)  
  
pivot4

## # A tibble: 6 x 3  
## Region Lightning People  
## <chr> <int> <int>  
## 1 Atlantic Region 2120 21073  
## 2 Central Region 25023 30116  
## 3 National Parks 1421 1096  
## 4 North Region 8549 2163  
## 5 Pacific Region 32648 23206  
## 6 Prairie Region 31234 36116

pivot5 <- pivot4 %>%  
 adorn\_totals("row") %>%   
 adorn\_totals("col")   
  
pivot5

## Region Lightning People Total  
## Atlantic Region 2120 21073 23193  
## Central Region 25023 30116 55139  
## National Parks 1421 1096 2517  
## North Region 8549 2163 10712  
## Pacific Region 32648 23206 55854  
## Prairie Region 31234 36116 67350  
## Total 100995 113770 214765

##################################################  
#CORRELATION USE FOR pivot3 ONLY  
CorDataFrame <- pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)  
  
CorDataFrame

## # A tibble: 6 x 3  
## Region Lightning People  
## <chr> <int> <int>  
## 1 Atlantic Region 2120 21073  
## 2 Central Region 25023 30116  
## 3 National Parks 1421 1096  
## 4 North Region 8549 2163  
## 5 Pacific Region 32648 23206  
## 6 Prairie Region 31234 36116

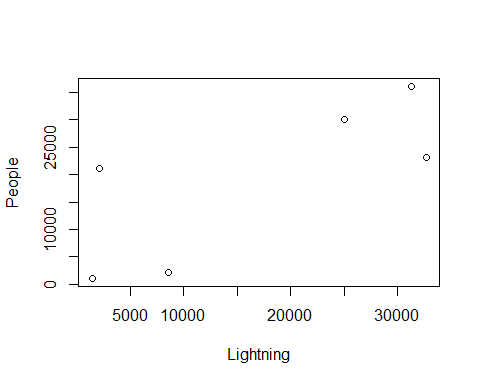
sapply(CorDataFrame, is.numeric) # Which columns are numeric?

## Region Lightning People   
## FALSE TRUE TRUE

my\_num\_data <- CorDataFrame[, sapply(CorDataFrame, is.numeric)] # Subset numeric columns  
my\_num\_data

## # A tibble: 6 x 2  
## Lightning People  
## <int> <int>  
## 1 2120 21073  
## 2 25023 30116  
## 3 1421 1096  
## 4 8549 2163  
## 5 32648 23206  
## 6 31234 36116

plot(my\_num\_data) # Works



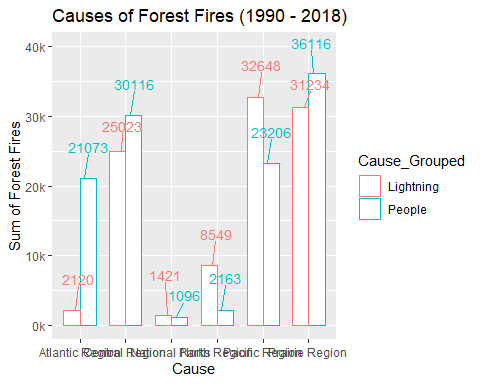
cor(my\_num\_data)

## Lightning People  
## Lightning 1.0000000 0.7550789  
## People 0.7550789 1.0000000

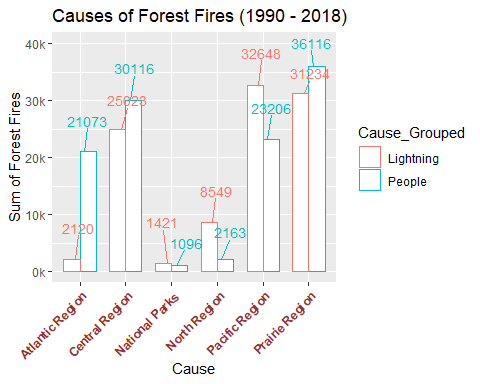
##################################################  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = pivot3,  
 aes(x = Region, y = sum\_Number, color=Cause\_Grouped)) +  
 geom\_bar(position = "dodge", stat="identity", width = 0.7, fill="white") +  
 geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 40000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")

## Warning: `show\_guide` has been deprecated. Please use `show.legend`  
## instead.

p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 45))



########################################################################################################################################  
#10 Matrix WITH TOTALS for Regions and total number of fires for each cause (Lightning & Human) in the region.  
pivot3 <- data %>%  
dplyr::select(Region, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Region Number Cause\_Grouped  
## <chr> <int> <chr>   
## 1 Prairie Region 22 People   
## 2 Prairie Region 14 People   
## 3 Prairie Region 12 People   
## 4 Prairie Region 11 People   
## 5 Prairie Region 13 People   
## 6 Prairie Region 14 People

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Region, Number, Cause\_Grouped) %>%   
 group\_by(Cause\_Grouped, Region) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
  
pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)

## # A tibble: 6 x 3  
## Region Lightning People  
## <chr> <int> <int>  
## 1 Atlantic Region 2120 21073  
## 2 Central Region 25023 30116  
## 3 National Parks 1421 1096  
## 4 North Region 8549 2163  
## 5 Pacific Region 32648 23206  
## 6 Prairie Region 31234 36116

##################################################  
#CORRELATION  
CorDataFrame <- pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)  
  
CorDataFrame

## # A tibble: 6 x 3  
## Region Lightning People  
## <chr> <int> <int>  
## 1 Atlantic Region 2120 21073  
## 2 Central Region 25023 30116  
## 3 National Parks 1421 1096  
## 4 North Region 8549 2163  
## 5 Pacific Region 32648 23206  
## 6 Prairie Region 31234 36116

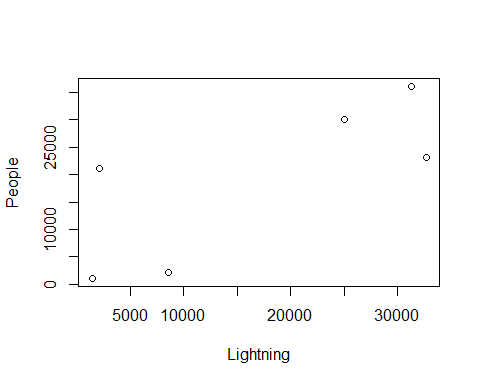
sapply(CorDataFrame, is.numeric) # Which columns are numeric?

## Region Lightning People   
## FALSE TRUE TRUE

my\_num\_data <- CorDataFrame[, sapply(CorDataFrame, is.numeric)] # Subset numeric columns  
my\_num\_data

## # A tibble: 6 x 2  
## Lightning People  
## <int> <int>  
## 1 2120 21073  
## 2 25023 30116  
## 3 1421 1096  
## 4 8549 2163  
## 5 32648 23206  
## 6 31234 36116

plot(my\_num\_data) # Works



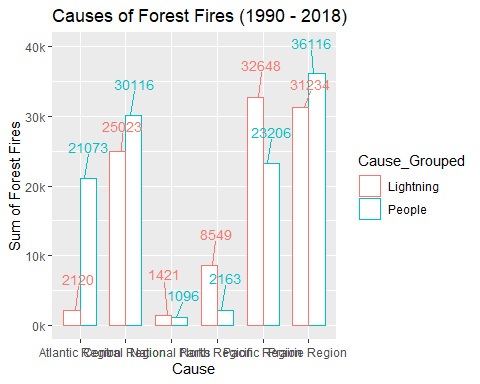
cor(my\_num\_data)

## Lightning People  
## Lightning 1.0000000 0.7550789  
## People 0.7550789 1.0000000

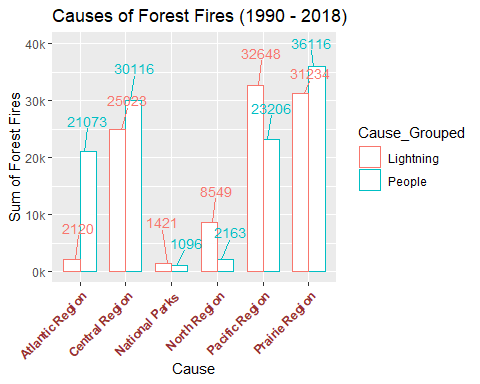
##################################################  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = pivot3,  
 aes(x = Region, y = sum\_Number, color=Cause\_Grouped)) +  
 geom\_bar(position = "dodge", stat="identity", width = 0.7, fill="white") +  
 geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 40000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")

## Warning: `show\_guide` has been deprecated. Please use `show.legend`  
## instead.

p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 45))



########################################################################################################################################  
#9 Time Series chart for number of fires in each province (1990-2018)  
pivot3 <- data %>%  
dplyr::select(Year, Number, Jurisdiction)  
head(pivot3)

## # A tibble: 6 x 3  
## Year Number Jurisdiction  
## <int> <int> <fct>   
## 1 1990 22 AB   
## 2 1991 14 AB   
## 3 1992 12 AB   
## 4 1993 11 AB   
## 5 1994 13 AB   
## 6 1995 14 AB

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Year) %>%   
 group\_by(Year, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
  
pivot3 %>%   
 spread(Year, sum\_Number)

## # A tibble: 13 x 30  
## Jurisdiction `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <fct> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 AB 1296 923 1055 848 872 803 376 456  
## 2 BC 3255 2013 3805 1497 4088 1474 1346 1161  
## 3 MB 570 676 298 239 555 660 424 373  
## 4 NP 128 56 72 63 166 62 NA 55  
## 5 NB 377 656 576 430 518 547 367 368  
## 6 NL 197 166 109 83 143 103 148 110  
## 7 NT 236 331 285 469 627 215 350 105  
## 8 NS 498 733 299 317 245 408 272 371  
## 9 ON 1614 2560 960 743 1053 2122 1245 1636  
## 10 PE 38 48 27 29 43 29 0 34  
## 11 QC 851 1216 765 543 499 1265 1250 876  
## 12 SK 897 762 701 646 699 650 422 491  
## 13 YT 154 187 116 136 255 148 149 112  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

#Produces matrix with zero  
pivot4 <- pivot3 %>%   
 spread(Year, sum\_Number)  
  
pivot4

## # A tibble: 13 x 30  
## Jurisdiction `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <fct> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 AB 1296 923 1055 848 872 803 376 456  
## 2 BC 3255 2013 3805 1497 4088 1474 1346 1161  
## 3 MB 570 676 298 239 555 660 424 373  
## 4 NP 128 56 72 63 166 62 NA 55  
## 5 NB 377 656 576 430 518 547 367 368  
## 6 NL 197 166 109 83 143 103 148 110  
## 7 NT 236 331 285 469 627 215 350 105  
## 8 NS 498 733 299 317 245 408 272 371  
## 9 ON 1614 2560 960 743 1053 2122 1245 1636  
## 10 PE 38 48 27 29 43 29 0 34  
## 11 QC 851 1216 765 543 499 1265 1250 876  
## 12 SK 897 762 701 646 699 650 422 491  
## 13 YT 154 187 116 136 255 148 149 112  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

#Remove NAs from matrix, replace with zero  
pivot4[is.na(pivot4)] <- 0  
#Matrix now has NAs removed, now replaced with zero  
pivot4

## # A tibble: 13 x 30  
## Jurisdiction `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <fct> <int> <int> <int> <int> <int> <int> <dbl> <int>  
## 1 AB 1296 923 1055 848 872 803 376 456  
## 2 BC 3255 2013 3805 1497 4088 1474 1346 1161  
## 3 MB 570 676 298 239 555 660 424 373  
## 4 NP 128 56 72 63 166 62 0 55  
## 5 NB 377 656 576 430 518 547 367 368  
## 6 NL 197 166 109 83 143 103 148 110  
## 7 NT 236 331 285 469 627 215 350 105  
## 8 NS 498 733 299 317 245 408 272 371  
## 9 ON 1614 2560 960 743 1053 2122 1245 1636  
## 10 PE 38 48 27 29 43 29 0 34  
## 11 QC 851 1216 765 543 499 1265 1250 876  
## 12 SK 897 762 701 646 699 650 422 491  
## 13 YT 154 187 116 136 255 148 149 112  
## # ... with 21 more variables: `1998` <dbl>, `1999` <dbl>, `2000` <dbl>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

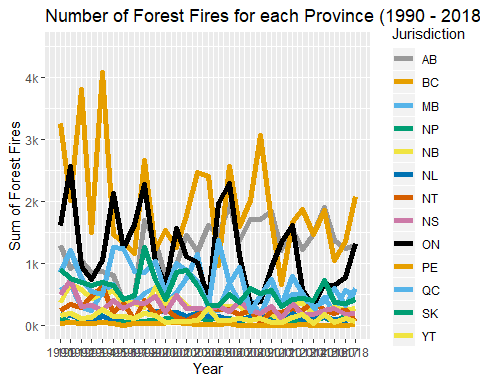
############  
#SUMMING COLUMNS AND ROWS  
  
pivot5 <- pivot4 %>%  
 adorn\_totals("row") %>%   
 adorn\_totals("col")   
  
pivot5

## Jurisdiction 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000  
## AB 1296 923 1055 848 872 803 376 456 1698 1355 783  
## BC 3255 2013 3805 1497 4088 1474 1346 1161 2662 1214 1539  
## MB 570 676 298 239 555 660 424 373 515 613 354  
## NP 128 56 72 63 166 62 0 55 0 0 0  
## NB 377 656 576 430 518 547 367 368 286 607 333  
## NL 197 166 109 83 143 103 148 110 192 228 219  
## NT 236 331 285 469 627 215 350 105 399 170 275  
## NS 498 733 299 317 245 408 272 371 348 464 212  
## ON 1614 2560 960 743 1053 2122 1245 1636 2278 1016 644  
## PE 38 48 27 29 43 29 0 34 27 34 0  
## QC 851 1216 765 543 499 1265 1250 876 854 1037 516  
## SK 897 762 701 646 699 650 422 491 1266 735 419  
## YT 154 187 116 136 255 148 149 112 198 160 55  
## Total 10111 10327 9068 6043 9763 8486 6349 6148 10723 7633 5349  
## 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014  
## 989 1447 1188 1612 1448 1954 1349 1712 1710 1840 1218 1568 1226 1470  
## 1264 1781 2472 2398 971 2569 1594 2023 3064 1673 655 1662 1865 1465  
## 537 754 1148 234 248 682 382 397 184 581 312 497 494 245  
## 128 86 112 101 107 118 65 108 134 121 76 86 93 84  
## 490 317 228 253 306 308 316 168 197 179 81 344 354 178  
## 202 143 191 153 145 96 87 139 176 61 53 198 101 124  
## 127 85 160 297 261 261 184 241 42 224 207 279 248 385  
## 486 267 272 258 302 234 393 248 198 313 116 352 171 171  
## 1561 1111 1012 424 1961 2298 1124 341 385 931 1334 1619 580 303  
## 46 29 14 20 13 36 8 4 8 4 4 8 10 4  
## 1003 895 716 319 1374 683 935 222 483 737 329 795 515 292  
## 857 880 640 329 323 501 370 599 511 571 302 422 430 403  
## 63 66 77 282 83 80 110 76 118 56 56 126 177 34  
## 7753 7861 8230 6680 7542 9820 6917 6278 7210 7291 4743 7956 6264 5158  
## 2015 2016 2017 2018 Total  
## 1898 1376 1244 1288 37002  
## 1858 1049 1351 2086 55854  
## 459 202 559 477 13669  
## 122 65 169 140 2517  
## 221 285 245 282 9817  
## 128 91 80 132 3998  
## 245 189 262 59 7218  
## 247 274 175 190 8834  
## 668 645 776 1327 34271  
## 5 8 4 10 544  
## 384 602 319 593 20868  
## 720 364 353 416 16679  
## 185 53 115 67 3494  
## 7140 5203 5652 7067 214765

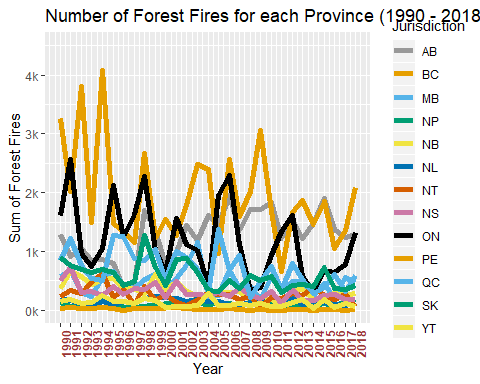
##################################################  
# Test 4 - Time Series chart for number of fires in each province (1990-2018) with thicker lines  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
  
p <- ggplot(data = pivot3, aes(x = Year,  
 y = sum\_Number,  
 color = Jurisdiction)  
 ) +  
 geom\_line(stat="identity", width = 0.7, fill="white", size = 2) +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 scale\_color\_manual(values = c("#999999", "#E69F00", "#56B4E9", "#009E73", "#F0E442", "#0072B2", "#D55E00", "#CC79A7",  
 "#000000", "#E69F00", "#56B4E9", "#009E73", "#F0E442")) +  
 scale\_x\_continuous(breaks=1990:2018)+  
 #stat\_summary(fun.y = sum, aes(label = ..y.., group = Year), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Year") +  
 ylab("Number of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 4500))+  
 labs(title = "Number of Forest Fires for each Province (1990 - 2018)")

## Warning: Ignoring unknown parameters: width, fill

p



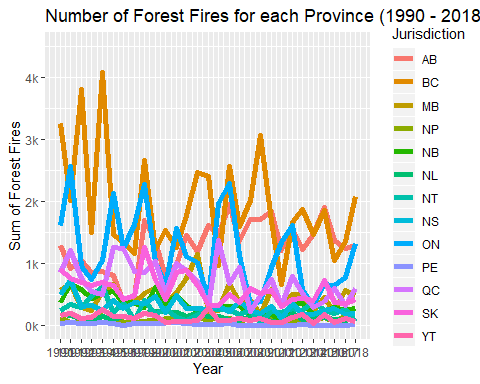
p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 0 ,size = 9, angle = 90))



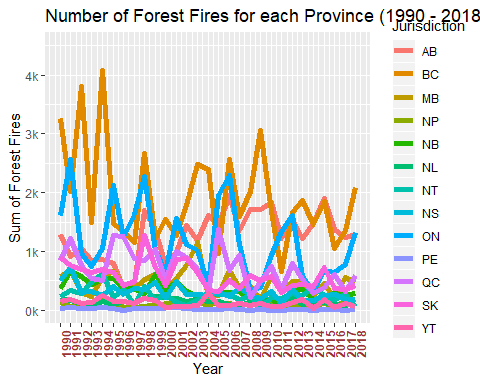
##################################################  
# Test 3 - Time Series chart for number of fires in each province (1990-2018) with thicker lines  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
  
p <- ggplot(data = pivot3, aes(x = Year,  
 y = sum\_Number,  
 color = Jurisdiction)  
 ) +  
 geom\_line(stat="identity", width = 0.7, fill="white", size = 2) +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 scale\_x\_continuous(breaks=1990:2018)+  
 #stat\_summary(fun.y = sum, aes(label = ..y.., group = Year), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Year") +  
 ylab("Number of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 4500))+  
 labs(title = "Number of Forest Fires for each Province (1990 - 2018)")

## Warning: Ignoring unknown parameters: width, fill

p



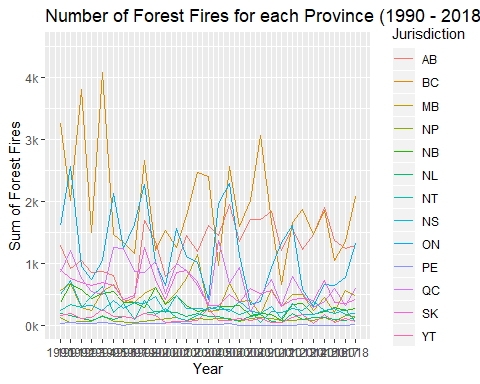
p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 0 ,size = 9, angle = 90))



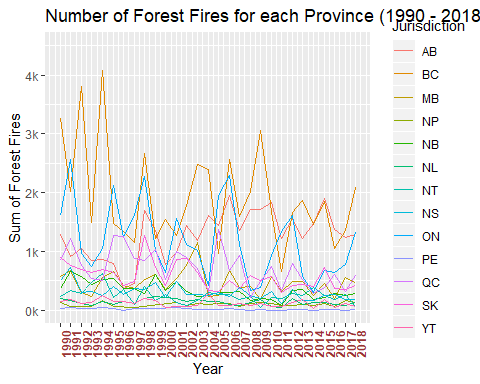
##################################################  
# Test 2 - Time Series chart for number of fires in each province (1990-2018) with thin lines  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
  
p <- ggplot(data = pivot3, aes(x = Year,  
 y = sum\_Number,  
 color = Jurisdiction)  
 ) +  
 geom\_line(stat="identity", width = 0.7, fill="white") +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 scale\_x\_continuous(breaks=1990:2018)+  
 #stat\_summary(fun.y = sum, aes(label = ..y.., group = Year), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Year") +  
 ylab("Number of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 4500))+  
 labs(title = "Number of Forest Fires for each Province (1990 - 2018)")

## Warning: Ignoring unknown parameters: width, fill

p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 0 ,size = 9, angle = 90))



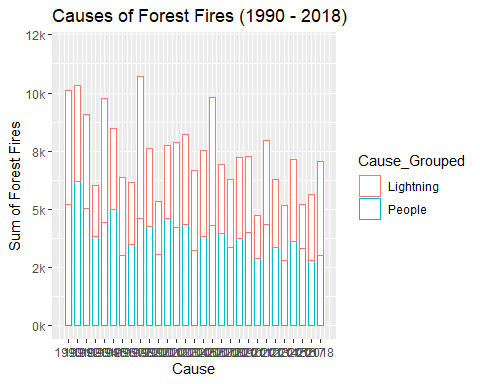
########################################################################################################################################  
#8 - Stacked bar (cause of fire, Lightning vs Human) chart for all provinces by (1990-2018)  
pivot3 <- data %>%  
dplyr::select(Year, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Year Number Cause\_Grouped  
## <int> <int> <chr>   
## 1 1990 22 People   
## 2 1991 14 People   
## 3 1992 12 People   
## 4 1993 11 People   
## 5 1994 13 People   
## 6 1995 14 People

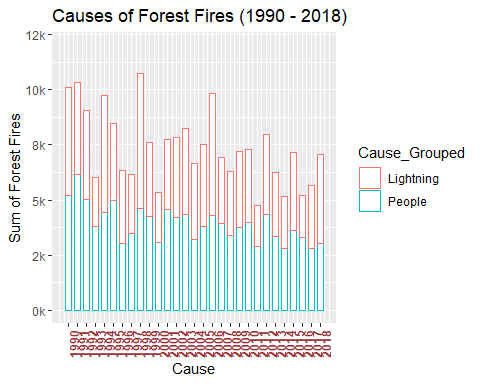
pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Cause\_Grouped, Number, Year) %>%   
 group\_by(Year, Cause\_Grouped) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
  
pivot3 %>%   
 spread(Year, sum\_Number)

## # A tibble: 2 x 30  
## Cause\_Grouped `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <chr> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 Lightning 4895 4146 4021 2229 5324 3504 3317 2652  
## 2 People 5216 6181 5047 3814 4439 4982 3032 3496  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

##################################################  
# Test 8 Stacked bar (cause of fire, Lightning vs Human) chart for all provinces by (1990-2018)  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = pivot3, aes(x = Year,  
 y = sum\_Number,  
 color = Cause\_Grouped)  
 ) +  
 geom\_bar(stat="identity", width = 0.7, fill="white") +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 scale\_x\_continuous(breaks=1990:2018)+  
 #stat\_summary(fun.y = sum, aes(label = ..y.., group = Year), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 12000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")  
  
p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 0 ,size = 9, angle = 90))



########################################################################################################################################  
#7 Boxplot outlier detection  
pivot3 <- data %>%  
dplyr::select(Jurisdiction, Number, Year)  
head(pivot3)

## # A tibble: 6 x 3  
## Jurisdiction Number Year  
## <fct> <int> <int>  
## 1 AB 22 1990  
## 2 AB 14 1991  
## 3 AB 12 1992  
## 4 AB 11 1993  
## 5 AB 13 1994  
## 6 AB 14 1995

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Year) %>%   
 group\_by(Year, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
   
#Produces matrix with zero  
pivot4 <- pivot3 %>%   
 spread(Year, sum\_Number)  
  
pivot4

## # A tibble: 13 x 30  
## Jurisdiction `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <fct> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 AB 1296 923 1055 848 872 803 376 456  
## 2 BC 3255 2013 3805 1497 4088 1474 1346 1161  
## 3 MB 570 676 298 239 555 660 424 373  
## 4 NP 128 56 72 63 166 62 NA 55  
## 5 NB 377 656 576 430 518 547 367 368  
## 6 NL 197 166 109 83 143 103 148 110  
## 7 NT 236 331 285 469 627 215 350 105  
## 8 NS 498 733 299 317 245 408 272 371  
## 9 ON 1614 2560 960 743 1053 2122 1245 1636  
## 10 PE 38 48 27 29 43 29 0 34  
## 11 QC 851 1216 765 543 499 1265 1250 876  
## 12 SK 897 762 701 646 699 650 422 491  
## 13 YT 154 187 116 136 255 148 149 112  
## # ... with 21 more variables: `1998` <int>, `1999` <int>, `2000` <int>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

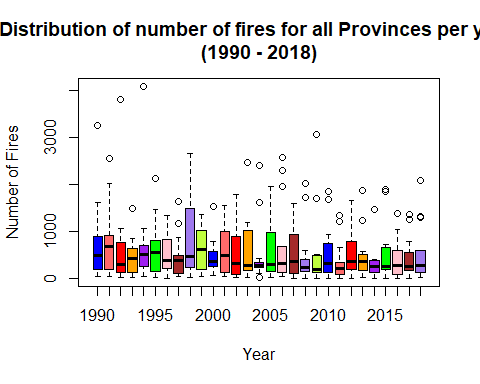
#Remove NAs from matrix, replace with zero  
pivot4[is.na(pivot4)] <- 0  
#Matrix now has NAs removed, now replaced with zero  
pivot4

## # A tibble: 13 x 30  
## Jurisdiction `1990` `1991` `1992` `1993` `1994` `1995` `1996` `1997`  
## <fct> <int> <int> <int> <int> <int> <int> <dbl> <int>  
## 1 AB 1296 923 1055 848 872 803 376 456  
## 2 BC 3255 2013 3805 1497 4088 1474 1346 1161  
## 3 MB 570 676 298 239 555 660 424 373  
## 4 NP 128 56 72 63 166 62 0 55  
## 5 NB 377 656 576 430 518 547 367 368  
## 6 NL 197 166 109 83 143 103 148 110  
## 7 NT 236 331 285 469 627 215 350 105  
## 8 NS 498 733 299 317 245 408 272 371  
## 9 ON 1614 2560 960 743 1053 2122 1245 1636  
## 10 PE 38 48 27 29 43 29 0 34  
## 11 QC 851 1216 765 543 499 1265 1250 876  
## 12 SK 897 762 701 646 699 650 422 491  
## 13 YT 154 187 116 136 255 148 149 112  
## # ... with 21 more variables: `1998` <dbl>, `1999` <dbl>, `2000` <dbl>,  
## # `2001` <int>, `2002` <int>, `2003` <int>, `2004` <int>, `2005` <int>,  
## # `2006` <int>, `2007` <int>, `2008` <int>, `2009` <int>, `2010` <int>,  
## # `2011` <int>, `2012` <int>, `2013` <int>, `2014` <int>, `2015` <int>,  
## # `2016` <int>, `2017` <int>, `2018` <int>

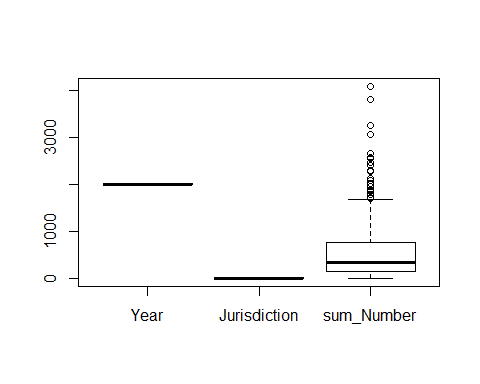
############  
#SUMMING COLUMNS AND ROWS  
  
pivot5 <- pivot4 %>%  
 adorn\_totals("row") %>%   
 adorn\_totals("col")   
  
pivot5

## Jurisdiction 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000  
## AB 1296 923 1055 848 872 803 376 456 1698 1355 783  
## BC 3255 2013 3805 1497 4088 1474 1346 1161 2662 1214 1539  
## MB 570 676 298 239 555 660 424 373 515 613 354  
## NP 128 56 72 63 166 62 0 55 0 0 0  
## NB 377 656 576 430 518 547 367 368 286 607 333  
## NL 197 166 109 83 143 103 148 110 192 228 219  
## NT 236 331 285 469 627 215 350 105 399 170 275  
## NS 498 733 299 317 245 408 272 371 348 464 212  
## ON 1614 2560 960 743 1053 2122 1245 1636 2278 1016 644  
## PE 38 48 27 29 43 29 0 34 27 34 0  
## QC 851 1216 765 543 499 1265 1250 876 854 1037 516  
## SK 897 762 701 646 699 650 422 491 1266 735 419  
## YT 154 187 116 136 255 148 149 112 198 160 55  
## Total 10111 10327 9068 6043 9763 8486 6349 6148 10723 7633 5349  
## 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014  
## 989 1447 1188 1612 1448 1954 1349 1712 1710 1840 1218 1568 1226 1470  
## 1264 1781 2472 2398 971 2569 1594 2023 3064 1673 655 1662 1865 1465  
## 537 754 1148 234 248 682 382 397 184 581 312 497 494 245  
## 128 86 112 101 107 118 65 108 134 121 76 86 93 84  
## 490 317 228 253 306 308 316 168 197 179 81 344 354 178  
## 202 143 191 153 145 96 87 139 176 61 53 198 101 124  
## 127 85 160 297 261 261 184 241 42 224 207 279 248 385  
## 486 267 272 258 302 234 393 248 198 313 116 352 171 171  
## 1561 1111 1012 424 1961 2298 1124 341 385 931 1334 1619 580 303  
## 46 29 14 20 13 36 8 4 8 4 4 8 10 4  
## 1003 895 716 319 1374 683 935 222 483 737 329 795 515 292  
## 857 880 640 329 323 501 370 599 511 571 302 422 430 403  
## 63 66 77 282 83 80 110 76 118 56 56 126 177 34  
## 7753 7861 8230 6680 7542 9820 6917 6278 7210 7291 4743 7956 6264 5158  
## 2015 2016 2017 2018 Total  
## 1898 1376 1244 1288 37002  
## 1858 1049 1351 2086 55854  
## 459 202 559 477 13669  
## 122 65 169 140 2517  
## 221 285 245 282 9817  
## 128 91 80 132 3998  
## 245 189 262 59 7218  
## 247 274 175 190 8834  
## 668 645 776 1327 34271  
## 5 8 4 10 544  
## 384 602 319 593 20868  
## 720 364 353 416 16679  
## 185 53 115 67 3494  
## 7140 5203 5652 7067 214765

##################################################  
boxplot(sum\_Number~Year,  
 data=pivot3,  
 main="Distribution of number of fires for all Provinces per year \n(1990 - 2018)",  
 xlab="Year",  
 ylab="Number of Fires",  
 col=c("blue", "indianred1","red","orange","purple","green",  
 "pink","brown", "mediumpurple2","olivedrab1"),  
 border="black"  
)



# Outlier detection  
OutVals = boxplot(pivot3)$out



OutVals

## [1] 3255 2013 2560 3805 4088 2122 1698 2662 2278 1781 2472 2398 1961 1954  
## [15] 2569 2298 1712 2023 1710 3064 1840 1865 1898 1858 2086

# Find Outlier index position  
#which(pivot3 )  
########################################################################################################################################  
#6 Boxplot - outlier detection  
pivot3 <- data %>%  
dplyr::select(Jurisdiction, Number, Year)  
head(pivot3)

## # A tibble: 6 x 3  
## Jurisdiction Number Year  
## <fct> <int> <int>  
## 1 AB 22 1990  
## 2 AB 14 1991  
## 3 AB 12 1992  
## 4 AB 11 1993  
## 5 AB 13 1994  
## 6 AB 14 1995

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Year) %>%   
 group\_by(Year, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
  
pivot3 %>%   
 spread(Jurisdiction, sum\_Number)

## # A tibble: 29 x 14  
## # Groups: Year [29]  
## Year AB BC MB NP NB NL NT NS ON PE QC  
## <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 1990 1296 3255 570 128 377 197 236 498 1614 38 851  
## 2 1991 923 2013 676 56 656 166 331 733 2560 48 1216  
## 3 1992 1055 3805 298 72 576 109 285 299 960 27 765  
## 4 1993 848 1497 239 63 430 83 469 317 743 29 543  
## 5 1994 872 4088 555 166 518 143 627 245 1053 43 499  
## 6 1995 803 1474 660 62 547 103 215 408 2122 29 1265  
## 7 1996 376 1346 424 NA 367 148 350 272 1245 0 1250  
## 8 1997 456 1161 373 55 368 110 105 371 1636 34 876  
## 9 1998 1698 2662 515 NA 286 192 399 348 2278 27 854  
## 10 1999 1355 1214 613 NA 607 228 170 464 1016 34 1037  
## # ... with 19 more rows, and 2 more variables: SK <int>, YT <int>

#Produces matrix with zero  
pivot4 <- pivot3 %>%   
 spread(Jurisdiction, sum\_Number)  
  
pivot4

## # A tibble: 29 x 14  
## # Groups: Year [29]  
## Year AB BC MB NP NB NL NT NS ON PE QC  
## <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 1990 1296 3255 570 128 377 197 236 498 1614 38 851  
## 2 1991 923 2013 676 56 656 166 331 733 2560 48 1216  
## 3 1992 1055 3805 298 72 576 109 285 299 960 27 765  
## 4 1993 848 1497 239 63 430 83 469 317 743 29 543  
## 5 1994 872 4088 555 166 518 143 627 245 1053 43 499  
## 6 1995 803 1474 660 62 547 103 215 408 2122 29 1265  
## 7 1996 376 1346 424 NA 367 148 350 272 1245 0 1250  
## 8 1997 456 1161 373 55 368 110 105 371 1636 34 876  
## 9 1998 1698 2662 515 NA 286 192 399 348 2278 27 854  
## 10 1999 1355 1214 613 NA 607 228 170 464 1016 34 1037  
## # ... with 19 more rows, and 2 more variables: SK <int>, YT <int>

#Remove NAs from matrix, replace with zero  
pivot4[is.na(pivot4)] <- 0  
#Matrix now has NAs removed, now replaced with zero  
pivot4

## # A tibble: 29 x 14  
## # Groups: Year [29]  
## Year AB BC MB NP NB NL NT NS ON PE QC  
## <int> <int> <int> <int> <dbl> <int> <int> <int> <int> <int> <dbl> <int>  
## 1 1990 1296 3255 570 128 377 197 236 498 1614 38 851  
## 2 1991 923 2013 676 56 656 166 331 733 2560 48 1216  
## 3 1992 1055 3805 298 72 576 109 285 299 960 27 765  
## 4 1993 848 1497 239 63 430 83 469 317 743 29 543  
## 5 1994 872 4088 555 166 518 143 627 245 1053 43 499  
## 6 1995 803 1474 660 62 547 103 215 408 2122 29 1265  
## 7 1996 376 1346 424 0 367 148 350 272 1245 0 1250  
## 8 1997 456 1161 373 55 368 110 105 371 1636 34 876  
## 9 1998 1698 2662 515 0 286 192 399 348 2278 27 854  
## 10 1999 1355 1214 613 0 607 228 170 464 1016 34 1037  
## # ... with 19 more rows, and 2 more variables: SK <int>, YT <int>

############  
#SUMMING COLUMNS AND ROWS  
  
pivot5 <- pivot4 %>%  
 adorn\_totals("row") %>%   
 adorn\_totals("col")   
  
pivot5

## Year AB BC MB NP NB NL NT NS ON PE QC SK  
## 1990 1296 3255 570 128 377 197 236 498 1614 38 851 897  
## 1991 923 2013 676 56 656 166 331 733 2560 48 1216 762  
## 1992 1055 3805 298 72 576 109 285 299 960 27 765 701  
## 1993 848 1497 239 63 430 83 469 317 743 29 543 646  
## 1994 872 4088 555 166 518 143 627 245 1053 43 499 699  
## 1995 803 1474 660 62 547 103 215 408 2122 29 1265 650  
## 1996 376 1346 424 0 367 148 350 272 1245 0 1250 422  
## 1997 456 1161 373 55 368 110 105 371 1636 34 876 491  
## 1998 1698 2662 515 0 286 192 399 348 2278 27 854 1266  
## 1999 1355 1214 613 0 607 228 170 464 1016 34 1037 735  
## 2000 783 1539 354 0 333 219 275 212 644 0 516 419  
## 2001 989 1264 537 128 490 202 127 486 1561 46 1003 857  
## 2002 1447 1781 754 86 317 143 85 267 1111 29 895 880  
## 2003 1188 2472 1148 112 228 191 160 272 1012 14 716 640  
## 2004 1612 2398 234 101 253 153 297 258 424 20 319 329  
## 2005 1448 971 248 107 306 145 261 302 1961 13 1374 323  
## 2006 1954 2569 682 118 308 96 261 234 2298 36 683 501  
## 2007 1349 1594 382 65 316 87 184 393 1124 8 935 370  
## 2008 1712 2023 397 108 168 139 241 248 341 4 222 599  
## 2009 1710 3064 184 134 197 176 42 198 385 8 483 511  
## 2010 1840 1673 581 121 179 61 224 313 931 4 737 571  
## 2011 1218 655 312 76 81 53 207 116 1334 4 329 302  
## 2012 1568 1662 497 86 344 198 279 352 1619 8 795 422  
## 2013 1226 1865 494 93 354 101 248 171 580 10 515 430  
## 2014 1470 1465 245 84 178 124 385 171 303 4 292 403  
## 2015 1898 1858 459 122 221 128 245 247 668 5 384 720  
## 2016 1376 1049 202 65 285 91 189 274 645 8 602 364  
## 2017 1244 1351 559 169 245 80 262 175 776 4 319 353  
## 2018 1288 2086 477 140 282 132 59 190 1327 10 593 416  
## Total 37002 55854 13669 2517 9817 3998 7218 8834 34271 544 20868 16679  
## YT Total  
## 154 10111  
## 187 10327  
## 116 9068  
## 136 6043  
## 255 9763  
## 148 8486  
## 149 6349  
## 112 6148  
## 198 10723  
## 160 7633  
## 55 5349  
## 63 7753  
## 66 7861  
## 77 8230  
## 282 6680  
## 83 7542  
## 80 9820  
## 110 6917  
## 76 6278  
## 118 7210  
## 56 7291  
## 56 4743  
## 126 7956  
## 177 6264  
## 34 5158  
## 185 7140  
## 53 5203  
## 115 5652  
## 67 7067  
## 3494 214765

##################################################  
#CORRELATION  
CorDataFrame <- pivot3 %>%   
 spread(Jurisdiction, sum\_Number)  
  
CorDataFrame

## # A tibble: 29 x 14  
## # Groups: Year [29]  
## Year AB BC MB NP NB NL NT NS ON PE QC  
## <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 1990 1296 3255 570 128 377 197 236 498 1614 38 851  
## 2 1991 923 2013 676 56 656 166 331 733 2560 48 1216  
## 3 1992 1055 3805 298 72 576 109 285 299 960 27 765  
## 4 1993 848 1497 239 63 430 83 469 317 743 29 543  
## 5 1994 872 4088 555 166 518 143 627 245 1053 43 499  
## 6 1995 803 1474 660 62 547 103 215 408 2122 29 1265  
## 7 1996 376 1346 424 NA 367 148 350 272 1245 0 1250  
## 8 1997 456 1161 373 55 368 110 105 371 1636 34 876  
## 9 1998 1698 2662 515 NA 286 192 399 348 2278 27 854  
## 10 1999 1355 1214 613 NA 607 228 170 464 1016 34 1037  
## # ... with 19 more rows, and 2 more variables: SK <int>, YT <int>

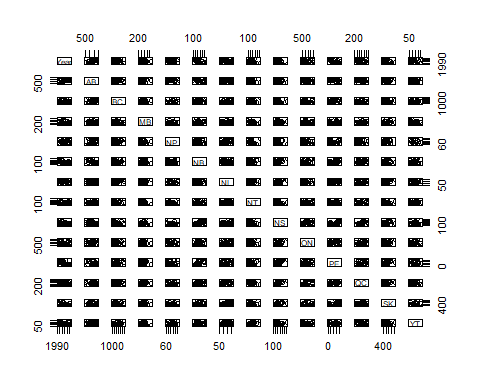
sapply(CorDataFrame, is.numeric) # Which columns are numeric?

## Year AB BC MB NP NB NL NT NS ON PE QC SK YT   
## TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE TRUE

my\_num\_data <- CorDataFrame[, sapply(CorDataFrame, is.numeric)] # Subset numeric columns  
my\_num\_data

## # A tibble: 29 x 14  
## # Groups: Year [29]  
## Year AB BC MB NP NB NL NT NS ON PE QC  
## <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int> <int>  
## 1 1990 1296 3255 570 128 377 197 236 498 1614 38 851  
## 2 1991 923 2013 676 56 656 166 331 733 2560 48 1216  
## 3 1992 1055 3805 298 72 576 109 285 299 960 27 765  
## 4 1993 848 1497 239 63 430 83 469 317 743 29 543  
## 5 1994 872 4088 555 166 518 143 627 245 1053 43 499  
## 6 1995 803 1474 660 62 547 103 215 408 2122 29 1265  
## 7 1996 376 1346 424 NA 367 148 350 272 1245 0 1250  
## 8 1997 456 1161 373 55 368 110 105 371 1636 34 876  
## 9 1998 1698 2662 515 NA 286 192 399 348 2278 27 854  
## 10 1999 1355 1214 613 NA 607 228 170 464 1016 34 1037  
## # ... with 19 more rows, and 2 more variables: SK <int>, YT <int>

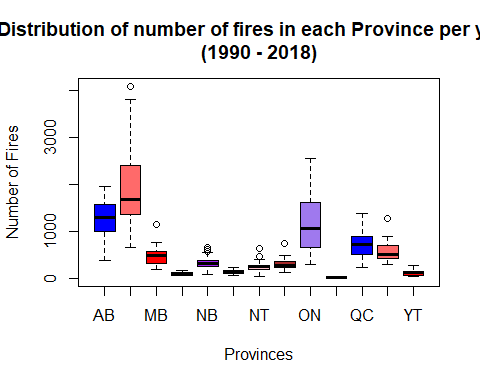
plot(my\_num\_data) # Works



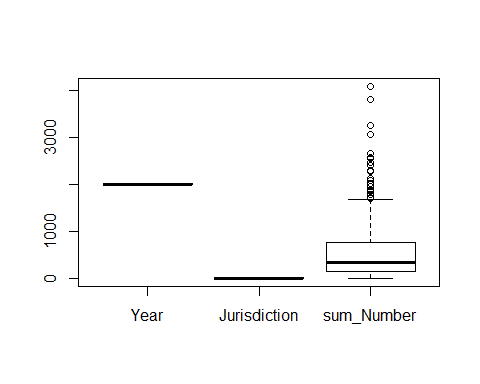
cor(my\_num\_data)

## Year AB BC MB NP NB  
## Year 1.0000000 0.546335923 -0.36110450 -0.185100904 NA -0.7000538  
## AB 0.5463359 1.000000000 0.15023454 -0.007571187 NA -0.5189530  
## BC -0.3611045 0.150234537 1.00000000 0.161751543 NA 0.2114017  
## MB -0.1851009 -0.007571187 0.16175154 1.000000000 NA 0.2038883  
## NP NA NA NA NA 1 NA  
## NB -0.7000538 -0.518953042 0.21140166 0.203888335 NA 1.0000000  
## NL -0.3317171 -0.041129119 0.22401619 0.247988400 NA 0.3037542  
## NT -0.3474347 -0.172973137 0.30415171 -0.120227227 NA 0.2320419  
## NS -0.6080368 -0.232706662 0.01817127 0.286415878 NA 0.6993488  
## ON -0.4188543 -0.148060585 -0.01483963 0.375743689 NA 0.4197618  
## PE NA NA NA NA NA NA  
## QC -0.5246978 -0.367004187 -0.16781797 0.281679330 NA 0.5951643  
## SK -0.5412805 0.062870086 0.41185714 0.418406166 NA 0.3824341  
## YT -0.3859273 -0.076749198 0.44794406 0.015002077 NA 0.3890247  
## NL NT NS ON PE QC  
## Year -0.33171713 -0.347434654 -0.608036773 -0.41885428 NA -0.52469782  
## AB -0.04112912 -0.172973137 -0.232706662 -0.14806059 NA -0.36700419  
## BC 0.22401619 0.304151713 0.018171267 -0.01483963 NA -0.16781797  
## MB 0.24798840 -0.120227227 0.286415878 0.37574369 NA 0.28167933  
## NP NA NA NA NA NA NA  
## NB 0.30375423 0.232041878 0.699348814 0.41976184 NA 0.59516430  
## NL 1.00000000 -0.056363050 0.378076786 0.12265643 NA 0.25919831  
## NT -0.05636305 1.000000000 0.003673412 0.02984490 NA -0.11646900  
## NS 0.37807679 0.003673412 1.000000000 0.58423893 NA 0.67343110  
## ON 0.12265643 0.029844896 0.584238930 1.00000000 NA 0.70744952  
## PE NA NA NA NA 1 NA  
## QC 0.25919831 -0.116469001 0.673431099 0.70744952 NA 1.00000000  
## SK 0.42672134 0.134702176 0.490365233 0.36364534 NA 0.26994050  
## YT 0.20183017 0.487585257 0.253303187 0.09305185 NA 0.03992442  
## SK YT  
## Year -0.54128047 -0.38592735  
## AB 0.06287009 -0.07674920  
## BC 0.41185714 0.44794406  
## MB 0.41840617 0.01500208  
## NP NA NA  
## NB 0.38243408 0.38902468  
## NL 0.42672134 0.20183017  
## NT 0.13470218 0.48758526  
## NS 0.49036523 0.25330319  
## ON 0.36364534 0.09305185  
## PE NA NA  
## QC 0.26994050 0.03992442  
## SK 1.00000000 0.27080987  
## YT 0.27080987 1.00000000

##################################################  
# Test 1  
boxplot(sum\_Number~Jurisdiction,  
 data=pivot3,  
 main="Distribution of number of fires in each Province per year \n(1990 - 2018)",  
 xlab="Provinces",  
 ylab="Number of Fires",  
 col=c("blue", "indianred1","red","orange","purple","green",  
 "pink","brown", "mediumpurple2","olivedrab1"),  
 border="black"  
)



# Outlier detection  
OutVals = boxplot(pivot3)$out



OutVals

## [1] 3255 2013 2560 3805 4088 2122 1698 2662 2278 1781 2472 2398 1961 1954  
## [15] 2569 2298 1712 2023 1710 3064 1840 1865 1898 1858 2086

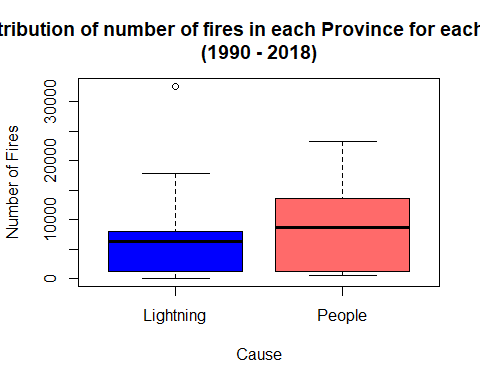
########################################################################################################################################  
#5 Boxplot - outlier detection  
pivot3 <- data %>%  
dplyr::select(Jurisdiction, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Jurisdiction Number Cause\_Grouped  
## <fct> <int> <chr>   
## 1 AB 22 People   
## 2 AB 14 People   
## 3 AB 12 People   
## 4 AB 11 People   
## 5 AB 13 People   
## 6 AB 14 People

pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Cause\_Grouped) %>%   
 group\_by(Cause\_Grouped, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
   
pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)

## # A tibble: 13 x 3  
## Jurisdiction Lightning People  
## <fct> <int> <int>  
## 1 AB 16457 20545  
## 2 BC 32648 23206  
## 3 MB 6838 6831  
## 4 NP 1421 1096  
## 5 NB 1156 8661  
## 6 NL 765 3233  
## 7 NT 6274 944  
## 8 NS 198 8636  
## 9 ON 17782 16489  
## 10 PE 1 543  
## 11 QC 7241 13627  
## 12 SK 7939 8740  
## 13 YT 2275 1219

###############################################  
# Test 2  
boxplot(sum\_Number~Cause\_Grouped,  
 data=pivot3,  
 main="Distribution of number of fires in each Province for each cause \n(1990 - 2018)",  
 xlab="Cause",  
 ylab="Number of Fires",  
 col=c("blue", "indianred1","red","orange","purple","green",  
 "pink","brown", "mediumpurple2","olivedrab1"),  
 border="black"  
)



# Outlier detection  
#OutVals = boxplot(pivot3)$out  
#OutVals  
########################################################################################################################################  
#4  
pivot3 <- data %>%  
dplyr::select(Jurisdiction, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Jurisdiction Number Cause\_Grouped  
## <fct> <int> <chr>   
## 1 AB 22 People   
## 2 AB 14 People   
## 3 AB 12 People   
## 4 AB 11 People   
## 5 AB 13 People   
## 6 AB 14 People

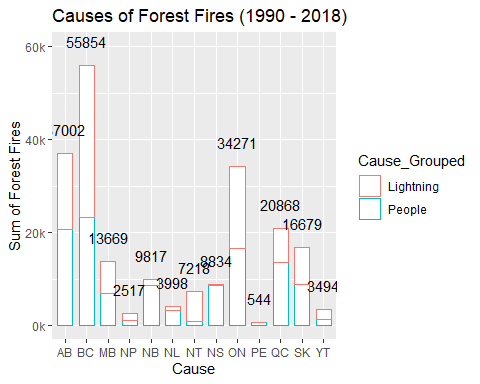
pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Cause\_Grouped) %>%   
 group\_by(Cause\_Grouped, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
   
pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)

## # A tibble: 13 x 3  
## Jurisdiction Lightning People  
## <fct> <int> <int>  
## 1 AB 16457 20545  
## 2 BC 32648 23206  
## 3 MB 6838 6831  
## 4 NP 1421 1096  
## 5 NB 1156 8661  
## 6 NL 765 3233  
## 7 NT 6274 944  
## 8 NS 198 8636  
## 9 ON 17782 16489  
## 10 PE 1 543  
## 11 QC 7241 13627  
## 12 SK 7939 8740  
## 13 YT 2275 1219

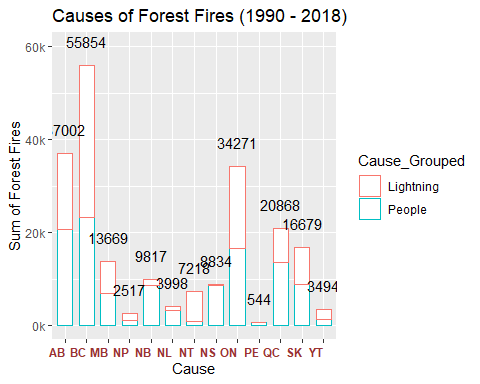
##################################################  
# Test 5  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = pivot3, aes(x = Jurisdiction,  
 y = sum\_Number,  
 color = Cause\_Grouped)  
 ) +  
 geom\_bar(stat="identity", width = 0.7, fill="white") +  
 # geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 # vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 stat\_summary(fun.y = sum, aes(label = ..y.., group = Jurisdiction), geom = "text", vjust= -1.5, show\_guide = F)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 60000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")

## Warning: `show\_guide` has been deprecated. Please use `show.legend`  
## instead.

p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 0))



########################################################################################################################################  
#3  
pivot3 <- data %>%  
dplyr::select(Jurisdiction, Number, Cause\_Grouped)  
head(pivot3)

## # A tibble: 6 x 3  
## Jurisdiction Number Cause\_Grouped  
## <fct> <int> <chr>   
## 1 AB 22 People   
## 2 AB 14 People   
## 3 AB 12 People   
## 4 AB 11 People   
## 5 AB 13 People   
## 6 AB 14 People

# attach(pivot3)  
# detach(pivot3)  
  
pivot3 <- data %>% #Groups Cause together and sums Number  
 dplyr::select(Jurisdiction, Number, Cause\_Grouped) %>%   
 group\_by(Cause\_Grouped, Jurisdiction) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))   
   
pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)

## # A tibble: 13 x 3  
## Jurisdiction Lightning People  
## <fct> <int> <int>  
## 1 AB 16457 20545  
## 2 BC 32648 23206  
## 3 MB 6838 6831  
## 4 NP 1421 1096  
## 5 NB 1156 8661  
## 6 NL 765 3233  
## 7 NT 6274 944  
## 8 NS 198 8636  
## 9 ON 17782 16489  
## 10 PE 1 543  
## 11 QC 7241 13627  
## 12 SK 7939 8740  
## 13 YT 2275 1219

##################################################  
#CORRELATION  
CorDataFrame <- pivot3 %>%   
 spread(Cause\_Grouped, sum\_Number)  
  
CorDataFrame

## # A tibble: 13 x 3  
## Jurisdiction Lightning People  
## <fct> <int> <int>  
## 1 AB 16457 20545  
## 2 BC 32648 23206  
## 3 MB 6838 6831  
## 4 NP 1421 1096  
## 5 NB 1156 8661  
## 6 NL 765 3233  
## 7 NT 6274 944  
## 8 NS 198 8636  
## 9 ON 17782 16489  
## 10 PE 1 543  
## 11 QC 7241 13627  
## 12 SK 7939 8740  
## 13 YT 2275 1219

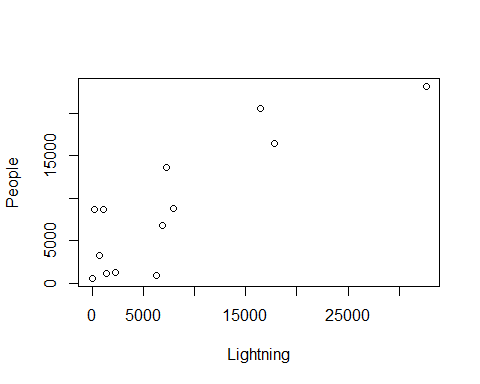
sapply(CorDataFrame, is.numeric) # Which columns are numeric?

## Jurisdiction Lightning People   
## FALSE TRUE TRUE

my\_num\_data <- CorDataFrame[, sapply(CorDataFrame, is.numeric)] # Subset numeric columns  
my\_num\_data

## # A tibble: 13 x 2  
## Lightning People  
## <int> <int>  
## 1 16457 20545  
## 2 32648 23206  
## 3 6838 6831  
## 4 1421 1096  
## 5 1156 8661  
## 6 765 3233  
## 7 6274 944  
## 8 198 8636  
## 9 17782 16489  
## 10 1 543  
## 11 7241 13627  
## 12 7939 8740  
## 13 2275 1219

plot(my\_num\_data) # Works



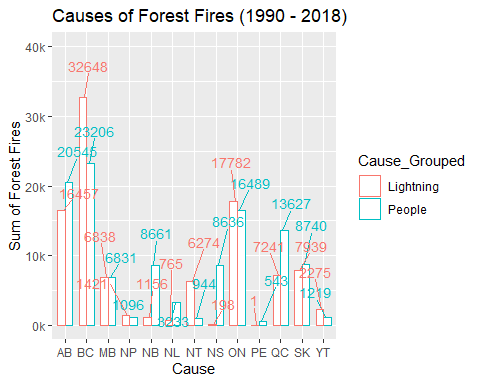
cor(my\_num\_data)

## Lightning People  
## Lightning 1.0000000 0.8506535  
## People 0.8506535 1.0000000

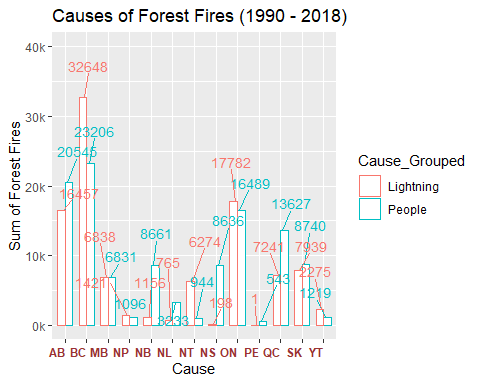
##################################################  
# Test 11  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
  
p <- ggplot(data = pivot3,  
 aes(x = Jurisdiction, y = sum\_Number, color=Cause\_Grouped)) +  
 geom\_bar(position = "dodge", stat="identity", width = 0.7, fill="white") +  
 geom\_text\_repel(aes(label=sum\_Number), show\_guide = F, position=position\_dodge(width=0.4),  
 vjust= -2.4, hjust = 0.4, size = 3.8, angle = 0)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 40000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")

## Warning: `show\_guide` has been deprecated. Please use `show.legend`  
## instead.

p



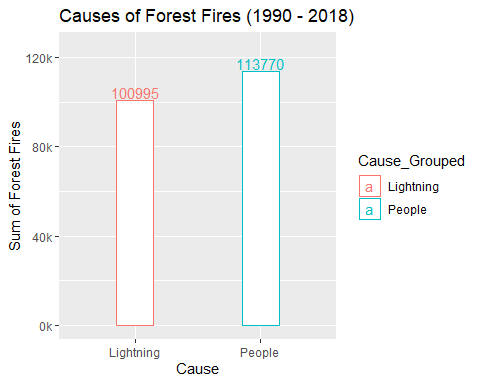
p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 0))



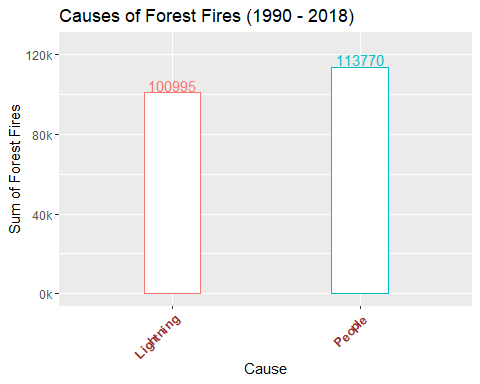
########################################################################################################################################  
#2  
#Below works with percentage totals  
GCause\_HvsL <- data %>% #Groups Cause together and sums Number  
 group\_by(Cause\_Grouped) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE)) %>%   
 mutate(rel.freq = paste0(round(100 \* sum\_Number/sum(sum\_Number),0),"%"))  
  
GCause\_HvsL

## # A tibble: 2 x 3  
## Cause\_Grouped sum\_Number rel.freq  
## <chr> <int> <chr>   
## 1 Lightning 100995 47%   
## 2 People 113770 53%

##################################################  
# Boxplot GCause 11, testing  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = GCause\_HvsL,  
 aes(x = Cause\_Grouped, y = sum\_Number, color=Cause\_Grouped)) +  
 geom\_bar(stat="identity", width = 0.3, fill="white") +  
 geom\_text(aes(label=sum\_Number), position=position\_dodge(width=0.9), vjust=-0.15)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 125000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")  
  
p



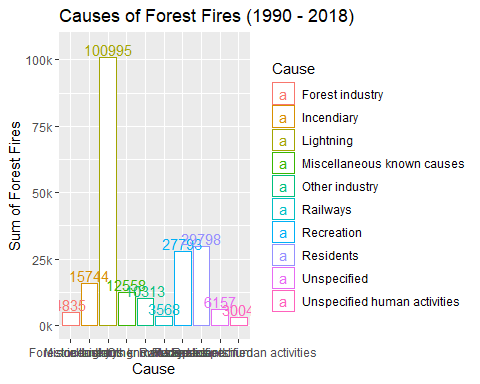
p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 45), legend.position = "none")



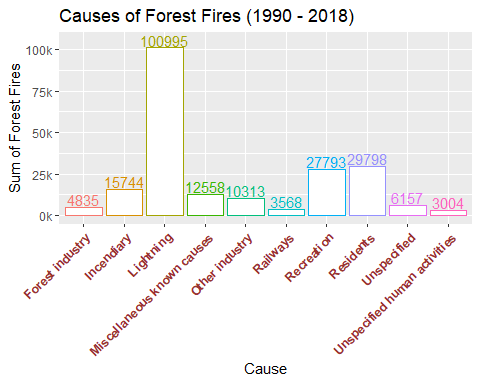
########################################################################################################################################  
#1  
#Below works with percentage totals  
GCause <- data %>% #Groups Cause together and sums Number  
 group\_by(Cause) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE)) %>%   
 mutate(rel.freq = paste0(round(100 \* sum\_Number/sum(sum\_Number),0),"%"))  
  
GCause

## # A tibble: 10 x 3  
## Cause sum\_Number rel.freq  
## <fct> <int> <chr>   
## 1 Forest industry 4835 2%   
## 2 Incendiary 15744 7%   
## 3 Lightning 100995 47%   
## 4 Miscellaneous known causes 12558 6%   
## 5 Other industry 10313 5%   
## 6 Railways 3568 2%   
## 7 Recreation 27793 13%   
## 8 Residents 29798 14%   
## 9 Unspecified 6157 3%   
## 10 Unspecified human activities 3004 1%

##################################################  
ks <- function (x) { number\_format(accuracy = 1,  
 scale = 1/1000,  
 suffix = "k",  
 big.mark = ",")(x) }  
  
p <- ggplot(data = GCause,  
 aes(x = Cause, y = sum\_Number, color=Cause)) +  
 geom\_bar(stat="identity", fill="white") +  
 geom\_text(aes(label=sum\_Number), position=position\_dodge(width=0.9), vjust=-0.15)+  
 xlab("Cause") +  
 ylab("Causes of Forest Fires (1990 - 2018)") +  
 scale\_y\_continuous(name="Sum of Forest Fires", labels = ks)+  
 coord\_cartesian(ylim = c(0, 105000))+  
 labs(title = "Causes of Forest Fires (1990 - 2018)")  
  
p



p + theme(  
 axis.text.x = element\_text(face = "bold", color = "#993333", hjust = 1,size = 9, angle = 45), legend.position = "none")



########################################################################################################################################  
#Sample code for various statistics  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Cause, Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 262 x 3  
## # Groups: Cause [10]  
## Cause Year sum\_Number  
## <fct> <int> <int>  
## 1 Forest industry 1990 355  
## 2 Forest industry 1991 299  
## 3 Forest industry 1992 258  
## 4 Forest industry 1993 240  
## 5 Forest industry 1994 222  
## 6 Forest industry 1995 309  
## 7 Forest industry 1996 282  
## 8 Forest industry 1997 276  
## 9 Forest industry 1998 151  
## 10 Forest industry 1999 239  
## # ... with 252 more rows

#Below code works  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Cause, Jurisdiction, Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 3,219 x 4  
## # Groups: Cause, Jurisdiction [129]  
## Cause Jurisdiction Year sum\_Number  
## <fct> <fct> <int> <int>  
## 1 Forest industry AB 1990 22  
## 2 Forest industry AB 1991 14  
## 3 Forest industry AB 1992 12  
## 4 Forest industry AB 1993 11  
## 5 Forest industry AB 1994 13  
## 6 Forest industry AB 1995 14  
## 7 Forest industry AB 1996 8  
## 8 Forest industry AB 1997 29  
## 9 Forest industry AB 1998 10  
## 10 Forest industry AB 1999 20  
## # ... with 3,209 more rows

#Below code works  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Jurisdiction, Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 372 x 3  
## # Groups: Jurisdiction [13]  
## Jurisdiction Year sum\_Number  
## <fct> <int> <int>  
## 1 AB 1990 1296  
## 2 AB 1991 923  
## 3 AB 1992 1055  
## 4 AB 1993 848  
## 5 AB 1994 872  
## 6 AB 1995 803  
## 7 AB 1996 376  
## 8 AB 1997 456  
## 9 AB 1998 1698  
## 10 AB 1999 1355  
## # ... with 362 more rows

#Below code works  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Year, Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 372 x 3  
## # Groups: Year [29]  
## Year Jurisdiction sum\_Number  
## <int> <fct> <int>  
## 1 1990 AB 1296  
## 2 1990 BC 3255  
## 3 1990 MB 570  
## 4 1990 NP 128  
## 5 1990 NB 377  
## 6 1990 NL 197  
## 7 1990 NT 236  
## 8 1990 NS 498  
## 9 1990 ON 1614  
## 10 1990 PE 38  
## # ... with 362 more rows

#Below code works  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 13 x 2  
## Jurisdiction sum\_Number  
## <fct> <int>  
## 1 AB 37002  
## 2 BC 55854  
## 3 MB 13669  
## 4 NP 2517  
## 5 NB 9817  
## 6 NL 3998  
## 7 NT 7218  
## 8 NS 8834  
## 9 ON 34271  
## 10 PE 544  
## 11 QC 20868  
## 12 SK 16679  
## 13 YT 3494

#Below code works  
data %>% #Groups Cause, Year together and sums Number  
 group\_by(Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 13 x 2  
## Jurisdiction sum\_Number  
## <fct> <int>  
## 1 AB 37002  
## 2 BC 55854  
## 3 MB 13669  
## 4 NP 2517  
## 5 NB 9817  
## 6 NL 3998  
## 7 NT 7218  
## 8 NS 8834  
## 9 ON 34271  
## 10 PE 544  
## 11 QC 20868  
## 12 SK 16679  
## 13 YT 3494

#######################################################  
#Below code works  
data %>% #Groups Cause, Year, Jurisdiction and sums Number  
 group\_by(Cause, Year, Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE)) %>%   
 filter(Jurisdiction == "BC") %>%  
 filter(Cause == "Lightning")

## # A tibble: 29 x 4  
## # Groups: Cause, Year [38]  
## Cause Year Jurisdiction sum\_Number  
## <fct> <int> <fct> <int>  
## 1 Lightning 1990 BC 2015  
## 2 Lightning 1991 BC 759  
## 3 Lightning 1992 BC 2344  
## 4 Lightning 1993 BC 609  
## 5 Lightning 1994 BC 2913  
## 6 Lightning 1995 BC 342  
## 7 Lightning 1996 BC 723  
## 8 Lightning 1997 BC 675  
## 9 Lightning 1998 BC 1773  
## 10 Lightning 1999 BC 585  
## # ... with 19 more rows

#Below code works  
data %>% #Groups Cause together and sums Number  
 group\_by(Cause, Year, Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE)) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning")

## # A tibble: 29 x 4  
## # Groups: Cause, Year [38]  
## Cause Year Jurisdiction sum\_Number  
## <fct> <int> <fct> <int>  
## 1 Lightning 1990 AB 914  
## 2 Lightning 1991 AB 466  
## 3 Lightning 1992 AB 626  
## 4 Lightning 1993 AB 517  
## 5 Lightning 1994 AB 499  
## 6 Lightning 1995 AB 357  
## 7 Lightning 1996 AB 217  
## 8 Lightning 1997 AB 242  
## 9 Lightning 1998 AB 1192  
## 10 Lightning 1999 AB 890  
## # ... with 19 more rows

#Below works great, show max number of fires and year for Alberta  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 top\_n(n=1) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning")

## Selecting by max\_Number

## # A tibble: 1 x 4  
## # Groups: Jurisdiction, Cause [130]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 1998 1192

#Below works great, Top 10 years for Lightning in Alberta  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 top\_n(n=10) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning") %>%   
 arrange(desc(max\_Number))

## Selecting by max\_Number

## # A tibble: 10 x 4  
## # Groups: Jurisdiction, Cause [1]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 1998 1192  
## 2 AB Lightning 1990 914  
## 3 AB Lightning 1999 890  
## 4 AB Lightning 2002 868  
## 5 AB Lightning 2008 779  
## 6 AB Lightning 2015 772  
## 7 AB Lightning 2006 746  
## 8 AB Lightning 2010 741  
## 9 AB Lightning 2004 732  
## 10 AB Lightning 1992 626

#Below works great, Top 10 years for Lightning in Alberta  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 top\_n(n=10) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning")

## Selecting by max\_Number

## # A tibble: 10 x 4  
## # Groups: Jurisdiction, Cause [130]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 1990 914  
## 2 AB Lightning 1992 626  
## 3 AB Lightning 1998 1192  
## 4 AB Lightning 1999 890  
## 5 AB Lightning 2002 868  
## 6 AB Lightning 2004 732  
## 7 AB Lightning 2006 746  
## 8 AB Lightning 2008 779  
## 9 AB Lightning 2010 741  
## 10 AB Lightning 2015 772

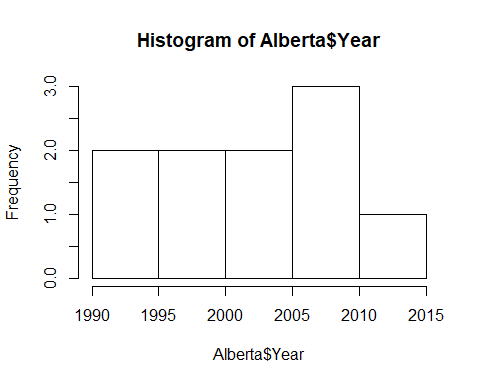
#Below works great, Top 10 years for Lightning in Alberta  
Alberta <- data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 top\_n(n=10) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning")

## Selecting by max\_Number

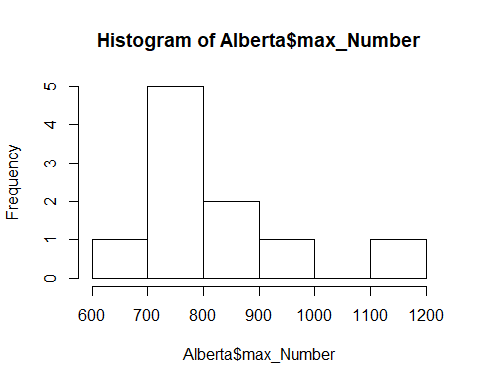
Alberta

## # A tibble: 10 x 4  
## # Groups: Jurisdiction, Cause [130]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 1990 914  
## 2 AB Lightning 1992 626  
## 3 AB Lightning 1998 1192  
## 4 AB Lightning 1999 890  
## 5 AB Lightning 2002 868  
## 6 AB Lightning 2004 732  
## 7 AB Lightning 2006 746  
## 8 AB Lightning 2008 779  
## 9 AB Lightning 2010 741  
## 10 AB Lightning 2015 772

hist(Alberta$Year)



hist(Alberta$max\_Number)



#Below works  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning") %>%   
 filter(Year > "2003")

## # A tibble: 15 x 4  
## # Groups: Jurisdiction, Cause [130]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 2004 732  
## 2 AB Lightning 2005 432  
## 3 AB Lightning 2006 746  
## 4 AB Lightning 2007 513  
## 5 AB Lightning 2008 779  
## 6 AB Lightning 2009 566  
## 7 AB Lightning 2010 741  
## 8 AB Lightning 2011 215  
## 9 AB Lightning 2012 436  
## 10 AB Lightning 2013 287  
## 11 AB Lightning 2014 563  
## 12 AB Lightning 2015 772  
## 13 AB Lightning 2016 514  
## 14 AB Lightning 2017 416  
## 15 AB Lightning 2018 511

#Below works, Top 10 after 2003  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning") %>%   
 filter(Year > "2003") %>%   
 arrange(desc(max\_Number))

## # A tibble: 15 x 4  
## # Groups: Jurisdiction, Cause [1]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 2008 779  
## 2 AB Lightning 2015 772  
## 3 AB Lightning 2006 746  
## 4 AB Lightning 2010 741  
## 5 AB Lightning 2004 732  
## 6 AB Lightning 2009 566  
## 7 AB Lightning 2014 563  
## 8 AB Lightning 2016 514  
## 9 AB Lightning 2007 513  
## 10 AB Lightning 2018 511  
## 11 AB Lightning 2012 436  
## 12 AB Lightning 2005 432  
## 13 AB Lightning 2017 416  
## 14 AB Lightning 2013 287  
## 15 AB Lightning 2011 215

data %>%   
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 3,219 x 4  
## # Groups: Jurisdiction, Cause [129]  
## Jurisdiction Cause Year sum\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Forest industry 1990 22  
## 2 AB Forest industry 1991 14  
## 3 AB Forest industry 1992 12  
## 4 AB Forest industry 1993 11  
## 5 AB Forest industry 1994 13  
## 6 AB Forest industry 1995 14  
## 7 AB Forest industry 1996 8  
## 8 AB Forest industry 1997 29  
## 9 AB Forest industry 1998 10  
## 10 AB Forest industry 1999 20  
## # ... with 3,209 more rows

#Below works, Top 10 after 2003  
data %>% #Groups Cause together and sums Number  
 group\_by(Jurisdiction, Cause, Year) %>%   
 summarize(max\_Number = max(Number, na.rm = TRUE)) %>%   
 filter(Jurisdiction == "AB") %>%  
 filter(Cause == "Lightning") %>%   
 filter(Year > "2003") %>%   
 arrange(desc(max\_Number))

## # A tibble: 15 x 4  
## # Groups: Jurisdiction, Cause [1]  
## Jurisdiction Cause Year max\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Lightning 2008 779  
## 2 AB Lightning 2015 772  
## 3 AB Lightning 2006 746  
## 4 AB Lightning 2010 741  
## 5 AB Lightning 2004 732  
## 6 AB Lightning 2009 566  
## 7 AB Lightning 2014 563  
## 8 AB Lightning 2016 514  
## 9 AB Lightning 2007 513  
## 10 AB Lightning 2018 511  
## 11 AB Lightning 2012 436  
## 12 AB Lightning 2005 432  
## 13 AB Lightning 2017 416  
## 14 AB Lightning 2013 287  
## 15 AB Lightning 2011 215

data %>% #Groups Cause together and sums Number. Also provides avg for Number of fires.  
 group\_by(Cause) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE),  
 count = n(),  
 average\_fire = mean(Number, na.rm = TRUE))

## # A tibble: 10 x 4  
## Cause sum\_Number count average\_fire  
## <fct> <int> <int> <dbl>  
## 1 Forest industry 4835 1262 3.83  
## 2 Incendiary 15744 1271 12.4   
## 3 Lightning 100995 1325 76.2   
## 4 Miscellaneous known causes 12558 1279 9.82  
## 5 Other industry 10313 1261 8.18  
## 6 Railways 3568 1265 2.82  
## 7 Recreation 27793 1274 21.8   
## 8 Residents 29798 1268 23.5   
## 9 Unspecified 6157 1290 4.77  
## 10 Unspecified human activities 3004 24 125.

data %>% #Groups Cause together and sums Number. Also provides avg for Number of fires.  
 group\_by(Cause) %>%   
 summarize(  
 sum\_Number = sum(Number, na.rm = TRUE),  
 count = n(),  
 average\_fire = mean(Number, na.rm = TRUE),  
 total = sum(sum\_Number)  
 )

## # A tibble: 10 x 5  
## Cause sum\_Number count average\_fire total  
## <fct> <int> <int> <dbl> <int>  
## 1 Forest industry 4835 1262 3.83 4835  
## 2 Incendiary 15744 1271 12.4 15744  
## 3 Lightning 100995 1325 76.2 100995  
## 4 Miscellaneous known causes 12558 1279 9.82 12558  
## 5 Other industry 10313 1261 8.18 10313  
## 6 Railways 3568 1265 2.82 3568  
## 7 Recreation 27793 1274 21.8 27793  
## 8 Residents 29798 1268 23.5 29798  
## 9 Unspecified 6157 1290 4.77 6157  
## 10 Unspecified human activities 3004 24 125. 3004

data %>% #Groups Year and sums Number  
 group\_by(Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 29 x 2  
## Year sum\_Number  
## <int> <int>  
## 1 1990 10111  
## 2 1991 10327  
## 3 1992 9068  
## 4 1993 6043  
## 5 1994 9763  
## 6 1995 8486  
## 7 1996 6349  
## 8 1997 6148  
## 9 1998 10723  
## 10 1999 7633  
## # ... with 19 more rows

data %>% #Groups Jurisdiction and sums Number  
 group\_by(Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 13 x 2  
## Jurisdiction sum\_Number  
## <fct> <int>  
## 1 AB 37002  
## 2 BC 55854  
## 3 MB 13669  
## 4 NP 2517  
## 5 NB 9817  
## 6 NL 3998  
## 7 NT 7218  
## 8 NS 8834  
## 9 ON 34271  
## 10 PE 544  
## 11 QC 20868  
## 12 SK 16679  
## 13 YT 3494

data %>%   
 group\_by(Year) %>%  
 group\_by(Jurisdiction) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 13 x 2  
## Jurisdiction sum\_Number  
## <fct> <int>  
## 1 AB 37002  
## 2 BC 55854  
## 3 MB 13669  
## 4 NP 2517  
## 5 NB 9817  
## 6 NL 3998  
## 7 NT 7218  
## 8 NS 8834  
## 9 ON 34271  
## 10 PE 544  
## 11 QC 20868  
## 12 SK 16679  
## 13 YT 3494

data %>%   
 group\_by(Jurisdiction) %>%  
 group\_by(Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 29 x 2  
## Year sum\_Number  
## <int> <int>  
## 1 1990 10111  
## 2 1991 10327  
## 3 1992 9068  
## 4 1993 6043  
## 5 1994 9763  
## 6 1995 8486  
## 7 1996 6349  
## 8 1997 6148  
## 9 1998 10723  
## 10 1999 7633  
## # ... with 19 more rows

data %>%   
 group\_by(Jurisdiction) %>%  
 group\_by(Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 29 x 2  
## Year sum\_Number  
## <int> <int>  
## 1 1990 10111  
## 2 1991 10327  
## 3 1992 9068  
## 4 1993 6043  
## 5 1994 9763  
## 6 1995 8486  
## 7 1996 6349  
## 8 1997 6148  
## 9 1998 10723  
## 10 1999 7633  
## # ... with 19 more rows

data %>%   
 group\_by(Jurisdiction) %>%  
 group\_by(Year) %>%   
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 29 x 2  
## Year sum\_Number  
## <int> <int>  
## 1 1990 10111  
## 2 1991 10327  
## 3 1992 9068  
## 4 1993 6043  
## 5 1994 9763  
## 6 1995 8486  
## 7 1996 6349  
## 8 1997 6148  
## 9 1998 10723  
## 10 1999 7633  
## # ... with 19 more rows

data %>%   
 group\_by(Jurisdiction, Cause, Year) %>%  
 summarize(sum\_Number = sum(Number, na.rm = TRUE))

## # A tibble: 3,219 x 4  
## # Groups: Jurisdiction, Cause [129]  
## Jurisdiction Cause Year sum\_Number  
## <fct> <fct> <int> <int>  
## 1 AB Forest industry 1990 22  
## 2 AB Forest industry 1991 14  
## 3 AB Forest industry 1992 12  
## 4 AB Forest industry 1993 11  
## 5 AB Forest industry 1994 13  
## 6 AB Forest industry 1995 14  
## 7 AB Forest industry 1996 8  
## 8 AB Forest industry 1997 29  
## 9 AB Forest industry 1998 10  
## 10 AB Forest industry 1999 20  
## # ... with 3,209 more rows

data$Fire\_Cause\_Human = as.character(data$Cause)  
  
data$Fire\_Cause\_Human[ data$Fire\_Cause\_Human != "Lightning" & data$Fire\_Cause\_Human != "Unspecified" ] = "Human"  
# There are three types of fire causes, Lightning, Human and Unspecified.   
  
unique(data$Fire\_Cause\_Human)

## [1] "Human" "Lightning" "Unspecified"

#[1] "Human" "Lightning" "Unspecified"  
  
names(data)

## [1] "Cause" "Jurisdiction" "Number"   
## [4] "Protection.zone" "Response.category" "Year"   
## [7] "Juris\_Long" "Cause\_Grouped" "Time1"   
## [10] "Time2" "Region" "Fire\_Cause\_Human"

# [1] "Cause" "Jurisdiction" "Number" "Protection.zone" "Response.category" "Year" "Juris\_Long" "Cause\_Grouped" "Time1" "Time2"   
# [11] "Region" "Fire\_Cause\_Human"   
  
unique(data$Cause\_Grouped)

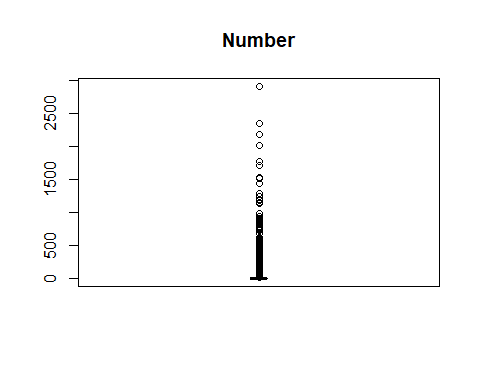
## [1] "People" "Lightning"

#[1] "People" "Lightning"  
  
unique(data$Year)

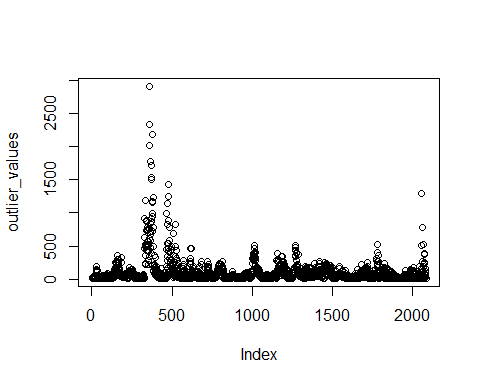
## [1] 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003  
## [15] 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017  
## [29] 2018

## Outlier detection

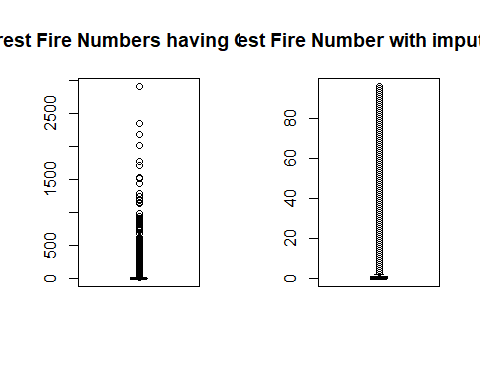
# Treating the outliers with mean/median imputation  
# We can handle outliers with mean or median imputation by replacing the observations lower than the 5th percentile with mean   
# and those higher than 95th percentile with median.   
# We can use the same statistics, mean or median, to impute outliers in both directions:  
  
# Outlier detection  
outlier\_values <- boxplot.stats(data$Number)$out  
boxplot(data$Number, main="Number", boxwex=0.1)



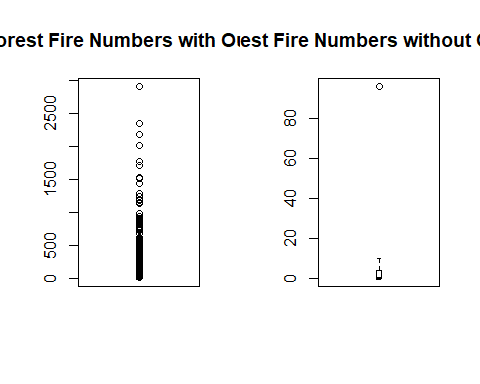
plot(outlier\_values)



impute\_outliers <- function(x,removeNA = TRUE){  
 quantiles <- quantile( x, c(.05, .95 ),na.rm = removeNA )  
 x[ x < quantiles[1] ] <- mean(x,na.rm = removeNA )  
 x[ x > quantiles[2] ] <- median(x,na.rm = removeNA )  
 x  
}  
  
imputed\_data <- impute\_outliers(data$Number)  
  
par(mfrow = c(1, 2))  
  
boxplot(data$Number, main="Forest Fire Numbers having Outliers", boxwex=0.3)  
  
boxplot(imputed\_data, main="Forest Fire Number with imputed data", boxwex=0.3)



########################################################################################################################################  
# Handling extreme values with capping  
# To handle extreme values that lie outside the 1.5 \* IQR(Inter Quartile Range) limits,   
# we could cap them by replacing those observations that lie below the lower limit,   
# with the value of 5th percentile and those that lie above the upper limit,   
# with the value of 95th percentile,   
  
replace\_outliers <- function(x, removeNA = TRUE) {  
 Number <- x  
 qnt <- quantile(Number, probs=c(.25, .75), na.rm = removeNA)  
 caps <- quantile(Number, probs=c(.05, .95), na.rm = removeNA)  
 H <- 1.5 \* IQR(Number, na.rm = removeNA)  
 Number[Number < (qnt[1] - H)] <- caps[1]  
 Number[Number > (qnt[2] + H)] <- caps[2]  
 Number  
 }  
  
capped\_Number <- replace\_outliers(data$Number)  
  
par(mfrow = c(1, 2))  
  
boxplot(data$Number, main="Forest Fire Numbers with Outliers", boxwex=0.1)  
  
boxplot(capped\_Number, main="Forest Fire Numbers without Outliers", boxwex=0.1)



## 17. Prepare packages for models

library(caret)  
library(lars)

## Loaded lars 1.2

library(elasticnet)

## 18.

## Split the data into training and test set

## Set the seed to make your partition reproducible

## We want to make sure that the training set and the test set do not have any common data points.

## R built in function “Sample”" randomly selects samples

set.seed(123)   
train\_index <- sample(1:nrow(data), 0.7 \* nrow(data))  
train.set <- data[train\_index,]  
test.set <- data[-train\_index,]

## 19.

## Set up model

## Set up K-fold cross-validation

## Defining the training controls for multiple models

train.control <- trainControl(method = "repeatedcv",   
 number = 10, repeats = 3)

## 20.

## Build the models with start time and end time for each model

#############################################################################################################################################  
# Model 1: lm model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
lm\_model <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "lm",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
lm\_model\_time.taken <- end.time - start.time  
#lm\_model\_time.taken  
  
#############################################################################################################################################  
# Model 2: glm model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
glm\_model <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "glm",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
glm\_model\_time.taken <- end.time - start.time  
#glm\_model\_time.taken  
  
#############################################################################################################################################  
# Model 3: lasso model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)  
lasso\_Mod <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "lasso",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
lasso\_Mod\_time.taken <- end.time - start.time  
#lasso\_Mod\_time.taken  
#############################################################################################################################################  
# Model 4: knn model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)  
knn\_model <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "knn",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
knn\_model\_time.taken <- end.time - start.time  
#knn\_model\_time.taken  
#############################################################################################################################################  
# Model 5: leapForward model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)  
LF\_model <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "leapForward",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
LF\_model\_time.taken <- end.time - start.time  
#LF\_model\_time.taken  
#############################################################################################################################################  
# Model 6: leapBackward model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)  
LB\_model <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "leapBackward",  
 trControl = train.control)  
  
# Stop the clock  
end.time <- Sys.time()  
  
LB\_model\_time.taken <- end.time - start.time  
#LB\_model\_time.taken  
#############################################################################################################################################  
# Model 7: lmStepAIC model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)  
lmStepAIC\_Mod <- train(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set, method = "lmStepAIC",  
 trControl = train.control)

## Start: AIC=62978.4  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 3 42426729 62976  
## <none> 42426726 62978  
## - Fire\_Cause\_HumanUnspecified 1 26565 42453292 62981  
## - Response.categoryUnspecified 1 32282 42459008 62982  
## - Juris\_LongOntario 1 53289 42480015 62986  
## - Juris\_LongSaskatchewan 1 104669 42531395 62994  
## - `Juris\_LongNew Brunswick` 1 130683 42557409 62999  
## - Juris\_LongQuebec 1 177804 42604531 63007  
## - Protection.zoneLimited 1 199823 42626549 63010  
## - `Juris\_LongNova Scotia` 1 206358 42633085 63012  
## - Juris\_LongManitoba 1 254113 42680839 63020  
## - `Juris\_LongNorthwest Territories` 1 294758 42721484 63027  
## - `Juris\_LongBritish Columbia` 1 296509 42723235 63027  
## - `Juris\_LongNewfoundland and Labrador` 1 368710 42795437 63039  
## - `Juris\_LongNational parks` 1 370204 42796931 63039  
## - Juris\_LongYukon 1 381109 42807836 63041  
## - `Juris\_LongPrince Edward Island` 1 420182 42846909 63048  
## - Protection.zoneUnspecified 1 518315 42945041 63065  
## - Response.categoryNone 1 2049899 44476625 63319  
## - Response.categoryModified 1 2089533 44516260 63325  
## - Fire\_Cause\_HumanLightning 1 2511487 44938214 63394  
##   
## Step: AIC=62976.4  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 42426729 62976  
## - Fire\_Cause\_HumanUnspecified 1 26566 42453295 62979  
## - Response.categoryUnspecified 1 33127 42459856 62980  
## - Juris\_LongOntario 1 53356 42480085 62984  
## - Juris\_LongSaskatchewan 1 104809 42531538 62992  
## - `Juris\_LongNew Brunswick` 1 130696 42557426 62997  
## - Juris\_LongQuebec 1 177827 42604556 63005  
## - Protection.zoneLimited 1 200857 42627586 63009  
## - `Juris\_LongNova Scotia` 1 206358 42633087 63010  
## - Juris\_LongManitoba 1 254649 42681379 63018  
## - `Juris\_LongNorthwest Territories` 1 295106 42721836 63025  
## - `Juris\_LongBritish Columbia` 1 297022 42723751 63025  
## - `Juris\_LongNewfoundland and Labrador` 1 368767 42795496 63037  
## - `Juris\_LongNational parks` 1 370446 42797175 63037  
## - Juris\_LongYukon 1 381917 42808646 63039  
## - `Juris\_LongPrince Edward Island` 1 421272 42848001 63046  
## - Protection.zoneUnspecified 1 526051 42952780 63064  
## - Response.categoryNone 1 2051560 44478290 63317  
## - Response.categoryModified 1 2089559 44516288 63323  
## - Fire\_Cause\_HumanLightning 1 2511515 44938244 63392  
## Start: AIC=63936.12  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2120 48311106 63934  
## <none> 48308986 63936  
## - Response.categoryUnspecified 1 23349 48332336 63938  
## - Fire\_Cause\_HumanUnspecified 1 29583 48338570 63939  
## - Juris\_LongOntario 1 97916 48406902 63949  
## - Juris\_LongSaskatchewan 1 158402 48467388 63958  
## - Protection.zoneLimited 1 178921 48487908 63961  
## - `Juris\_LongNew Brunswick` 1 187630 48496616 63962  
## - Juris\_LongQuebec 1 251199 48560186 63972  
## - `Juris\_LongNova Scotia` 1 302477 48611463 63979  
## - Juris\_LongManitoba 1 325964 48634950 63983  
## - `Juris\_LongNorthwest Territories` 1 364039 48673026 63989  
## - `Juris\_LongBritish Columbia` 1 426649 48735635 63998  
## - `Juris\_LongNational parks` 1 434342 48743329 63999  
## - Juris\_LongYukon 1 460541 48769528 64003  
## - `Juris\_LongNewfoundland and Labrador` 1 464138 48773125 64004  
## - Protection.zoneUnspecified 1 508705 48817692 64010  
## - `Juris\_LongPrince Edward Island` 1 522187 48831173 64012  
## - Response.categoryModified 1 2193225 50502211 64256  
## - Response.categoryNone 1 2238292 50547279 64263  
## - Fire\_Cause\_HumanLightning 1 2791719 51100705 64342  
##   
## Step: AIC=63934.44  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48311106 63934  
## - Response.categoryUnspecified 1 26166 48337272 63936  
## - Fire\_Cause\_HumanUnspecified 1 29601 48340706 63937  
## - Juris\_LongOntario 1 96683 48407789 63947  
## - Juris\_LongSaskatchewan 1 159533 48470639 63956  
## - Protection.zoneLimited 1 182895 48494001 63960  
## - `Juris\_LongNew Brunswick` 1 187878 48498984 63961  
## - Juris\_LongQuebec 1 250479 48561584 63970  
## - `Juris\_LongNova Scotia` 1 302535 48613641 63978  
## - Juris\_LongManitoba 1 328430 48639535 63982  
## - `Juris\_LongNorthwest Territories` 1 365809 48676915 63987  
## - `Juris\_LongBritish Columbia` 1 429830 48740936 63997  
## - `Juris\_LongNational parks` 1 435988 48747094 63998  
## - `Juris\_LongNewfoundland and Labrador` 1 463364 48774470 64002  
## - Juris\_LongYukon 1 463987 48775093 64002  
## - Protection.zoneUnspecified 1 508202 48819308 64008  
## - `Juris\_LongPrince Edward Island` 1 520166 48831272 64010  
## - Response.categoryModified 1 2193115 50504221 64255  
## - Response.categoryNone 1 2236173 50547279 64261  
## - Fire\_Cause\_HumanLightning 1 2791799 51102905 64340  
## Start: AIC=63920.69  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 156 48258363 63919  
## <none> 48258207 63921  
## - Fire\_Cause\_HumanUnspecified 1 32732 48290939 63924  
## - Response.categoryUnspecified 1 50223 48308430 63926  
## - Juris\_LongOntario 1 53121 48311328 63927  
## - Juris\_LongSaskatchewan 1 117502 48375708 63936  
## - `Juris\_LongNew Brunswick` 1 152760 48410967 63942  
## - Juris\_LongQuebec 1 199558 48457765 63949  
## - Protection.zoneLimited 1 206943 48465150 63950  
## - `Juris\_LongNova Scotia` 1 247692 48505898 63956  
## - Juris\_LongManitoba 1 257665 48515872 63957  
## - `Juris\_LongNorthwest Territories` 1 311283 48569490 63965  
## - `Juris\_LongNewfoundland and Labrador` 1 359232 48617439 63973  
## - `Juris\_LongNational parks` 1 376164 48634370 63975  
## - Juris\_LongYukon 1 393286 48651493 63978  
## - `Juris\_LongBritish Columbia` 1 443705 48701912 63985  
## - `Juris\_LongPrince Edward Island` 1 470828 48729034 63989  
## - Protection.zoneUnspecified 1 517475 48775682 63996  
## - Response.categoryNone 1 2135156 50393363 64233  
## - Response.categoryModified 1 2176781 50434987 64239  
## - Fire\_Cause\_HumanLightning 1 3002823 51261029 64357  
##   
## Step: AIC=63918.71  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48258363 63919  
## - Fire\_Cause\_HumanUnspecified 1 32755 48291117 63922  
## - Response.categoryUnspecified 1 52261 48310623 63925  
## - Juris\_LongOntario 1 52966 48311329 63925  
## - Juris\_LongSaskatchewan 1 117842 48376204 63934  
## - `Juris\_LongNew Brunswick` 1 152810 48411173 63940  
## - Juris\_LongQuebec 1 199413 48457775 63947  
## - Protection.zoneLimited 1 208782 48467145 63948  
## - `Juris\_LongNova Scotia` 1 247804 48506167 63954  
## - Juris\_LongManitoba 1 258484 48516846 63955  
## - `Juris\_LongNorthwest Territories` 1 311793 48570156 63963  
## - `Juris\_LongNewfoundland and Labrador` 1 359089 48617451 63971  
## - `Juris\_LongNational parks` 1 376739 48635101 63973  
## - Juris\_LongYukon 1 394517 48652879 63976  
## - `Juris\_LongBritish Columbia` 1 444998 48703360 63983  
## - `Juris\_LongPrince Edward Island` 1 471257 48729620 63987  
## - Protection.zoneUnspecified 1 522564 48780927 63995  
## - Response.categoryNone 1 2135560 50393922 64231  
## - Response.categoryModified 1 2177115 50435477 64237  
## - Fire\_Cause\_HumanLightning 1 3002858 51261221 64355  
## Start: AIC=63959.87  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 14 48571741 63958  
## <none> 48571726 63960  
## - Fire\_Cause\_HumanUnspecified 1 34496 48606222 63963  
## - Response.categoryUnspecified 1 49628 48621354 63965  
## - Juris\_LongOntario 1 61531 48633257 63967  
## - Juris\_LongSaskatchewan 1 133312 48705038 63978  
## - `Juris\_LongNew Brunswick` 1 158066 48729792 63981  
## - Protection.zoneLimited 1 200929 48772655 63988  
## - Juris\_LongQuebec 1 206381 48778107 63989  
## - `Juris\_LongNova Scotia` 1 251770 48823496 63995  
## - Juris\_LongManitoba 1 284878 48856604 64000  
## - `Juris\_LongNorthwest Territories` 1 319977 48891703 64006  
## - `Juris\_LongNewfoundland and Labrador` 1 401121 48972847 64018  
## - `Juris\_LongNational parks` 1 407056 48978783 64018  
## - Juris\_LongYukon 1 415097 48986823 64020  
## - `Juris\_LongBritish Columbia` 1 441581 49013307 64024  
## - `Juris\_LongPrince Edward Island` 1 472237 49043963 64028  
## - Protection.zoneUnspecified 1 491068 49062794 64031  
## - Response.categoryNone 1 2140272 50711998 64271  
## - Response.categoryModified 1 2215408 50787134 64282  
## - Fire\_Cause\_HumanLightning 1 2859427 51431153 64373  
##   
## Step: AIC=63957.88  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48571741 63958  
## - Fire\_Cause\_HumanUnspecified 1 34487 48606228 63961  
## - Response.categoryUnspecified 1 50534 48622275 63963  
## - Juris\_LongOntario 1 61738 48633479 63965  
## - Juris\_LongSaskatchewan 1 133327 48705068 63976  
## - `Juris\_LongNew Brunswick` 1 158057 48729798 63979  
## - Protection.zoneLimited 1 201489 48773229 63986  
## - Juris\_LongQuebec 1 206496 48778237 63987  
## - `Juris\_LongNova Scotia` 1 251760 48823500 63993  
## - Juris\_LongManitoba 1 285277 48857017 63998  
## - `Juris\_LongNorthwest Territories` 1 320101 48891841 64004  
## - `Juris\_LongNewfoundland and Labrador` 1 401264 48973004 64016  
## - `Juris\_LongNational parks` 1 407192 48978933 64016  
## - Juris\_LongYukon 1 415822 48987562 64018  
## - `Juris\_LongBritish Columbia` 1 442124 49013865 64022  
## - `Juris\_LongPrince Edward Island` 1 473989 49045730 64026  
## - Protection.zoneUnspecified 1 499078 49070818 64030  
## - Response.categoryNone 1 2142823 50714564 64269  
## - Response.categoryModified 1 2215469 50787210 64280  
## - Fire\_Cause\_HumanLightning 1 2859529 51431270 64371  
## Start: AIC=63741.12  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 81 47129343 63739  
## <none> 47129262 63741  
## - Fire\_Cause\_HumanUnspecified 1 30076 47159338 63744  
## - Response.categoryUnspecified 1 45925 47175187 63746  
## - Juris\_LongOntario 1 51792 47181054 63747  
## - Juris\_LongSaskatchewan 1 111076 47240338 63756  
## - `Juris\_LongNew Brunswick` 1 138112 47267374 63760  
## - Protection.zoneLimited 1 184658 47313920 63767  
## - Juris\_LongQuebec 1 187001 47316263 63768  
## - `Juris\_LongNova Scotia` 1 210398 47339660 63771  
## - Juris\_LongManitoba 1 250459 47379721 63778  
## - `Juris\_LongNorthwest Territories` 1 283020 47412282 63783  
## - Protection.zoneUnspecified 1 337928 47467189 63791  
## - `Juris\_LongNational parks` 1 354097 47483359 63793  
## - `Juris\_LongNewfoundland and Labrador` 1 359086 47488348 63794  
## - Juris\_LongYukon 1 369130 47498392 63796  
## - `Juris\_LongPrince Edward Island` 1 443103 47572365 63807  
## - `Juris\_LongBritish Columbia` 1 453647 47582909 63809  
## - Response.categoryNone 1 2111817 49241079 64057  
## - Response.categoryModified 1 2144714 49273976 64062  
## - Fire\_Cause\_HumanLightning 1 2741699 49870961 64149  
##   
## Step: AIC=63739.14  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 47129343 63739  
## - Fire\_Cause\_HumanUnspecified 1 30078 47159421 63742  
## - Response.categoryUnspecified 1 47606 47176949 63744  
## - Juris\_LongOntario 1 51712 47181055 63745  
## - Juris\_LongSaskatchewan 1 111315 47240658 63754  
## - `Juris\_LongNew Brunswick` 1 138104 47267447 63758  
## - Protection.zoneLimited 1 185933 47315276 63766  
## - Juris\_LongQuebec 1 186920 47316264 63766  
## - `Juris\_LongNova Scotia` 1 210413 47339756 63769  
## - Juris\_LongManitoba 1 251182 47380525 63776  
## - `Juris\_LongNorthwest Territories` 1 283574 47412917 63781  
## - Protection.zoneUnspecified 1 341163 47470506 63789  
## - `Juris\_LongNational parks` 1 354375 47483718 63791  
## - `Juris\_LongNewfoundland and Labrador` 1 359005 47488348 63792  
## - Juris\_LongYukon 1 370485 47499828 63794  
## - `Juris\_LongPrince Edward Island` 1 443834 47573177 63805  
## - `Juris\_LongBritish Columbia` 1 454908 47584251 63807  
## - Response.categoryNone 1 2113285 49242628 64055  
## - Response.categoryModified 1 2144882 49274225 64060  
## - Fire\_Cause\_HumanLightning 1 2741789 49871132 64147  
## Start: AIC=64155.25  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2233 49899608 64154  
## <none> 49897375 64155  
## - Fire\_Cause\_HumanUnspecified 1 25416 49922791 64157  
## - Juris\_LongOntario 1 28916 49926291 64157  
## - Response.categoryUnspecified 1 42325 49939700 64159  
## - Juris\_LongSaskatchewan 1 94874 49992249 64167  
## - `Juris\_LongNew Brunswick` 1 134044 50031420 64173  
## - Juris\_LongQuebec 1 153030 50050405 64175  
## - `Juris\_LongNova Scotia` 1 207186 50104561 64183  
## - Protection.zoneLimited 1 209355 50106730 64184  
## - Juris\_LongManitoba 1 214693 50112068 64184  
## - `Juris\_LongNorthwest Territories` 1 267196 50164572 64192  
## - `Juris\_LongNewfoundland and Labrador` 1 296241 50193616 64196  
## - Juris\_LongYukon 1 308109 50205484 64198  
## - `Juris\_LongNational parks` 1 323520 50220895 64200  
## - Protection.zoneUnspecified 1 349359 50246734 64204  
## - `Juris\_LongPrince Edward Island` 1 428754 50326129 64215  
## - `Juris\_LongBritish Columbia` 1 525766 50423141 64229  
## - Response.categoryNone 1 2217758 52115133 64469  
## - Response.categoryModified 1 2249395 52146770 64473  
## - Fire\_Cause\_HumanLightning 1 3139912 53037287 64596  
##   
## Step: AIC=64153.58  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49899608 64154  
## - Fire\_Cause\_HumanUnspecified 1 25469 49925077 64155  
## - Juris\_LongOntario 1 28218 49927825 64156  
## - Response.categoryUnspecified 1 46557 49946164 64158  
## - Juris\_LongSaskatchewan 1 95858 49995466 64166  
## - `Juris\_LongNew Brunswick` 1 134086 50033694 64171  
## - Juris\_LongQuebec 1 152414 50052022 64174  
## - `Juris\_LongNova Scotia` 1 207226 50106834 64182  
## - Protection.zoneLimited 1 213113 50112721 64183  
## - Juris\_LongManitoba 1 216904 50116512 64183  
## - `Juris\_LongNorthwest Territories` 1 268783 50168390 64191  
## - `Juris\_LongNewfoundland and Labrador` 1 295574 50195181 64194  
## - Juris\_LongYukon 1 311072 50210679 64197  
## - `Juris\_LongNational parks` 1 325175 50224782 64199  
## - Protection.zoneUnspecified 1 347758 50247365 64202  
## - `Juris\_LongPrince Edward Island` 1 426724 50326332 64213  
## - `Juris\_LongBritish Columbia` 1 529425 50429033 64228  
## - Response.categoryNone 1 2215554 52115162 64467  
## - Response.categoryModified 1 2250839 52150447 64472  
## - Fire\_Cause\_HumanLightning 1 3140034 53039642 64594  
## Start: AIC=62962.47  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 33 42333721 62960  
## <none> 42333688 62962  
## - Fire\_Cause\_HumanUnspecified 1 31678 42365367 62966  
## - Response.categoryUnspecified 1 31949 42365637 62966  
## - Juris\_LongOntario 1 66558 42400247 62972  
## - Juris\_LongSaskatchewan 1 145178 42478866 62985  
## - `Juris\_LongNew Brunswick` 1 170996 42504684 62990  
## - Protection.zoneLimited 1 203799 42537487 62995  
## - Juris\_LongQuebec 1 213614 42547303 62997  
## - `Juris\_LongBritish Columbia` 1 238676 42572364 63001  
## - `Juris\_LongNova Scotia` 1 276331 42610019 63008  
## - Juris\_LongManitoba 1 296075 42629763 63011  
## - `Juris\_LongNorthwest Territories` 1 321613 42655302 63015  
## - `Juris\_LongNewfoundland and Labrador` 1 412601 42746289 63031  
## - `Juris\_LongNational parks` 1 421604 42755293 63032  
## - Juris\_LongYukon 1 427109 42760797 63033  
## - `Juris\_LongPrince Edward Island` 1 497133 42830822 63045  
## - Protection.zoneUnspecified 1 508999 42842688 63047  
## - Response.categoryNone 1 2152567 44486255 63320  
## - Response.categoryModified 1 2203850 44537538 63329  
## - Fire\_Cause\_HumanLightning 1 2702119 45035807 63409  
##   
## Step: AIC=62960.48  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 42333721 62960  
## - Fire\_Cause\_HumanUnspecified 1 31697 42365418 62964  
## - Response.categoryUnspecified 1 33043 42366764 62964  
## - Juris\_LongOntario 1 66583 42400305 62970  
## - Juris\_LongSaskatchewan 1 145454 42479175 62983  
## - `Juris\_LongNew Brunswick` 1 171017 42504738 62988  
## - Protection.zoneLimited 1 204984 42538705 62994  
## - Juris\_LongQuebec 1 213591 42547312 62995  
## - `Juris\_LongBritish Columbia` 1 239408 42573129 62999  
## - `Juris\_LongNova Scotia` 1 276359 42610080 63006  
## - Juris\_LongManitoba 1 296720 42630442 63009  
## - `Juris\_LongNorthwest Territories` 1 322018 42655740 63013  
## - `Juris\_LongNewfoundland and Labrador` 1 412576 42746297 63029  
## - `Juris\_LongNational parks` 1 421926 42755648 63030  
## - Juris\_LongYukon 1 428345 42762067 63032  
## - `Juris\_LongPrince Edward Island` 1 498180 42831901 63043  
## - Protection.zoneUnspecified 1 515347 42849068 63046  
## - Response.categoryNone 1 2154883 44488604 63319  
## - Response.categoryModified 1 2203824 44537545 63327  
## - Fire\_Cause\_HumanLightning 1 2702135 45035857 63407  
## Start: AIC=63914.81  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 6933 48174283 63914  
## <none> 48167350 63915  
## - Fire\_Cause\_HumanUnspecified 1 33820 48201170 63918  
## - Response.categoryUnspecified 1 37819 48205169 63919  
## - Juris\_LongOntario 1 88751 48256101 63926  
## - Juris\_LongSaskatchewan 1 159056 48326406 63937  
## - `Juris\_LongNew Brunswick` 1 182598 48349948 63940  
## - Protection.zoneLimited 1 191446 48358796 63942  
## - Juris\_LongQuebec 1 243418 48410768 63949  
## - `Juris\_LongBritish Columbia` 1 273630 48440980 63954  
## - `Juris\_LongNova Scotia` 1 287609 48454959 63956  
## - Juris\_LongManitoba 1 327387 48494737 63962  
## - `Juris\_LongNorthwest Territories` 1 362703 48530053 63967  
## - Protection.zoneUnspecified 1 415066 48582416 63975  
## - `Juris\_LongNational parks` 1 451326 48618676 63981  
## - Juris\_LongYukon 1 463789 48631139 63982  
## - `Juris\_LongNewfoundland and Labrador` 1 466252 48633602 63983  
## - `Juris\_LongPrince Edward Island` 1 540773 48708123 63994  
## - Response.categoryNone 1 2150729 50318079 64230  
## - Response.categoryModified 1 2185989 50353339 64235  
## - Fire\_Cause\_HumanLightning 1 2859982 51027332 64331  
##   
## Step: AIC=63913.86  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48174283 63914  
## - Fire\_Cause\_HumanUnspecified 1 33984 48208267 63917  
## - Response.categoryUnspecified 1 44097 48218380 63918  
## - Juris\_LongOntario 1 86362 48260645 63925  
## - Juris\_LongSaskatchewan 1 160668 48334951 63936  
## - `Juris\_LongNew Brunswick` 1 182495 48356778 63939  
## - Protection.zoneLimited 1 196594 48370877 63941  
## - Juris\_LongQuebec 1 241948 48416231 63948  
## - `Juris\_LongBritish Columbia` 1 278244 48452527 63954  
## - `Juris\_LongNova Scotia` 1 287573 48461856 63955  
## - Juris\_LongManitoba 1 331273 48505556 63962  
## - `Juris\_LongNorthwest Territories` 1 365210 48539493 63967  
## - Protection.zoneUnspecified 1 408165 48582448 63973  
## - `Juris\_LongNational parks` 1 453962 48628245 63980  
## - `Juris\_LongNewfoundland and Labrador` 1 464554 48638836 63982  
## - Juris\_LongYukon 1 468606 48642889 63982  
## - `Juris\_LongPrince Edward Island` 1 536192 48710475 63992  
## - Response.categoryNone 1 2144993 50319276 64228  
## - Response.categoryModified 1 2187199 50361482 64234  
## - Fire\_Cause\_HumanLightning 1 2860426 51034708 64331  
## Start: AIC=63636.06  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1400 46403513 63634  
## <none> 46402113 63636  
## - Response.categoryUnspecified 1 27178 46429291 63638  
## - Fire\_Cause\_HumanUnspecified 1 29600 46431714 63639  
## - Juris\_LongOntario 1 49328 46451441 63642  
## - Juris\_LongSaskatchewan 1 116322 46518435 63652  
## - `Juris\_LongNew Brunswick` 1 140813 46542927 63656  
## - Juris\_LongQuebec 1 201065 46603178 63665  
## - Protection.zoneLimited 1 205095 46607208 63666  
## - `Juris\_LongNova Scotia` 1 233567 46635680 63670  
## - Juris\_LongManitoba 1 244936 46647050 63672  
## - Protection.zoneUnspecified 1 250322 46652435 63673  
## - `Juris\_LongNorthwest Territories` 1 321437 46723551 63684  
## - `Juris\_LongNewfoundland and Labrador` 1 360758 46762872 63690  
## - `Juris\_LongNational parks` 1 362186 46764300 63690  
## - Juris\_LongYukon 1 368129 46770242 63691  
## - `Juris\_LongBritish Columbia` 1 373076 46775190 63692  
## - `Juris\_LongPrince Edward Island` 1 434063 46836176 63702  
## - Response.categoryModified 1 2133814 48535927 63960  
## - Response.categoryNone 1 2140224 48542338 63961  
## - Fire\_Cause\_HumanLightning 1 2711808 49113921 64046  
##   
## Step: AIC=63634.28  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 46403513 63634  
## - Fire\_Cause\_HumanUnspecified 1 29649 46433162 63637  
## - Response.categoryUnspecified 1 29858 46433371 63637  
## - Juris\_LongOntario 1 48584 46452097 63640  
## - Juris\_LongSaskatchewan 1 117091 46520604 63651  
## - `Juris\_LongNew Brunswick` 1 140560 46544073 63654  
## - Juris\_LongQuebec 1 200434 46603947 63664  
## - Protection.zoneLimited 1 208333 46611846 63665  
## - `Juris\_LongNova Scotia` 1 233533 46637046 63669  
## - Juris\_LongManitoba 1 246614 46650127 63671  
## - Protection.zoneUnspecified 1 249303 46652816 63671  
## - `Juris\_LongNorthwest Territories` 1 322625 46726138 63683  
## - `Juris\_LongNewfoundland and Labrador` 1 359949 46763462 63688  
## - `Juris\_LongNational parks` 1 363562 46767075 63689  
## - Juris\_LongYukon 1 370626 46774140 63690  
## - `Juris\_LongBritish Columbia` 1 375308 46778822 63691  
## - `Juris\_LongPrince Edward Island` 1 432663 46836176 63700  
## - Response.categoryModified 1 2134257 48537770 63959  
## - Response.categoryNone 1 2139086 48542599 63959  
## - Fire\_Cause\_HumanLightning 1 2711422 49114935 64044  
## Start: AIC=64131.68  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2526 49684398 64130  
## <none> 49681872 64132  
## - Fire\_Cause\_HumanUnspecified 1 29651 49711524 64134  
## - Response.categoryUnspecified 1 43502 49725374 64136  
## - Juris\_LongOntario 1 64296 49746169 64139  
## - Juris\_LongSaskatchewan 1 135357 49817229 64149  
## - `Juris\_LongNew Brunswick` 1 148675 49830547 64151  
## - Protection.zoneLimited 1 191071 49872943 64158  
## - Juris\_LongQuebec 1 225351 49907224 64163  
## - `Juris\_LongNova Scotia` 1 257970 49939842 64167  
## - Juris\_LongManitoba 1 289384 49971256 64172  
## - `Juris\_LongNorthwest Territories` 1 333883 50015755 64178  
## - `Juris\_LongBritish Columbia` 1 395285 50077157 64187  
## - `Juris\_LongNewfoundland and Labrador` 1 398524 50080396 64188  
## - Juris\_LongYukon 1 411393 50093265 64190  
## - `Juris\_LongNational parks` 1 416990 50098862 64190  
## - Protection.zoneUnspecified 1 444333 50126206 64194  
## - `Juris\_LongPrince Edward Island` 1 468469 50150342 64198  
## - Response.categoryModified 1 2213548 51895421 64446  
## - Response.categoryNone 1 2228751 51910623 64448  
## - Fire\_Cause\_HumanLightning 1 3007041 52688913 64556  
##   
## Step: AIC=64130.05  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49684398 64130  
## - Fire\_Cause\_HumanUnspecified 1 29853 49714251 64132  
## - Response.categoryUnspecified 1 47912 49732310 64135  
## - Juris\_LongOntario 1 63170 49747568 64137  
## - Juris\_LongSaskatchewan 1 136587 49820985 64148  
## - `Juris\_LongNew Brunswick` 1 148445 49832843 64150  
## - Protection.zoneLimited 1 194704 49879102 64156  
## - Juris\_LongQuebec 1 224515 49908913 64161  
## - `Juris\_LongNova Scotia` 1 258229 49942627 64166  
## - Juris\_LongManitoba 1 291463 49975860 64170  
## - `Juris\_LongNorthwest Territories` 1 334942 50019339 64177  
## - `Juris\_LongNewfoundland and Labrador` 1 397785 50082183 64186  
## - `Juris\_LongBritish Columbia` 1 398355 50082753 64186  
## - Juris\_LongYukon 1 414472 50098870 64188  
## - `Juris\_LongNational parks` 1 418453 50102851 64189  
## - Protection.zoneUnspecified 1 442492 50126889 64192  
## - `Juris\_LongPrince Edward Island` 1 466205 50150603 64196  
## - Response.categoryModified 1 2213291 51897689 64444  
## - Response.categoryNone 1 2226236 51910633 64446  
## - Fire\_Cause\_HumanLightning 1 3007360 52691757 64555  
## Start: AIC=64288.35  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 827 50766953 64286  
## <none> 50766126 64288  
## - Fire\_Cause\_HumanUnspecified 1 27092 50793218 64290  
## - Response.categoryUnspecified 1 45406 50811532 64293  
## - Juris\_LongOntario 1 76478 50842604 64297  
## - Juris\_LongSaskatchewan 1 148615 50914741 64308  
## - `Juris\_LongNew Brunswick` 1 202920 50969046 64315  
## - Protection.zoneLimited 1 207790 50973916 64316  
## - Juris\_LongQuebec 1 247931 51014057 64322  
## - `Juris\_LongNova Scotia` 1 276198 51042324 64326  
## - Juris\_LongManitoba 1 321980 51088106 64332  
## - Protection.zoneUnspecified 1 347513 51113639 64336  
## - `Juris\_LongNorthwest Territories` 1 355982 51122108 64337  
## - `Juris\_LongBritish Columbia` 1 409671 51175797 64345  
## - `Juris\_LongNational parks` 1 411443 51177569 64345  
## - `Juris\_LongNewfoundland and Labrador` 1 443356 51209482 64349  
## - Juris\_LongYukon 1 446427 51212553 64350  
## - `Juris\_LongPrince Edward Island` 1 503035 51269161 64358  
## - Response.categoryNone 1 2265501 53031627 64603  
## - Response.categoryModified 1 2328028 53094153 64612  
## - Fire\_Cause\_HumanLightning 1 3131778 53897904 64721  
##   
## Step: AIC=64286.47  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 50766953 64286  
## - Fire\_Cause\_HumanUnspecified 1 27107 50794060 64288  
## - Response.categoryUnspecified 1 48416 50815369 64291  
## - Juris\_LongOntario 1 75882 50842835 64295  
## - Juris\_LongSaskatchewan 1 149543 50916496 64306  
## - `Juris\_LongNew Brunswick` 1 202976 50969928 64313  
## - Protection.zoneLimited 1 210570 50977522 64315  
## - Juris\_LongQuebec 1 247497 51014449 64320  
## - `Juris\_LongNova Scotia` 1 276275 51043227 64324  
## - Juris\_LongManitoba 1 323799 51090751 64331  
## - Protection.zoneUnspecified 1 348185 51115138 64334  
## - `Juris\_LongNorthwest Territories` 1 357069 51124021 64335  
## - `Juris\_LongBritish Columbia` 1 411867 51178819 64343  
## - `Juris\_LongNational parks` 1 412501 51179454 64343  
## - `Juris\_LongNewfoundland and Labrador` 1 442945 51209897 64348  
## - Juris\_LongYukon 1 448856 51215809 64348  
## - `Juris\_LongPrince Edward Island` 1 502290 51269242 64356  
## - Response.categoryNone 1 2265313 53032265 64601  
## - Response.categoryModified 1 2327670 53094623 64610  
## - Fire\_Cause\_HumanLightning 1 3132874 53899826 64719  
## Start: AIC=64052.18  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2086 49142671 64050  
## <none> 49140586 64052  
## - Fire\_Cause\_HumanUnspecified 1 30907 49171493 64055  
## - Response.categoryUnspecified 1 38465 49179051 64056  
## - Juris\_LongOntario 1 45114 49185700 64057  
## - Juris\_LongSaskatchewan 1 109779 49250364 64066  
## - `Juris\_LongNew Brunswick` 1 139642 49280228 64071  
## - Juris\_LongQuebec 1 192443 49333029 64079  
## - Protection.zoneLimited 1 198194 49338780 64079  
## - `Juris\_LongNova Scotia` 1 218128 49358714 64082  
## - Juris\_LongManitoba 1 241271 49381857 64086  
## - `Juris\_LongNorthwest Territories` 1 296867 49437452 64094  
## - `Juris\_LongNewfoundland and Labrador` 1 355833 49496419 64103  
## - `Juris\_LongNational parks` 1 371198 49511783 64105  
## - Juris\_LongYukon 1 372714 49513300 64105  
## - `Juris\_LongBritish Columbia` 1 431346 49571932 64114  
## - Protection.zoneUnspecified 1 432376 49572962 64114  
## - `Juris\_LongPrince Edward Island` 1 450914 49591500 64116  
## - Response.categoryNone 1 2228830 51369415 64372  
## - Response.categoryModified 1 2263288 51403873 64377  
## - Fire\_Cause\_HumanLightning 1 2977043 52117629 64477  
##   
## Step: AIC=64050.49  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49142671 64050  
## - Fire\_Cause\_HumanUnspecified 1 31054 49173725 64053  
## - Response.categoryUnspecified 1 42293 49184965 64055  
## - Juris\_LongOntario 1 44312 49186983 64055  
## - Juris\_LongSaskatchewan 1 110737 49253408 64065  
## - `Juris\_LongNew Brunswick` 1 139695 49282366 64069  
## - Juris\_LongQuebec 1 191852 49334523 64077  
## - Protection.zoneLimited 1 201379 49344051 64078  
## - `Juris\_LongNova Scotia` 1 218256 49360927 64081  
## - Juris\_LongManitoba 1 243536 49386208 64084  
## - `Juris\_LongNorthwest Territories` 1 298721 49441392 64092  
## - `Juris\_LongNewfoundland and Labrador` 1 355247 49497919 64101  
## - `Juris\_LongNational parks` 1 373017 49515688 64103  
## - Juris\_LongYukon 1 376396 49519068 64104  
## - Protection.zoneUnspecified 1 431355 49574026 64112  
## - `Juris\_LongBritish Columbia` 1 434209 49576880 64112  
## - `Juris\_LongPrince Edward Island` 1 448964 49591636 64114  
## - Response.categoryNone 1 2226806 51369477 64370  
## - Response.categoryModified 1 2263776 51406448 64375  
## - Fire\_Cause\_HumanLightning 1 2977842 52120513 64475  
## Start: AIC=64033.05  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 233 49011441 64031  
## <none> 49011209 64033  
## - Fire\_Cause\_HumanUnspecified 1 36073 49047281 64036  
## - Juris\_LongOntario 1 48026 49059234 64038  
## - Response.categoryUnspecified 1 49349 49060558 64038  
## - Juris\_LongSaskatchewan 1 112002 49123211 64048  
## - `Juris\_LongNew Brunswick` 1 152401 49163610 64054  
## - Juris\_LongQuebec 1 182450 49193659 64058  
## - Protection.zoneLimited 1 193935 49205144 64060  
## - `Juris\_LongNova Scotia` 1 238237 49249445 64066  
## - Juris\_LongManitoba 1 261154 49272363 64070  
## - `Juris\_LongNorthwest Territories` 1 297154 49308363 64075  
## - Juris\_LongYukon 1 366662 49377871 64085  
## - `Juris\_LongNewfoundland and Labrador` 1 371352 49382561 64086  
## - `Juris\_LongNational parks` 1 377046 49388255 64087  
## - `Juris\_LongBritish Columbia` 1 437819 49449028 64096  
## - `Juris\_LongPrince Edward Island` 1 452095 49463303 64098  
## - Protection.zoneUnspecified 1 479041 49490250 64102  
## - Response.categoryNone 1 2135147 51146356 64341  
## - Response.categoryModified 1 2202689 51213898 64350  
## - Fire\_Cause\_HumanLightning 1 2928476 51939685 64452  
##   
## Step: AIC=64031.08  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49011441 64031  
## - Fire\_Cause\_HumanUnspecified 1 36094 49047536 64034  
## - Juris\_LongOntario 1 47819 49059260 64036  
## - Response.categoryUnspecified 1 51631 49063072 64037  
## - Juris\_LongSaskatchewan 1 112393 49123835 64046  
## - `Juris\_LongNew Brunswick` 1 152525 49163967 64052  
## - Juris\_LongQuebec 1 182316 49193757 64056  
## - Protection.zoneLimited 1 196080 49207522 64058  
## - `Juris\_LongNova Scotia` 1 238343 49249785 64064  
## - Juris\_LongManitoba 1 262373 49273814 64068  
## - `Juris\_LongNorthwest Territories` 1 297975 49309416 64073  
## - Juris\_LongYukon 1 368321 49379762 64083  
## - `Juris\_LongNewfoundland and Labrador` 1 371184 49382626 64084  
## - `Juris\_LongNational parks` 1 377922 49389363 64085  
## - `Juris\_LongBritish Columbia` 1 438904 49450345 64094  
## - `Juris\_LongPrince Edward Island` 1 452193 49463634 64096  
## - Protection.zoneUnspecified 1 483895 49495337 64100  
## - Response.categoryNone 1 2135908 51147350 64339  
## - Response.categoryModified 1 2202753 51214195 64348  
## - Fire\_Cause\_HumanLightning 1 2928501 51939943 64450  
## Start: AIC=64230.08  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 8 50414582 64228  
## <none> 50414574 64230  
## - Fire\_Cause\_HumanUnspecified 1 27520 50442094 64232  
## - Response.categoryUnspecified 1 44980 50459554 64235  
## - Juris\_LongOntario 1 55871 50470445 64236  
## - Juris\_LongSaskatchewan 1 128985 50543559 64247  
## - `Juris\_LongNew Brunswick` 1 152387 50566961 64250  
## - Protection.zoneLimited 1 209103 50623677 64258  
## - Juris\_LongQuebec 1 210097 50624671 64258  
## - `Juris\_LongNova Scotia` 1 246839 50661413 64264  
## - Juris\_LongManitoba 1 279212 50693786 64268  
## - `Juris\_LongNorthwest Territories` 1 322311 50736885 64274  
## - `Juris\_LongNewfoundland and Labrador` 1 375206 50789780 64282  
## - Juris\_LongYukon 1 396595 50811169 64285  
## - `Juris\_LongNational parks` 1 397994 50812568 64285  
## - Protection.zoneUnspecified 1 468839 50883412 64295  
## - `Juris\_LongPrince Edward Island` 1 487340 50901914 64298  
## - `Juris\_LongBritish Columbia` 1 513255 50927829 64302  
## - Response.categoryNone 1 2199054 52613628 64538  
## - Response.categoryModified 1 2244924 52659498 64544  
## - Fire\_Cause\_HumanLightning 1 3087805 53502379 64659  
##   
## Step: AIC=64228.08  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 50414582 64228  
## - Fire\_Cause\_HumanUnspecified 1 27525 50442107 64230  
## - Response.categoryUnspecified 1 46239 50460821 64233  
## - Juris\_LongOntario 1 55972 50470554 64234  
## - Juris\_LongSaskatchewan 1 129124 50543706 64245  
## - `Juris\_LongNew Brunswick` 1 152399 50566981 64248  
## - Juris\_LongQuebec 1 210143 50624725 64256  
## - Protection.zoneLimited 1 210328 50624910 64256  
## - `Juris\_LongNova Scotia` 1 246834 50661416 64262  
## - Juris\_LongManitoba 1 279600 50694182 64266  
## - `Juris\_LongNorthwest Territories` 1 322486 50737068 64272  
## - `Juris\_LongNewfoundland and Labrador` 1 375296 50789878 64280  
## - Juris\_LongYukon 1 397344 50811926 64283  
## - `Juris\_LongNational parks` 1 398141 50812723 64283  
## - Protection.zoneUnspecified 1 475594 50890176 64294  
## - `Juris\_LongPrince Edward Island` 1 488652 50903234 64296  
## - `Juris\_LongBritish Columbia` 1 514616 50929198 64300  
## - Response.categoryNone 1 2201049 52615631 64536  
## - Response.categoryModified 1 2244975 52659557 64542  
## - Fire\_Cause\_HumanLightning 1 3087806 53502388 64657  
## Start: AIC=60688.92  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 486 30946652 60687  
## <none> 30946166 60689  
## - Fire\_Cause\_HumanUnspecified 1 30889 30977055 60694  
## - Response.categoryUnspecified 1 38268 30984434 60696  
## - Juris\_LongOntario 1 62975 31009141 60702  
## - `Juris\_LongNew Brunswick` 1 106331 31052497 60712  
## - Juris\_LongSaskatchewan 1 120560 31066726 60715  
## - `Juris\_LongBritish Columbia` 1 162817 31108983 60725  
## - Protection.zoneLimited 1 176811 31122977 60728  
## - Juris\_LongQuebec 1 192374 31138540 60732  
## - `Juris\_LongNova Scotia` 1 225350 31171516 60740  
## - Juris\_LongManitoba 1 266593 31212759 60749  
## - `Juris\_LongNorthwest Territories` 1 303523 31249689 60758  
## - `Juris\_LongNewfoundland and Labrador` 1 368540 31314706 60773  
## - `Juris\_LongNational parks` 1 375772 31321938 60775  
## - Juris\_LongYukon 1 379029 31325195 60775  
## - Protection.zoneUnspecified 1 415008 31361174 60784  
## - `Juris\_LongPrince Edward Island` 1 445621 31391787 60791  
## - Response.categoryNone 1 1837886 32784052 61106  
## - Response.categoryModified 1 1884582 32830748 61116  
## - Fire\_Cause\_HumanLightning 1 1996357 32942523 61141  
##   
## Step: AIC=60687.04  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 30946652 60687  
## - Fire\_Cause\_HumanUnspecified 1 30847 30977499 60692  
## - Response.categoryUnspecified 1 37843 30984495 60694  
## - Juris\_LongOntario 1 63589 31010241 60700  
## - `Juris\_LongNew Brunswick` 1 106224 31052876 60710  
## - Juris\_LongSaskatchewan 1 120214 31066866 60713  
## - `Juris\_LongBritish Columbia` 1 162401 31109053 60723  
## - Protection.zoneLimited 1 176363 31123015 60726  
## - Juris\_LongQuebec 1 192750 31139402 60730  
## - `Juris\_LongNova Scotia` 1 225116 31171769 60738  
## - Juris\_LongManitoba 1 266107 31212759 60747  
## - `Juris\_LongNorthwest Territories` 1 303082 31249734 60756  
## - `Juris\_LongNewfoundland and Labrador` 1 368926 31315578 60771  
## - `Juris\_LongNational parks` 1 375319 31321971 60773  
## - Juris\_LongYukon 1 378592 31325245 60773  
## - Protection.zoneUnspecified 1 424074 31370727 60784  
## - `Juris\_LongPrince Edward Island` 1 447728 31394380 60789  
## - Response.categoryNone 1 1840818 32787471 61104  
## - Response.categoryModified 1 1884299 32830951 61114  
## - Fire\_Cause\_HumanLightning 1 1996248 32942900 61139  
## Start: AIC=63982.95  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1826 48675845 63981  
## <none> 48674020 63983  
## - Response.categoryUnspecified 1 30169 48704189 63985  
## - Fire\_Cause\_HumanUnspecified 1 32013 48706033 63986  
## - Juris\_LongOntario 1 55055 48729075 63989  
## - Juris\_LongSaskatchewan 1 133746 48807766 64001  
## - `Juris\_LongNew Brunswick` 1 134378 48808398 64001  
## - Protection.zoneLimited 1 207164 48881184 64012  
## - Juris\_LongQuebec 1 210425 48884445 64012  
## - `Juris\_LongNova Scotia` 1 253216 48927235 64019  
## - Juris\_LongManitoba 1 264714 48938734 64020  
## - Protection.zoneUnspecified 1 277936 48951956 64022  
## - `Juris\_LongNorthwest Territories` 1 296674 48970693 64025  
## - `Juris\_LongNational parks` 1 384131 49058150 64038  
## - `Juris\_LongNewfoundland and Labrador` 1 393816 49067836 64039  
## - Juris\_LongYukon 1 400729 49074749 64040  
## - `Juris\_LongBritish Columbia` 1 430556 49104575 64045  
## - `Juris\_LongPrince Edward Island` 1 471190 49145210 64051  
## - Response.categoryModified 1 2213564 50887584 64304  
## - Response.categoryNone 1 2231378 50905398 64306  
## - Fire\_Cause\_HumanLightning 1 2854559 51528578 64395  
##   
## Step: AIC=63981.22  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48675845 63981  
## - Fire\_Cause\_HumanUnspecified 1 32089 48707934 63984  
## - Response.categoryUnspecified 1 33181 48709026 63984  
## - Juris\_LongOntario 1 54170 48730016 63987  
## - `Juris\_LongNew Brunswick` 1 134267 48810113 63999  
## - Juris\_LongSaskatchewan 1 134584 48810430 63999  
## - Juris\_LongQuebec 1 209707 48885553 64010  
## - Protection.zoneLimited 1 210509 48886355 64011  
## - `Juris\_LongNova Scotia` 1 253010 48928856 64017  
## - Juris\_LongManitoba 1 266608 48942453 64019  
## - Protection.zoneUnspecified 1 276514 48952359 64020  
## - `Juris\_LongNorthwest Territories` 1 298108 48973953 64024  
## - `Juris\_LongNational parks` 1 385237 49061082 64036  
## - `Juris\_LongNewfoundland and Labrador` 1 392942 49068787 64038  
## - Juris\_LongYukon 1 403548 49079394 64039  
## - `Juris\_LongBritish Columbia` 1 433739 49109584 64044  
## - `Juris\_LongPrince Edward Island` 1 469385 49145231 64049  
## - Response.categoryModified 1 2213708 50889554 64302  
## - Response.categoryNone 1 2229555 50905400 64304  
## - Fire\_Cause\_HumanLightning 1 2854106 51529951 64393  
## Start: AIC=63565.62  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 40 46003053 63564  
## <none> 46003013 63566  
## - Fire\_Cause\_HumanUnspecified 1 34052 46037065 63569  
## - Response.categoryUnspecified 1 42266 46045279 63570  
## - Juris\_LongOntario 1 86485 46089498 63577  
## - Juris\_LongSaskatchewan 1 138073 46141086 63585  
## - `Juris\_LongNew Brunswick` 1 145718 46148731 63587  
## - Protection.zoneLimited 1 174707 46177720 63591  
## - Juris\_LongQuebec 1 203855 46206868 63596  
## - `Juris\_LongNova Scotia` 1 251954 46254967 63603  
## - Juris\_LongManitoba 1 287391 46290404 63609  
## - `Juris\_LongNorthwest Territories` 1 308299 46311312 63612  
## - `Juris\_LongBritish Columbia` 1 361281 46364294 63620  
## - `Juris\_LongNewfoundland and Labrador` 1 389607 46392620 63625  
## - `Juris\_LongNational parks` 1 396812 46399825 63626  
## - Juris\_LongYukon 1 405497 46408510 63627  
## - Protection.zoneUnspecified 1 423007 46426020 63630  
## - `Juris\_LongPrince Edward Island` 1 449880 46452893 63634  
## - Response.categoryModified 1 2052485 48055498 63880  
## - Response.categoryNone 1 2081799 48084812 63885  
## - Fire\_Cause\_HumanLightning 1 2583070 48586083 63960  
##   
## Step: AIC=63563.63  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 46003053 63564  
## - Fire\_Cause\_HumanUnspecified 1 34059 46037112 63567  
## - Response.categoryUnspecified 1 43714 46046766 63569  
## - Juris\_LongOntario 1 86495 46089548 63575  
## - Juris\_LongSaskatchewan 1 138328 46141380 63583  
## - `Juris\_LongNew Brunswick` 1 145732 46148785 63585  
## - Protection.zoneLimited 1 175791 46178843 63589  
## - Juris\_LongQuebec 1 203827 46206880 63594  
## - `Juris\_LongNova Scotia` 1 251983 46255035 63601  
## - Juris\_LongManitoba 1 288014 46291067 63607  
## - `Juris\_LongNorthwest Territories` 1 308670 46311723 63610  
## - `Juris\_LongBritish Columbia` 1 362452 46365505 63619  
## - `Juris\_LongNewfoundland and Labrador` 1 389572 46392624 63623  
## - `Juris\_LongNational parks` 1 397258 46400310 63624  
## - Juris\_LongYukon 1 406508 46409561 63625  
## - Protection.zoneUnspecified 1 427365 46430417 63629  
## - `Juris\_LongPrince Edward Island` 1 450762 46453815 63632  
## - Response.categoryModified 1 2052530 48055583 63878  
## - Response.categoryNone 1 2083084 48086136 63883  
## - Fire\_Cause\_HumanLightning 1 2583096 48586149 63958  
## Start: AIC=63917.23  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 4228 48239460 63916  
## <none> 48235232 63917  
## - Fire\_Cause\_HumanUnspecified 1 27279 48262512 63919  
## - Response.categoryUnspecified 1 33145 48268377 63920  
## - Juris\_LongOntario 1 56790 48292022 63924  
## - Juris\_LongSaskatchewan 1 119183 48354415 63933  
## - `Juris\_LongNew Brunswick` 1 153585 48388817 63938  
## - Juris\_LongQuebec 1 196923 48432155 63945  
## - Protection.zoneLimited 1 205457 48440689 63946  
## - `Juris\_LongNova Scotia` 1 241458 48476690 63951  
## - Juris\_LongManitoba 1 260786 48496018 63954  
## - `Juris\_LongNorthwest Territories` 1 309054 48544286 63962  
## - `Juris\_LongBritish Columbia` 1 323171 48558404 63964  
## - `Juris\_LongNewfoundland and Labrador` 1 382007 48617239 63972  
## - `Juris\_LongNational parks` 1 387799 48623031 63973  
## - Juris\_LongYukon 1 401157 48636390 63975  
## - Protection.zoneUnspecified 1 465505 48700737 63985  
## - `Juris\_LongPrince Edward Island` 1 484047 48719279 63988  
## - Response.categoryModified 1 2216199 50451431 64241  
## - Response.categoryNone 1 2234132 50469364 64244  
## - Fire\_Cause\_HumanLightning 1 3018675 51253907 64356  
##   
## Step: AIC=63915.87  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48239460 63916  
## - Fire\_Cause\_HumanUnspecified 1 27325 48266786 63918  
## - Response.categoryUnspecified 1 37984 48277444 63920  
## - Juris\_LongOntario 1 55345 48294805 63922  
## - Juris\_LongSaskatchewan 1 120447 48359908 63932  
## - `Juris\_LongNew Brunswick` 1 152772 48392232 63937  
## - Juris\_LongQuebec 1 195806 48435267 63943  
## - Protection.zoneLimited 1 209987 48449447 63945  
## - `Juris\_LongNova Scotia` 1 241380 48480840 63950  
## - Juris\_LongManitoba 1 263530 48502990 63953  
## - `Juris\_LongNorthwest Territories` 1 310816 48550276 63960  
## - `Juris\_LongBritish Columbia` 1 327057 48566517 63963  
## - `Juris\_LongNewfoundland and Labrador` 1 380567 48620027 63971  
## - `Juris\_LongNational parks` 1 389448 48628908 63972  
## - Juris\_LongYukon 1 404607 48644068 63974  
## - Protection.zoneUnspecified 1 461601 48701061 63983  
## - `Juris\_LongPrince Edward Island` 1 480447 48719908 63986  
## - Response.categoryModified 1 2216718 50456178 64240  
## - Response.categoryNone 1 2230009 50469469 64242  
## - Fire\_Cause\_HumanLightning 1 3018177 51257638 64354  
## Start: AIC=64011.76  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 4923 48872544 64010  
## <none> 48867621 64012  
## - Fire\_Cause\_HumanUnspecified 1 31391 48899012 64014  
## - Response.categoryUnspecified 1 45763 48913385 64017  
## - Juris\_LongOntario 1 61179 48928800 64019  
## - Juris\_LongSaskatchewan 1 136814 49004435 64030  
## - Protection.zoneLimited 1 201835 49069456 64040  
## - `Juris\_LongNew Brunswick` 1 203844 49071465 64040  
## - Juris\_LongQuebec 1 216280 49083901 64042  
## - `Juris\_LongNova Scotia` 1 267203 49134824 64049  
## - Juris\_LongManitoba 1 285050 49152671 64052  
## - `Juris\_LongNorthwest Territories` 1 342638 49210259 64060  
## - `Juris\_LongBritish Columbia` 1 380894 49248515 64066  
## - `Juris\_LongNewfoundland and Labrador` 1 408074 49275695 64070  
## - Juris\_LongYukon 1 410681 49278302 64070  
## - `Juris\_LongNational parks` 1 413357 49280978 64071  
## - `Juris\_LongPrince Edward Island` 1 458691 49326312 64078  
## - Protection.zoneUnspecified 1 514776 49382397 64086  
## - Response.categoryNone 1 2168418 51036039 64325  
## - Response.categoryModified 1 2178874 51046495 64326  
## - Fire\_Cause\_HumanLightning 1 2992776 51860397 64441  
##   
## Step: AIC=64010.49  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48872544 64010  
## - Fire\_Cause\_HumanUnspecified 1 31522 48904066 64013  
## - Response.categoryUnspecified 1 51798 48924342 64016  
## - Juris\_LongOntario 1 59619 48932163 64017  
## - Juris\_LongSaskatchewan 1 138392 49010937 64029  
## - `Juris\_LongNew Brunswick` 1 203870 49076414 64039  
## - Protection.zoneLimited 1 206446 49078991 64039  
## - Juris\_LongQuebec 1 215130 49087674 64040  
## - `Juris\_LongNova Scotia` 1 267097 49139641 64048  
## - Juris\_LongManitoba 1 288345 49160889 64051  
## - `Juris\_LongNorthwest Territories` 1 344978 49217523 64060  
## - `Juris\_LongBritish Columbia` 1 385212 49257756 64065  
## - `Juris\_LongNewfoundland and Labrador` 1 406952 49279496 64069  
## - Juris\_LongYukon 1 415371 49287916 64070  
## - `Juris\_LongNational parks` 1 415665 49288209 64070  
## - `Juris\_LongPrince Edward Island` 1 454807 49327351 64076  
## - Protection.zoneUnspecified 1 510095 49382639 64084  
## - Response.categoryNone 1 2164053 51036597 64323  
## - Response.categoryModified 1 2180373 51052917 64325  
## - Fire\_Cause\_HumanLightning 1 2991810 51864354 64440  
## Start: AIC=64028.46  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1164 48981379 64027  
## <none> 48980215 64028  
## - Response.categoryUnspecified 1 16176 48996391 64029  
## - Fire\_Cause\_HumanUnspecified 1 26033 49006248 64030  
## - Juris\_LongOntario 1 57198 49037413 64035  
## - Juris\_LongSaskatchewan 1 118609 49098823 64044  
## - `Juris\_LongNew Brunswick` 1 160520 49140734 64050  
## - Juris\_LongQuebec 1 198026 49178241 64056  
## - Protection.zoneLimited 1 199032 49179247 64056  
## - `Juris\_LongNova Scotia` 1 253263 49233478 64064  
## - Juris\_LongManitoba 1 265622 49245837 64066  
## - `Juris\_LongNorthwest Territories` 1 340872 49321087 64077  
## - `Juris\_LongNewfoundland and Labrador` 1 386669 49366884 64084  
## - `Juris\_LongNational parks` 1 387890 49368104 64084  
## - Juris\_LongYukon 1 405460 49385675 64086  
## - `Juris\_LongBritish Columbia` 1 431760 49411975 64090  
## - `Juris\_LongPrince Edward Island` 1 484341 49464556 64098  
## - Protection.zoneUnspecified 1 504182 49484397 64101  
## - Response.categoryNone 1 2204545 51184759 64346  
## - Response.categoryModified 1 2241658 51221873 64351  
## - Fire\_Cause\_HumanLightning 1 2814398 51794613 64432  
##   
## Step: AIC=64026.63  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48981379 64027  
## - Response.categoryUnspecified 1 17870 48999249 64027  
## - Fire\_Cause\_HumanUnspecified 1 26119 49007498 64028  
## - Juris\_LongOntario 1 56507 49037885 64033  
## - Juris\_LongSaskatchewan 1 119304 49100683 64042  
## - `Juris\_LongNew Brunswick` 1 160513 49141892 64048  
## - Juris\_LongQuebec 1 197483 49178861 64054  
## - Protection.zoneLimited 1 202057 49183436 64055  
## - `Juris\_LongNova Scotia` 1 253359 49234738 64062  
## - Juris\_LongManitoba 1 267290 49248669 64064  
## - `Juris\_LongNorthwest Territories` 1 342039 49323417 64075  
## - `Juris\_LongNewfoundland and Labrador` 1 386069 49367447 64082  
## - `Juris\_LongNational parks` 1 388811 49370190 64082  
## - Juris\_LongYukon 1 407988 49389367 64085  
## - `Juris\_LongBritish Columbia` 1 434267 49415645 64089  
## - `Juris\_LongPrince Edward Island` 1 483178 49464556 64096  
## - Protection.zoneUnspecified 1 505604 49486983 64099  
## - Response.categoryNone 1 2203450 51184828 64344  
## - Response.categoryModified 1 2242354 51223733 64349  
## - Fire\_Cause\_HumanLightning 1 2814342 51795721 64430  
## Start: AIC=64139.72  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 185 49790878 64138  
## <none> 49790693 64140  
## - Fire\_Cause\_HumanUnspecified 1 33482 49824175 64143  
## - Response.categoryUnspecified 1 37722 49828416 64143  
## - Juris\_LongOntario 1 54980 49845673 64146  
## - Juris\_LongSaskatchewan 1 118334 49909028 64155  
## - `Juris\_LongNew Brunswick` 1 170180 49960873 64162  
## - Juris\_LongQuebec 1 199874 49990568 64167  
## - Protection.zoneLimited 1 204142 49994836 64167  
## - `Juris\_LongNova Scotia` 1 250263 50040957 64174  
## - Juris\_LongManitoba 1 275274 50065967 64178  
## - `Juris\_LongNorthwest Territories` 1 314331 50105025 64183  
## - `Juris\_LongNewfoundland and Labrador` 1 382030 50172724 64193  
## - Juris\_LongYukon 1 385806 50176500 64194  
## - `Juris\_LongNational parks` 1 386714 50177408 64194  
## - Protection.zoneUnspecified 1 409059 50199753 64197  
## - `Juris\_LongPrince Edward Island` 1 473002 50263696 64206  
## - `Juris\_LongBritish Columbia` 1 477634 50268328 64207  
## - Response.categoryNone 1 2231055 52021749 64456  
## - Response.categoryModified 1 2310008 52100702 64467  
## - Fire\_Cause\_HumanLightning 1 3112305 52902998 64578  
##   
## Step: AIC=64137.75  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49790878 64138  
## - Fire\_Cause\_HumanUnspecified 1 33489 49824368 64141  
## - Response.categoryUnspecified 1 39466 49830344 64141  
## - Juris\_LongOntario 1 54795 49845673 64144  
## - Juris\_LongSaskatchewan 1 118569 49909447 64153  
## - `Juris\_LongNew Brunswick` 1 170146 49961024 64161  
## - Juris\_LongQuebec 1 199691 49990569 64165  
## - Protection.zoneLimited 1 205922 49996800 64166  
## - `Juris\_LongNova Scotia` 1 250217 50041095 64172  
## - Juris\_LongManitoba 1 275930 50066808 64176  
## - `Juris\_LongNorthwest Territories` 1 314689 50105567 64181  
## - `Juris\_LongNewfoundland and Labrador` 1 381846 50172725 64191  
## - Juris\_LongYukon 1 386875 50177753 64192  
## - `Juris\_LongNational parks` 1 387008 50177886 64192  
## - Protection.zoneUnspecified 1 412776 50203654 64196  
## - `Juris\_LongPrince Edward Island` 1 473658 50264537 64204  
## - `Juris\_LongBritish Columbia` 1 479665 50270543 64205  
## - Response.categoryNone 1 2232034 52022913 64454  
## - Response.categoryModified 1 2310111 52100989 64465  
## - Fire\_Cause\_HumanLightning 1 3112123 52903001 64576  
## Start: AIC=63386.36  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 0 44784942 63384  
## <none> 44784942 63386  
## - Fire\_Cause\_HumanUnspecified 1 28872 44813814 63389  
## - Juris\_LongOntario 1 33000 44817941 63390  
## - Response.categoryUnspecified 1 60441 44845383 63394  
## - Juris\_LongSaskatchewan 1 97331 44882272 63400  
## - `Juris\_LongNew Brunswick` 1 118441 44903382 63404  
## - Juris\_LongQuebec 1 148192 44933133 63408  
## - `Juris\_LongNova Scotia` 1 201755 44986697 63417  
## - Protection.zoneLimited 1 207710 44992652 63418  
## - Juris\_LongManitoba 1 215883 45000825 63419  
## - `Juris\_LongNorthwest Territories` 1 251876 45036818 63425  
## - `Juris\_LongNewfoundland and Labrador` 1 316071 45101012 63435  
## - `Juris\_LongNational parks` 1 322041 45106983 63436  
## - Juris\_LongYukon 1 326302 45111243 63437  
## - `Juris\_LongPrince Edward Island` 1 428209 45213151 63453  
## - `Juris\_LongBritish Columbia` 1 443881 45228823 63456  
## - Protection.zoneUnspecified 1 565006 45349948 63475  
## - Response.categoryNone 1 2035604 46820546 63707  
## - Response.categoryModified 1 2128413 46913354 63721  
## - Fire\_Cause\_HumanLightning 1 2776658 47561600 63821  
##   
## Step: AIC=63384.36  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 44784942 63384  
## - Fire\_Cause\_HumanUnspecified 1 28874 44813816 63387  
## - Juris\_LongOntario 1 33054 44817996 63388  
## - Response.categoryUnspecified 1 61855 44846797 63392  
## - Juris\_LongSaskatchewan 1 97420 44882362 63398  
## - `Juris\_LongNew Brunswick` 1 118443 44903385 63402  
## - Juris\_LongQuebec 1 148232 44933174 63406  
## - `Juris\_LongNova Scotia` 1 201778 44986720 63415  
## - Protection.zoneLimited 1 208708 44993650 63416  
## - Juris\_LongManitoba 1 216261 45001203 63417  
## - `Juris\_LongNorthwest Territories` 1 252117 45037059 63423  
## - `Juris\_LongNewfoundland and Labrador` 1 316081 45101022 63433  
## - `Juris\_LongNational parks` 1 322272 45107214 63434  
## - Juris\_LongYukon 1 327110 45112052 63435  
## - `Juris\_LongPrince Edward Island` 1 429302 45214244 63452  
## - `Juris\_LongBritish Columbia` 1 444467 45229409 63454  
## - Protection.zoneUnspecified 1 572723 45357665 63475  
## - Response.categoryNone 1 2038078 46823020 63705  
## - Response.categoryModified 1 2128414 46913356 63719  
## - Fire\_Cause\_HumanLightning 1 2776720 47561662 63819  
## Start: AIC=63496.74  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2952 45522751 63495  
## <none> 45519799 63497  
## - Fire\_Cause\_HumanUnspecified 1 28555 45548353 63499  
## - Response.categoryUnspecified 1 49747 45569545 63503  
## - Juris\_LongOntario 1 54733 45574532 63503  
## - Juris\_LongSaskatchewan 1 122072 45641871 63514  
## - `Juris\_LongNew Brunswick` 1 129035 45648834 63515  
## - Juris\_LongQuebec 1 197769 45717568 63526  
## - Protection.zoneLimited 1 206367 45726165 63528  
## - Protection.zoneUnspecified 1 225144 45744942 63531  
## - `Juris\_LongNova Scotia` 1 241099 45760898 63533  
## - Juris\_LongManitoba 1 268724 45788522 63537  
## - `Juris\_LongBritish Columbia` 1 279713 45799512 63539  
## - `Juris\_LongNorthwest Territories` 1 314625 45834424 63545  
## - `Juris\_LongNational parks` 1 363257 45883055 63552  
## - `Juris\_LongNewfoundland and Labrador` 1 377792 45897590 63555  
## - Juris\_LongYukon 1 405636 45925435 63559  
## - `Juris\_LongPrince Edward Island` 1 453675 45973473 63567  
## - Response.categoryNone 1 2050491 47570289 63814  
## - Response.categoryModified 1 2060218 47580017 63816  
## - Fire\_Cause\_HumanLightning 1 2725433 48245232 63917  
##   
## Step: AIC=63495.22  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 45522751 63495  
## - Fire\_Cause\_HumanUnspecified 1 28686 45551437 63498  
## - Juris\_LongOntario 1 53677 45576428 63502  
## - Response.categoryUnspecified 1 54916 45577666 63502  
## - Juris\_LongSaskatchewan 1 123360 45646111 63513  
## - `Juris\_LongNew Brunswick` 1 128952 45651703 63514  
## - Juris\_LongQuebec 1 197009 45719760 63525  
## - Protection.zoneLimited 1 210182 45732933 63527  
## - Protection.zoneUnspecified 1 222196 45744947 63529  
## - `Juris\_LongNova Scotia` 1 241076 45763827 63532  
## - Juris\_LongManitoba 1 271117 45793867 63536  
## - `Juris\_LongBritish Columbia` 1 282487 45805238 63538  
## - `Juris\_LongNorthwest Territories` 1 316257 45839008 63543  
## - `Juris\_LongNational parks` 1 364506 45887257 63551  
## - `Juris\_LongNewfoundland and Labrador` 1 376833 45899584 63553  
## - Juris\_LongYukon 1 409209 45931960 63558  
## - `Juris\_LongPrince Edward Island` 1 451222 45973973 63565  
## - Response.categoryNone 1 2047769 47570520 63813  
## - Response.categoryModified 1 2061668 47584419 63815  
## - Fire\_Cause\_HumanLightning 1 2726251 48249001 63915  
## Start: AIC=63618.07  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 2052 46239821 63616  
## <none> 46237769 63618  
## - Fire\_Cause\_HumanUnspecified 1 31734 46269503 63621  
## - Response.categoryUnspecified 1 37157 46274926 63622  
## - Juris\_LongOntario 1 73309 46311078 63628  
## - Juris\_LongSaskatchewan 1 125781 46363550 63636  
## - `Juris\_LongNew Brunswick` 1 143877 46381646 63639  
## - Protection.zoneLimited 1 181806 46419575 63645  
## - Juris\_LongQuebec 1 200396 46438165 63647  
## - `Juris\_LongNova Scotia` 1 240981 46478751 63654  
## - Juris\_LongManitoba 1 270549 46508318 63658  
## - `Juris\_LongNorthwest Territories` 1 301308 46539077 63663  
## - `Juris\_LongNewfoundland and Labrador` 1 377700 46615469 63675  
## - Juris\_LongYukon 1 382776 46620546 63676  
## - `Juris\_LongNational parks` 1 396352 46634121 63678  
## - `Juris\_LongBritish Columbia` 1 410710 46648479 63680  
## - `Juris\_LongPrince Edward Island` 1 455147 46692917 63687  
## - Protection.zoneUnspecified 1 500390 46738159 63694  
## - Response.categoryNone 1 2159833 48397602 63947  
## - Response.categoryModified 1 2185870 48423639 63951  
## - Fire\_Cause\_HumanLightning 1 2756498 48994268 64036  
##   
## Step: AIC=63616.4  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 46239821 63616  
## - Fire\_Cause\_HumanUnspecified 1 31783 46271604 63619  
## - Response.categoryUnspecified 1 40895 46280716 63621  
## - Juris\_LongOntario 1 72256 46312077 63626  
## - Juris\_LongSaskatchewan 1 126913 46366734 63634  
## - `Juris\_LongNew Brunswick` 1 143722 46383543 63637  
## - Protection.zoneLimited 1 185020 46424841 63643  
## - Juris\_LongQuebec 1 199669 46439490 63646  
## - `Juris\_LongNova Scotia` 1 241136 46480957 63652  
## - Juris\_LongManitoba 1 272918 46512739 63657  
## - `Juris\_LongNorthwest Territories` 1 302976 46542797 63662  
## - `Juris\_LongNewfoundland and Labrador` 1 376916 46616737 63673  
## - Juris\_LongYukon 1 385939 46625760 63675  
## - `Juris\_LongNational parks` 1 397750 46637571 63677  
## - `Juris\_LongBritish Columbia` 1 413891 46653712 63679  
## - `Juris\_LongPrince Edward Island` 1 453190 46693011 63685  
## - Protection.zoneUnspecified 1 500125 46739946 63692  
## - Response.categoryNone 1 2157783 48397604 63945  
## - Response.categoryModified 1 2186102 48425923 63950  
## - Fire\_Cause\_HumanLightning 1 2756525 48996346 64035  
## Start: AIC=63478.25  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1201 45405166 63476  
## - Response.categoryUnspecified 1 11973 45415937 63478  
## <none> 45403965 63478  
## - Fire\_Cause\_HumanUnspecified 1 29023 45432988 63481  
## - Juris\_LongOntario 1 72960 45476925 63488  
## - Juris\_LongSaskatchewan 1 148240 45552205 63500  
## - `Juris\_LongNew Brunswick` 1 179902 45583867 63505  
## - Protection.zoneLimited 1 198485 45602449 63508  
## - Juris\_LongQuebec 1 220022 45623987 63511  
## - Protection.zoneUnspecified 1 246870 45650835 63516  
## - `Juris\_LongBritish Columbia` 1 262384 45666348 63518  
## - `Juris\_LongNova Scotia` 1 274748 45678712 63520  
## - Juris\_LongManitoba 1 294975 45698940 63523  
## - `Juris\_LongNorthwest Territories` 1 355231 45759196 63533  
## - `Juris\_LongNational parks` 1 412926 45816890 63542  
## - `Juris\_LongNewfoundland and Labrador` 1 426214 45830179 63544  
## - Juris\_LongYukon 1 436076 45840041 63546  
## - `Juris\_LongPrince Edward Island` 1 498751 45902716 63556  
## - Response.categoryModified 1 2131016 47534980 63809  
## - Response.categoryNone 1 2172797 47576762 63815  
## - Fire\_Cause\_HumanLightning 1 2646462 48050427 63887  
##   
## Step: AIC=63476.45  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 45405166 63476  
## - Response.categoryUnspecified 1 13456 45418622 63477  
## - Fire\_Cause\_HumanUnspecified 1 29007 45434173 63479  
## - Juris\_LongOntario 1 72133 45477299 63486  
## - Juris\_LongSaskatchewan 1 148979 45554145 63498  
## - `Juris\_LongNew Brunswick` 1 180100 45585266 63503  
## - Protection.zoneLimited 1 201886 45607052 63507  
## - Juris\_LongQuebec 1 219369 45624535 63509  
## - Protection.zoneUnspecified 1 246205 45651371 63514  
## - `Juris\_LongBritish Columbia` 1 264586 45669753 63517  
## - `Juris\_LongNova Scotia` 1 274690 45679857 63518  
## - Juris\_LongManitoba 1 296778 45701944 63522  
## - `Juris\_LongNorthwest Territories` 1 356775 45761941 63531  
## - `Juris\_LongNational parks` 1 414141 45819307 63540  
## - `Juris\_LongNewfoundland and Labrador` 1 425431 45830597 63542  
## - Juris\_LongYukon 1 438588 45843754 63544  
## - `Juris\_LongPrince Edward Island` 1 497557 45902723 63554  
## - Response.categoryModified 1 2130881 47536047 63807  
## - Response.categoryNone 1 2171739 47576905 63814  
## - Fire\_Cause\_HumanLightning 1 2646597 48051763 63886  
## Start: AIC=63898.02  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 3901 48111589 63897  
## <none> 48107689 63898  
## - Fire\_Cause\_HumanUnspecified 1 30168 48137857 63901  
## - Response.categoryUnspecified 1 34131 48141820 63901  
## - Juris\_LongOntario 1 60604 48168293 63905  
## - Juris\_LongSaskatchewan 1 143323 48251012 63918  
## - `Juris\_LongNew Brunswick` 1 145095 48252784 63918  
## - Protection.zoneLimited 1 198069 48305757 63926  
## - Juris\_LongQuebec 1 207867 48315556 63927  
## - `Juris\_LongNova Scotia` 1 248418 48356107 63933  
## - Juris\_LongManitoba 1 276171 48383860 63938  
## - `Juris\_LongNorthwest Territories` 1 316509 48424197 63944  
## - `Juris\_LongBritish Columbia` 1 340702 48448391 63947  
## - `Juris\_LongNational parks` 1 394222 48501911 63955  
## - `Juris\_LongNewfoundland and Labrador` 1 394644 48502333 63955  
## - Juris\_LongYukon 1 407940 48515628 63957  
## - `Juris\_LongPrince Edward Island` 1 482810 48590499 63968  
## - Protection.zoneUnspecified 1 510672 48618360 63973  
## - Response.categoryNone 1 2155260 50262949 64214  
## - Response.categoryModified 1 2167629 50275317 64216  
## - Fire\_Cause\_HumanLightning 1 2851928 50959617 64314  
##   
## Step: AIC=63896.61  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 48111589 63897  
## - Fire\_Cause\_HumanUnspecified 1 30255 48141844 63899  
## - Response.categoryUnspecified 1 38586 48150175 63900  
## - Juris\_LongOntario 1 59181 48170770 63904  
## - Juris\_LongSaskatchewan 1 144607 48256197 63916  
## - `Juris\_LongNew Brunswick` 1 145071 48256660 63916  
## - Protection.zoneLimited 1 202346 48313935 63925  
## - Juris\_LongQuebec 1 206750 48318339 63926  
## - `Juris\_LongNova Scotia` 1 248941 48360531 63932  
## - Juris\_LongManitoba 1 278838 48390427 63937  
## - `Juris\_LongNorthwest Territories` 1 318242 48429831 63942  
## - `Juris\_LongBritish Columbia` 1 344438 48456027 63946  
## - `Juris\_LongNewfoundland and Labrador` 1 393499 48505088 63954  
## - `Juris\_LongNational parks` 1 396426 48508015 63954  
## - Juris\_LongYukon 1 411765 48523354 63956  
## - `Juris\_LongPrince Edward Island` 1 479288 48590877 63967  
## - Protection.zoneUnspecified 1 507425 48619014 63971  
## - Response.categoryNone 1 2151627 50263217 64212  
## - Response.categoryModified 1 2169536 50281126 64215  
## - Fire\_Cause\_HumanLightning 1 2850999 50962588 64312  
## Start: AIC=62805.77  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 107 41429345 62804  
## <none> 41429238 62806  
## - Fire\_Cause\_HumanUnspecified 1 26549 41455786 62808  
## - Response.categoryUnspecified 1 33525 41462762 62810  
## - Juris\_LongOntario 1 39513 41468751 62811  
## - Juris\_LongSaskatchewan 1 106277 41535515 62822  
## - `Juris\_LongNew Brunswick` 1 130678 41559915 62827  
## - Juris\_LongQuebec 1 179484 41608722 62835  
## - Protection.zoneLimited 1 203314 41632552 62839  
## - `Juris\_LongNova Scotia` 1 206363 41635601 62840  
## - Juris\_LongManitoba 1 243401 41672639 62846  
## - `Juris\_LongNorthwest Territories` 1 287213 41716451 62854  
## - `Juris\_LongBritish Columbia` 1 288188 41717426 62854  
## - Juris\_LongYukon 1 347753 41776991 62864  
## - `Juris\_LongNewfoundland and Labrador` 1 359102 41788340 62866  
## - `Juris\_LongNational parks` 1 375071 41804309 62869  
## - `Juris\_LongPrince Edward Island` 1 432028 41861266 62879  
## - Protection.zoneUnspecified 1 568235 41997473 62903  
## - Response.categoryNone 1 2048921 43478158 63154  
## - Response.categoryModified 1 2057830 43487068 63156  
## - Fire\_Cause\_HumanLightning 1 2492415 43921653 63228  
##   
## Step: AIC=62803.79  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 41429345 62804  
## - Fire\_Cause\_HumanUnspecified 1 26555 41455900 62806  
## - Response.categoryUnspecified 1 34900 41464245 62808  
## - Juris\_LongOntario 1 39408 41468753 62809  
## - Juris\_LongSaskatchewan 1 106594 41535939 62820  
## - `Juris\_LongNew Brunswick` 1 130739 41560084 62825  
## - Juris\_LongQuebec 1 179393 41608738 62833  
## - Protection.zoneLimited 1 204983 41634327 62838  
## - `Juris\_LongNova Scotia` 1 206401 41635746 62838  
## - Juris\_LongManitoba 1 244254 41673599 62844  
## - `Juris\_LongNorthwest Territories` 1 287703 41717048 62852  
## - `Juris\_LongBritish Columbia` 1 288820 41718165 62852  
## - Juris\_LongYukon 1 349095 41778440 62863  
## - `Juris\_LongNewfoundland and Labrador` 1 358998 41788343 62864  
## - `Juris\_LongNational parks` 1 375652 41804997 62867  
## - `Juris\_LongPrince Edward Island` 1 432378 41861723 62877  
## - Protection.zoneUnspecified 1 573625 42002969 62902  
## - Response.categoryNone 1 2050444 43479789 63152  
## - Response.categoryModified 1 2057969 43487314 63154  
## - Fire\_Cause\_HumanLightning 1 2492755 43922100 63226  
## Start: AIC=64165.75  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 65 49969693 64164  
## <none> 49969628 64166  
## - Fire\_Cause\_HumanUnspecified 1 25046 49994675 64167  
## - Response.categoryUnspecified 1 44655 50014284 64170  
## - Juris\_LongOntario 1 66250 50035878 64173  
## - Juris\_LongSaskatchewan 1 127482 50097111 64182  
## - `Juris\_LongNew Brunswick` 1 167957 50137586 64188  
## - Protection.zoneLimited 1 191306 50160935 64191  
## - Juris\_LongQuebec 1 209604 50179232 64194  
## - `Juris\_LongNova Scotia` 1 247731 50217359 64200  
## - Juris\_LongManitoba 1 270533 50240162 64203  
## - `Juris\_LongNorthwest Territories` 1 317191 50286820 64210  
## - `Juris\_LongNewfoundland and Labrador` 1 387186 50356815 64220  
## - `Juris\_LongNational parks` 1 400757 50370385 64222  
## - Juris\_LongYukon 1 410479 50380108 64223  
## - `Juris\_LongPrince Edward Island` 1 445465 50415093 64228  
## - Protection.zoneUnspecified 1 490829 50460457 64235  
## - `Juris\_LongBritish Columbia` 1 506223 50475852 64237  
## - Response.categoryNone 1 2235438 52205067 64481  
## - Response.categoryModified 1 2278785 52248414 64487  
## - Fire\_Cause\_HumanLightning 1 3013746 52983375 64589  
##   
## Step: AIC=64163.76  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49969693 64164  
## - Fire\_Cause\_HumanUnspecified 1 25023 49994716 64165  
## - Response.categoryUnspecified 1 45225 50014918 64168  
## - Juris\_LongOntario 1 66536 50036229 64171  
## - Juris\_LongSaskatchewan 1 127439 50097132 64180  
## - `Juris\_LongNew Brunswick` 1 167941 50137634 64186  
## - Protection.zoneLimited 1 191623 50161316 64190  
## - Juris\_LongQuebec 1 209741 50179434 64192  
## - `Juris\_LongNova Scotia` 1 247726 50217419 64198  
## - Juris\_LongManitoba 1 270716 50240410 64201  
## - `Juris\_LongNorthwest Territories` 1 317218 50286911 64208  
## - `Juris\_LongNewfoundland and Labrador` 1 387247 50356940 64218  
## - `Juris\_LongNational parks` 1 400783 50370476 64220  
## - Juris\_LongYukon 1 410883 50380576 64221  
## - `Juris\_LongPrince Edward Island` 1 446586 50416279 64226  
## - Protection.zoneUnspecified 1 499382 50469075 64234  
## - `Juris\_LongBritish Columbia` 1 506668 50476361 64235  
## - Response.categoryNone 1 2237530 52207223 64480  
## - Response.categoryModified 1 2278721 52248414 64485  
## - Fire\_Cause\_HumanLightning 1 3013945 52983638 64587  
## Start: AIC=64170.49  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1456 50003721 64169  
## <none> 50002265 64170  
## - Fire\_Cause\_HumanUnspecified 1 32854 50035119 64173  
## - Response.categoryUnspecified 1 34113 50036378 64173  
## - Juris\_LongOntario 1 69471 50071736 64179  
## - Juris\_LongSaskatchewan 1 133764 50136029 64188  
## - `Juris\_LongNew Brunswick` 1 182813 50185078 64195  
## - Protection.zoneLimited 1 193839 50196104 64197  
## - Juris\_LongQuebec 1 241770 50244035 64203  
## - `Juris\_LongNova Scotia` 1 263491 50265756 64207  
## - Juris\_LongManitoba 1 296309 50298574 64211  
## - `Juris\_LongNorthwest Territories` 1 338410 50340675 64217  
## - Protection.zoneUnspecified 1 380962 50383228 64224  
## - `Juris\_LongNational parks` 1 404546 50406811 64227  
## - `Juris\_LongNewfoundland and Labrador` 1 406562 50408827 64227  
## - Juris\_LongYukon 1 430718 50432984 64231  
## - `Juris\_LongBritish Columbia` 1 448595 50450861 64233  
## - `Juris\_LongPrince Edward Island` 1 497717 50499982 64240  
## - Response.categoryNone 1 2251031 52253297 64488  
## - Response.categoryModified 1 2280370 52282635 64492  
## - Fire\_Cause\_HumanLightning 1 3050735 53053000 64598  
##   
## Step: AIC=64168.7  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 50003721 64169  
## - Fire\_Cause\_HumanUnspecified 1 33042 50036763 64171  
## - Response.categoryUnspecified 1 37290 50041011 64172  
## - Juris\_LongOntario 1 68672 50072393 64177  
## - Juris\_LongSaskatchewan 1 134587 50138308 64186  
## - `Juris\_LongNew Brunswick` 1 182804 50186525 64193  
## - Protection.zoneLimited 1 196698 50200418 64195  
## - Juris\_LongQuebec 1 241239 50244960 64202  
## - `Juris\_LongNova Scotia` 1 263461 50267182 64205  
## - Juris\_LongManitoba 1 298309 50302029 64210  
## - `Juris\_LongNorthwest Territories` 1 339690 50343411 64216  
## - Protection.zoneUnspecified 1 380745 50384466 64222  
## - `Juris\_LongNational parks` 1 405870 50409591 64225  
## - `Juris\_LongNewfoundland and Labrador` 1 405888 50409609 64225  
## - Juris\_LongYukon 1 434026 50437747 64229  
## - `Juris\_LongBritish Columbia` 1 451232 50454953 64232  
## - `Juris\_LongPrince Edward Island` 1 496278 50499998 64238  
## - Response.categoryNone 1 2249590 52253311 64486  
## - Response.categoryModified 1 2280672 52284392 64490  
## - Fire\_Cause\_HumanLightning 1 3052051 53055771 64597  
## Start: AIC=64147.89  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 1419 49848196 64146  
## <none> 49846777 64148  
## - Fire\_Cause\_HumanUnspecified 1 37444 49884221 64151  
## - Response.categoryUnspecified 1 46349 49893126 64153  
## - Juris\_LongOntario 1 84254 49931031 64158  
## - Juris\_LongSaskatchewan 1 148238 49995015 64167  
## - `Juris\_LongNew Brunswick` 1 177497 50024274 64172  
## - Protection.zoneLimited 1 186621 50033398 64173  
## - Juris\_LongQuebec 1 249140 50095917 64182  
## - `Juris\_LongNova Scotia` 1 297976 50144753 64189  
## - Juris\_LongManitoba 1 327018 50173795 64193  
## - `Juris\_LongNorthwest Territories` 1 380476 50227253 64201  
## - `Juris\_LongBritish Columbia` 1 405395 50252172 64205  
## - `Juris\_LongNewfoundland and Labrador` 1 448638 50295415 64211  
## - `Juris\_LongNational parks` 1 449014 50295791 64211  
## - Juris\_LongYukon 1 455311 50302088 64212  
## - Protection.zoneUnspecified 1 493723 50340500 64217  
## - `Juris\_LongPrince Edward Island` 1 520496 50367273 64221  
## - Response.categoryModified 1 2222735 52069512 64462  
## - Response.categoryNone 1 2233786 52080563 64464  
## - Fire\_Cause\_HumanLightning 1 2908707 52755484 64557  
##   
## Step: AIC=64146.1  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 49848196 64146  
## - Fire\_Cause\_HumanUnspecified 1 37464 49885661 64150  
## - Response.categoryUnspecified 1 50027 49898224 64151  
## - Juris\_LongOntario 1 83368 49931565 64156  
## - Juris\_LongSaskatchewan 1 149145 49997341 64166  
## - `Juris\_LongNew Brunswick` 1 177485 50025682 64170  
## - Protection.zoneLimited 1 189816 50038013 64172  
## - Juris\_LongQuebec 1 248602 50096799 64180  
## - `Juris\_LongNova Scotia` 1 298111 50146307 64187  
## - Juris\_LongManitoba 1 329329 50177525 64192  
## - `Juris\_LongNorthwest Territories` 1 381866 50230062 64199  
## - `Juris\_LongBritish Columbia` 1 407953 50256150 64203  
## - `Juris\_LongNewfoundland and Labrador` 1 447924 50296121 64209  
## - `Juris\_LongNational parks` 1 450447 50298643 64209  
## - Juris\_LongYukon 1 457956 50306152 64210  
## - Protection.zoneUnspecified 1 494585 50342782 64216  
## - `Juris\_LongPrince Edward Island` 1 519078 50367274 64219  
## - Response.categoryModified 1 2222227 52070424 64461  
## - Response.categoryNone 1 2232873 52081069 64462  
## - Fire\_Cause\_HumanLightning 1 2909244 52757441 64556  
## Start: AIC=70826.21  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Year + Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 930 52375561 70824  
## <none> 52374631 70826  
## - Fire\_Cause\_HumanUnspecified 1 33661 52408292 70829  
## - Response.categoryUnspecified 1 42109 52416740 70831  
## - Juris\_LongOntario 1 66641 52441272 70834  
## - Juris\_LongSaskatchewan 1 140564 52515195 70846  
## - `Juris\_LongNew Brunswick` 1 170795 52545426 70850  
## - Protection.zoneLimited 1 218919 52593550 70858  
## - Juris\_LongQuebec 1 227507 52602138 70859  
## - `Juris\_LongNova Scotia` 1 274260 52648891 70866  
## - Juris\_LongManitoba 1 303593 52678224 70871  
## - `Juris\_LongNorthwest Territories` 1 352274 52726905 70878  
## - `Juris\_LongBritish Columbia` 1 424063 52798694 70889  
## - `Juris\_LongNewfoundland and Labrador` 1 430172 52804803 70890  
## - `Juris\_LongNational parks` 1 433782 52808413 70891  
## - Juris\_LongYukon 1 442500 52817131 70892  
## - Protection.zoneUnspecified 1 478409 52853040 70898  
## - `Juris\_LongPrince Edward Island` 1 520930 52895561 70904  
## - Response.categoryNone 1 2396993 54771624 71185  
## - Response.categoryModified 1 2424546 54799177 71189  
## - Fire\_Cause\_HumanLightning 1 3145905 55520536 71295  
##   
## Step: AIC=70824.35  
## .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified  
##   
## Df Sum of Sq RSS AIC  
## <none> 52375561 70824  
## - Fire\_Cause\_HumanUnspecified 1 33715 52409276 70828  
## - Response.categoryUnspecified 1 45109 52420670 70829  
## - Juris\_LongOntario 1 66028 52441589 70833  
## - Juris\_LongSaskatchewan 1 141319 52516880 70844  
## - `Juris\_LongNew Brunswick` 1 170815 52546376 70849  
## - Protection.zoneLimited 1 221784 52597345 70856  
## - Juris\_LongQuebec 1 227041 52602602 70857  
## - `Juris\_LongNova Scotia` 1 274332 52649893 70864  
## - Juris\_LongManitoba 1 305342 52680903 70869  
## - `Juris\_LongNorthwest Territories` 1 353445 52729006 70877  
## - `Juris\_LongBritish Columbia` 1 426392 52801953 70888  
## - `Juris\_LongNewfoundland and Labrador` 1 429666 52805226 70888  
## - `Juris\_LongNational parks` 1 434908 52810469 70889  
## - Juris\_LongYukon 1 445042 52820603 70891  
## - Protection.zoneUnspecified 1 480183 52855744 70896  
## - `Juris\_LongPrince Edward Island` 1 520057 52895618 70902  
## - Response.categoryNone 1 2396407 54771968 71183  
## - Response.categoryModified 1 2424826 54800387 71187  
## - Fire\_Cause\_HumanLightning 1 3145943 55521504 71293

# Stop the clock  
end.time <- Sys.time()  
  
lmStepAIC\_Mod\_time.taken <- end.time - start.time  
#lmStepAIC\_Mod\_time.taken  
#############################################################################################################################################

## 21.

## View the total amount of time taken to run each model.

Model\_Time <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 Time\_train=c(lm\_model\_time.taken, glm\_model\_time.taken, lasso\_Mod\_time.taken, knn\_model\_time.taken, LF\_model\_time.taken, LB\_model\_time.taken, lmStepAIC\_Mod\_time.taken))  
Model\_Time

## Name Time\_train  
## 1 lm\_model 1.670344 secs  
## 2 glm\_model 2.069697 secs  
## 3 lasso\_Mod 3.104741 secs  
## 4 knn\_model 11.295562 secs  
## 5 LF\_model 1.355139 secs  
## 6 LB\_model 1.226130 secs  
## 7 lmStepAIC\_Mod 9.528383 secs

## 22.

## View summaries of the models.

############################################  
# Model 1  
# Summarize the results for lm\_model  
print(lm\_model)

## Linear Regression   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results:  
##   
## RMSE Rsquared MAE   
## 77.22247 0.1928973 31.98198  
##   
## Tuning parameter 'intercept' was held constant at a value of TRUE

summary(lm\_model)

##   
## Call:  
## lm(formula = .outcome ~ ., data = dat)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -213.58 -24.93 1.98 15.18 2740.26   
##   
## Coefficients:  
## Estimate Std. Error t value  
## (Intercept) 154.34909 230.53687 0.670  
## `Juris\_LongBritish Columbia` 41.81671 5.18219 8.069  
## Juris\_LongManitoba -30.91666 4.52820 -6.828  
## `Juris\_LongNational parks` -42.37293 5.19196 -8.161  
## `Juris\_LongNew Brunswick` -35.00041 6.83461 -5.121  
## `Juris\_LongNewfoundland and Labrador` -36.23266 4.45818 -8.127  
## `Juris\_LongNorthwest Territories` -36.25666 4.92976 -7.355  
## `Juris\_LongNova Scotia` -32.67640 5.03537 -6.489  
## Juris\_LongOntario -14.47370 4.52467 -3.199  
## `Juris\_LongPrince Edward Island` -54.14775 6.05437 -8.944  
## Juris\_LongQuebec -26.29163 4.44835 -5.910  
## Juris\_LongSaskatchewan -24.83616 5.34596 -4.646  
## Juris\_LongYukon -38.39054 4.65743 -8.243  
## Year -0.04347 0.11504 -0.378  
## Fire\_Cause\_HumanLightning 63.25427 2.87803 21.978  
## Fire\_Cause\_HumanUnspecified -6.50454 2.86108 -2.273  
## Protection.zoneLimited -13.44123 2.31833 -5.798  
## Protection.zoneUnspecified 120.37435 14.04471 8.571  
## Response.categoryModified -43.14013 2.23586 -19.295  
## Response.categoryNone -42.51983 2.21634 -19.185  
## Response.categoryUnspecified 23.40792 9.20564 2.543  
## Pr(>|t|)   
## (Intercept) 0.50318   
## `Juris\_LongBritish Columbia` 8.09e-16 \*\*\*  
## Juris\_LongManitoba 9.26e-12 \*\*\*  
## `Juris\_LongNational parks` 3.82e-16 \*\*\*  
## `Juris\_LongNew Brunswick` 3.11e-07 \*\*\*  
## `Juris\_LongNewfoundland and Labrador` 5.05e-16 \*\*\*  
## `Juris\_LongNorthwest Territories` 2.10e-13 \*\*\*  
## `Juris\_LongNova Scotia` 9.13e-11 \*\*\*  
## Juris\_LongOntario 0.00139 \*\*   
## `Juris\_LongPrince Edward Island` < 2e-16 \*\*\*  
## Juris\_LongQuebec 3.55e-09 \*\*\*  
## Juris\_LongSaskatchewan 3.44e-06 \*\*\*  
## Juris\_LongYukon < 2e-16 \*\*\*  
## Year 0.70554   
## Fire\_Cause\_HumanLightning < 2e-16 \*\*\*  
## Fire\_Cause\_HumanUnspecified 0.02302 \*   
## Protection.zoneLimited 6.97e-09 \*\*\*  
## Protection.zoneUnspecified < 2e-16 \*\*\*  
## Response.categoryModified < 2e-16 \*\*\*  
## Response.categoryNone < 2e-16 \*\*\*  
## Response.categoryUnspecified 0.01102 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 80.7 on 8042 degrees of freedom  
## Multiple R-squared: 0.1783, Adjusted R-squared: 0.1763   
## F-statistic: 87.26 on 20 and 8042 DF, p-value: < 2.2e-16

lm\_model$finalModel

##   
## Call:  
## lm(formula = .outcome ~ ., data = dat)  
##   
## Coefficients:  
## (Intercept)   
## 154.34909   
## `Juris\_LongBritish Columbia`   
## 41.81671   
## Juris\_LongManitoba   
## -30.91666   
## `Juris\_LongNational parks`   
## -42.37293   
## `Juris\_LongNew Brunswick`   
## -35.00041   
## `Juris\_LongNewfoundland and Labrador`   
## -36.23266   
## `Juris\_LongNorthwest Territories`   
## -36.25666   
## `Juris\_LongNova Scotia`   
## -32.67640   
## Juris\_LongOntario   
## -14.47370   
## `Juris\_LongPrince Edward Island`   
## -54.14775   
## Juris\_LongQuebec   
## -26.29163   
## Juris\_LongSaskatchewan   
## -24.83616   
## Juris\_LongYukon   
## -38.39054   
## Year   
## -0.04347   
## Fire\_Cause\_HumanLightning   
## 63.25427   
## Fire\_Cause\_HumanUnspecified   
## -6.50454   
## Protection.zoneLimited   
## -13.44123   
## Protection.zoneUnspecified   
## 120.37435   
## Response.categoryModified   
## -43.14013   
## Response.categoryNone   
## -42.51983   
## Response.categoryUnspecified   
## 23.40792

lm\_model$modelType

## [1] "Regression"

############################################  
# Model 2  
# Summarize the results for glm model  
print(glm\_model)

## Generalized Linear Model   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results:  
##   
## RMSE Rsquared MAE   
## 77.22247 0.1928973 31.98198

summary(glm\_model)

##   
## Call:  
## NULL  
##   
## Deviance Residuals:   
## Min 1Q Median 3Q Max   
## -213.58 -24.93 1.98 15.18 2740.26   
##   
## Coefficients:  
## Estimate Std. Error t value  
## (Intercept) 154.34909 230.53687 0.670  
## `Juris\_LongBritish Columbia` 41.81671 5.18219 8.069  
## Juris\_LongManitoba -30.91666 4.52820 -6.828  
## `Juris\_LongNational parks` -42.37293 5.19196 -8.161  
## `Juris\_LongNew Brunswick` -35.00041 6.83461 -5.121  
## `Juris\_LongNewfoundland and Labrador` -36.23266 4.45818 -8.127  
## `Juris\_LongNorthwest Territories` -36.25666 4.92976 -7.355  
## `Juris\_LongNova Scotia` -32.67640 5.03537 -6.489  
## Juris\_LongOntario -14.47370 4.52467 -3.199  
## `Juris\_LongPrince Edward Island` -54.14775 6.05437 -8.944  
## Juris\_LongQuebec -26.29163 4.44835 -5.910  
## Juris\_LongSaskatchewan -24.83616 5.34596 -4.646  
## Juris\_LongYukon -38.39054 4.65743 -8.243  
## Year -0.04347 0.11504 -0.378  
## Fire\_Cause\_HumanLightning 63.25427 2.87803 21.978  
## Fire\_Cause\_HumanUnspecified -6.50454 2.86108 -2.273  
## Protection.zoneLimited -13.44123 2.31833 -5.798  
## Protection.zoneUnspecified 120.37435 14.04471 8.571  
## Response.categoryModified -43.14013 2.23586 -19.295  
## Response.categoryNone -42.51983 2.21634 -19.185  
## Response.categoryUnspecified 23.40792 9.20564 2.543  
## Pr(>|t|)   
## (Intercept) 0.50318   
## `Juris\_LongBritish Columbia` 8.09e-16 \*\*\*  
## Juris\_LongManitoba 9.26e-12 \*\*\*  
## `Juris\_LongNational parks` 3.82e-16 \*\*\*  
## `Juris\_LongNew Brunswick` 3.11e-07 \*\*\*  
## `Juris\_LongNewfoundland and Labrador` 5.05e-16 \*\*\*  
## `Juris\_LongNorthwest Territories` 2.10e-13 \*\*\*  
## `Juris\_LongNova Scotia` 9.13e-11 \*\*\*  
## Juris\_LongOntario 0.00139 \*\*   
## `Juris\_LongPrince Edward Island` < 2e-16 \*\*\*  
## Juris\_LongQuebec 3.55e-09 \*\*\*  
## Juris\_LongSaskatchewan 3.44e-06 \*\*\*  
## Juris\_LongYukon < 2e-16 \*\*\*  
## Year 0.70554   
## Fire\_Cause\_HumanLightning < 2e-16 \*\*\*  
## Fire\_Cause\_HumanUnspecified 0.02302 \*   
## Protection.zoneLimited 6.97e-09 \*\*\*  
## Protection.zoneUnspecified < 2e-16 \*\*\*  
## Response.categoryModified < 2e-16 \*\*\*  
## Response.categoryNone < 2e-16 \*\*\*  
## Response.categoryUnspecified 0.01102 \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## (Dispersion parameter for gaussian family taken to be 6512.638)  
##   
## Null deviance: 63740265 on 8062 degrees of freedom  
## Residual deviance: 52374631 on 8042 degrees of freedom  
## AIC: 93710  
##   
## Number of Fisher Scoring iterations: 2

glm\_model$finalModel

##   
## Call: NULL  
##   
## Coefficients:  
## (Intercept)   
## 154.34909   
## `Juris\_LongBritish Columbia`   
## 41.81671   
## Juris\_LongManitoba   
## -30.91666   
## `Juris\_LongNational parks`   
## -42.37293   
## `Juris\_LongNew Brunswick`   
## -35.00041   
## `Juris\_LongNewfoundland and Labrador`   
## -36.23266   
## `Juris\_LongNorthwest Territories`   
## -36.25666   
## `Juris\_LongNova Scotia`   
## -32.67640   
## Juris\_LongOntario   
## -14.47370   
## `Juris\_LongPrince Edward Island`   
## -54.14775   
## Juris\_LongQuebec   
## -26.29163   
## Juris\_LongSaskatchewan   
## -24.83616   
## Juris\_LongYukon   
## -38.39054   
## Year   
## -0.04347   
## Fire\_Cause\_HumanLightning   
## 63.25427   
## Fire\_Cause\_HumanUnspecified   
## -6.50454   
## Protection.zoneLimited   
## -13.44123   
## Protection.zoneUnspecified   
## 120.37435   
## Response.categoryModified   
## -43.14013   
## Response.categoryNone   
## -42.51983   
## Response.categoryUnspecified   
## 23.40792   
##   
## Degrees of Freedom: 8062 Total (i.e. Null); 8042 Residual  
## Null Deviance: 63740000   
## Residual Deviance: 52370000 AIC: 93710

glm\_model$modelType

## [1] "Regression"

############################################  
# Model 3  
# Summarize the results  
print(lasso\_Mod)

## The lasso   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results across tuning parameters:  
##   
## fraction RMSE Rsquared MAE   
## 0.1 82.06836 0.1026530 27.46602  
## 0.5 77.64201 0.1814554 27.84705  
## 0.9 77.21586 0.1924205 31.45668  
##   
## RMSE was used to select the optimal model using the smallest value.  
## The final value used for the model was fraction = 0.9.

summary(lasso\_Mod)

## Length Class Mode   
## call 4 -none- call   
## actions 23 -none- list   
## allset 20 -none- numeric   
## beta.pure 460 -none- numeric   
## vn 20 -none- character  
## mu 1 -none- numeric   
## normx 20 -none- numeric   
## meanx 20 -none- numeric   
## lambda 1 -none- numeric   
## L1norm 23 -none- numeric   
## penalty 23 -none- numeric   
## df 23 -none- numeric   
## Cp 23 -none- numeric   
## sigma2 1 -none- numeric   
## xNames 20 -none- character  
## problemType 1 -none- character  
## tuneValue 1 data.frame list   
## obsLevels 1 -none- logical   
## param 0 -none- list

lasso\_Mod$finalModel

##   
## Call:  
## elasticnet::enet(x = as.matrix(x), y = y, lambda = 0)  
## Cp statistics of the Lasso fit   
## Cp: 1726.166 1579.967 1146.320 1128.205 859.369 721.493 332.227 296.328 266.146 262.880 257.602 230.616 174.415 153.688 112.116 113.737 90.479 79.546 65.367 43.739 40.769 35.819 21.000   
## DF: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 19 19 20 21   
## Sequence of moves:  
## Fire\_Cause\_HumanLightning Juris\_LongBritish Columbia  
## Var 14 1  
## Step 1 2  
## Response.categoryNone Response.categoryModified  
## Var 19 18  
## Step 3 4  
## Protection.zoneUnspecified Protection.zoneLimited Juris\_LongOntario  
## Var 17 16 8  
## Step 5 6 7  
## Juris\_LongPrince Edward Island Juris\_LongNewfoundland and Labrador  
## Var 9 5  
## Step 8 9  
## Juris\_LongYukon Response.categoryUnspecified Juris\_LongNational parks  
## Var 12 20 3  
## Step 10 11 12  
## Fire\_Cause\_HumanUnspecified Juris\_LongNorthwest Territories  
## Var 15 6  
## Step 13 14  
## Juris\_LongManitoba Juris\_LongNova Scotia Juris\_LongNew Brunswick  
## Var 2 7 4  
## Step 15 16 17  
## Juris\_LongQuebec Juris\_LongSaskatchewan Juris\_LongOntario Year  
## Var 10 11 -8 13  
## Step 18 19 20 21  
## Juris\_LongOntario   
## Var 8 23  
## Step 22 23

lasso\_Mod$modelType

## [1] "Regression"

############################################  
# Model 4  
# Summarize the results for knn model  
print(knn\_model)

## k-Nearest Neighbors   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results across tuning parameters:  
##   
## k RMSE Rsquared MAE   
## 5 71.39146 0.3370965 19.52759  
## 7 72.66055 0.3159042 20.54021  
## 9 74.58184 0.2730133 20.99600  
##   
## RMSE was used to select the optimal model using the smallest value.  
## The final value used for the model was k = 5.

summary(knn\_model)

## Length Class Mode   
## learn 2 -none- list   
## k 1 -none- numeric   
## theDots 0 -none- list   
## xNames 20 -none- character  
## problemType 1 -none- character  
## tuneValue 1 data.frame list   
## obsLevels 1 -none- logical   
## param 0 -none- list

knn\_model$finalModel

## 5-nearest neighbor regression model

knn\_model$modelType

## [1] "Regression"

############################################  
# Model 5  
# Summarize the results for LF model  
print(LF\_model)

## Linear Regression with Forward Selection   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results across tuning parameters:  
##   
## nvmax RMSE Rsquared MAE   
## 2 81.45493 0.09503802 26.84632  
## 3 80.75852 0.11134722 29.92717  
## 4 78.67288 0.15923082 31.12262  
##   
## RMSE was used to select the optimal model using the smallest value.  
## The final value used for the model was nvmax = 4.

summary(LF\_model)

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: forward  
## Juris\_LongBritish Columbia Juris\_LongManitoba  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) "\*" " "   
## 3 ( 1 ) "\*" " "   
## 4 ( 1 ) "\*" " "   
## Juris\_LongNational parks Juris\_LongNew Brunswick  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Juris\_LongNewfoundland and Labrador  
## 1 ( 1 ) " "   
## 2 ( 1 ) " "   
## 3 ( 1 ) " "   
## 4 ( 1 ) " "   
## Juris\_LongNorthwest Territories Juris\_LongNova Scotia  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Juris\_LongOntario Juris\_LongPrince Edward Island Juris\_LongQuebec  
## 1 ( 1 ) " " " " " "   
## 2 ( 1 ) " " " " " "   
## 3 ( 1 ) " " " " " "   
## 4 ( 1 ) " " " " " "   
## Juris\_LongSaskatchewan Juris\_LongYukon Year  
## 1 ( 1 ) " " " " " "   
## 2 ( 1 ) " " " " " "   
## 3 ( 1 ) " " " " " "   
## 4 ( 1 ) " " " " " "   
## Fire\_Cause\_HumanLightning Fire\_Cause\_HumanUnspecified  
## 1 ( 1 ) "\*" " "   
## 2 ( 1 ) "\*" " "   
## 3 ( 1 ) "\*" " "   
## 4 ( 1 ) "\*" " "   
## Protection.zoneLimited Protection.zoneUnspecified  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Response.categoryModified Response.categoryNone  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " "\*"   
## 4 ( 1 ) "\*" "\*"   
## Response.categoryUnspecified  
## 1 ( 1 ) " "   
## 2 ( 1 ) " "   
## 3 ( 1 ) " "   
## 4 ( 1 ) " "

LF\_model$finalModel

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: forward

LF\_model$modelType

## [1] "Regression"

############################################  
# Model 6  
# Summarize the results for LB Modle  
print(LB\_model)

## Linear Regression with Backwards Selection   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results across tuning parameters:  
##   
## nvmax RMSE Rsquared MAE   
## 2 82.34835 0.07300568 28.59664  
## 3 80.66547 0.11173818 28.85405  
## 4 78.67288 0.15923082 31.12262  
##   
## RMSE was used to select the optimal model using the smallest value.  
## The final value used for the model was nvmax = 4.

summary(LB\_model)

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: backward  
## Juris\_LongBritish Columbia Juris\_LongManitoba  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) "\*" " "   
## Juris\_LongNational parks Juris\_LongNew Brunswick  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Juris\_LongNewfoundland and Labrador  
## 1 ( 1 ) " "   
## 2 ( 1 ) " "   
## 3 ( 1 ) " "   
## 4 ( 1 ) " "   
## Juris\_LongNorthwest Territories Juris\_LongNova Scotia  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Juris\_LongOntario Juris\_LongPrince Edward Island Juris\_LongQuebec  
## 1 ( 1 ) " " " " " "   
## 2 ( 1 ) " " " " " "   
## 3 ( 1 ) " " " " " "   
## 4 ( 1 ) " " " " " "   
## Juris\_LongSaskatchewan Juris\_LongYukon Year  
## 1 ( 1 ) " " " " " "   
## 2 ( 1 ) " " " " " "   
## 3 ( 1 ) " " " " " "   
## 4 ( 1 ) " " " " " "   
## Fire\_Cause\_HumanLightning Fire\_Cause\_HumanUnspecified  
## 1 ( 1 ) "\*" " "   
## 2 ( 1 ) "\*" " "   
## 3 ( 1 ) "\*" " "   
## 4 ( 1 ) "\*" " "   
## Protection.zoneLimited Protection.zoneUnspecified  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " " "   
## 3 ( 1 ) " " " "   
## 4 ( 1 ) " " " "   
## Response.categoryModified Response.categoryNone  
## 1 ( 1 ) " " " "   
## 2 ( 1 ) " " "\*"   
## 3 ( 1 ) "\*" "\*"   
## 4 ( 1 ) "\*" "\*"   
## Response.categoryUnspecified  
## 1 ( 1 ) " "   
## 2 ( 1 ) " "   
## 3 ( 1 ) " "   
## 4 ( 1 ) " "

LB\_model$finalModel

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: backward

LB\_model$modelType

## [1] "Regression"

############################################  
# Model 7  
# Summarize the results for lmStepAIC  
print(lmStepAIC\_Mod)

## Linear Regression with Stepwise Selection   
##   
## 8063 samples  
## 5 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (10 fold, repeated 3 times)   
## Summary of sample sizes: 7256, 7258, 7257, 7256, 7256, 7256, ...   
## Resampling results:  
##   
## RMSE Rsquared MAE   
## 77.21136 0.1931339 31.97654

summary(lmStepAIC\_Mod)

##   
## Call:  
## lm(formula = .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified, data = dat)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -213.57 -24.76 2.15 15.04 2740.60   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 67.249 3.735 18.004 < 2e-16  
## `Juris\_LongBritish Columbia` 41.897 5.178 8.092 6.74e-16  
## Juris\_LongManitoba -30.983 4.525 -6.848 8.06e-12  
## `Juris\_LongNational parks` -42.417 5.190 -8.172 3.49e-16  
## `Juris\_LongNew Brunswick` -35.002 6.834 -5.122 3.10e-07  
## `Juris\_LongNewfoundland and Labrador` -36.207 4.457 -8.123 5.23e-16  
## `Juris\_LongNorthwest Territories` -36.305 4.928 -7.367 1.91e-13  
## `Juris\_LongNova Scotia` -32.681 5.035 -6.491 9.06e-11  
## Juris\_LongOntario -14.389 4.519 -3.184 0.00146  
## `Juris\_LongPrince Edward Island` -54.027 6.046 -8.937 < 2e-16  
## Juris\_LongQuebec -26.260 4.447 -5.905 3.68e-09  
## Juris\_LongSaskatchewan -24.893 5.344 -4.658 3.24e-06  
## Juris\_LongYukon -38.466 4.653 -8.267 < 2e-16  
## Fire\_Cause\_HumanLightning 63.255 2.878 21.980 < 2e-16  
## Fire\_Cause\_HumanUnspecified -6.510 2.861 -2.275 0.02291  
## Protection.zoneLimited -13.499 2.313 -5.836 5.56e-09  
## Protection.zoneUnspecified 119.744 13.945 8.587 < 2e-16  
## Response.categoryModified -43.142 2.236 -19.297 < 2e-16  
## Response.categoryNone -42.493 2.215 -19.183 < 2e-16  
## Response.categoryUnspecified 23.941 9.096 2.632 0.00851  
##   
## (Intercept) \*\*\*  
## `Juris\_LongBritish Columbia` \*\*\*  
## Juris\_LongManitoba \*\*\*  
## `Juris\_LongNational parks` \*\*\*  
## `Juris\_LongNew Brunswick` \*\*\*  
## `Juris\_LongNewfoundland and Labrador` \*\*\*  
## `Juris\_LongNorthwest Territories` \*\*\*  
## `Juris\_LongNova Scotia` \*\*\*  
## Juris\_LongOntario \*\*   
## `Juris\_LongPrince Edward Island` \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*   
## Protection.zoneLimited \*\*\*  
## Protection.zoneUnspecified \*\*\*  
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 80.7 on 8043 degrees of freedom  
## Multiple R-squared: 0.1783, Adjusted R-squared: 0.1764   
## F-statistic: 91.85 on 19 and 8043 DF, p-value: < 2.2e-16

lmStepAIC\_Mod$finalModel

##   
## Call:  
## lm(formula = .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified, data = dat)  
##   
## Coefficients:  
## (Intercept)   
## 67.25   
## `Juris\_LongBritish Columbia`   
## 41.90   
## Juris\_LongManitoba   
## -30.98   
## `Juris\_LongNational parks`   
## -42.42   
## `Juris\_LongNew Brunswick`   
## -35.00   
## `Juris\_LongNewfoundland and Labrador`   
## -36.21   
## `Juris\_LongNorthwest Territories`   
## -36.30   
## `Juris\_LongNova Scotia`   
## -32.68   
## Juris\_LongOntario   
## -14.39   
## `Juris\_LongPrince Edward Island`   
## -54.03   
## Juris\_LongQuebec   
## -26.26   
## Juris\_LongSaskatchewan   
## -24.89   
## Juris\_LongYukon   
## -38.47   
## Fire\_Cause\_HumanLightning   
## 63.25   
## Fire\_Cause\_HumanUnspecified   
## -6.51   
## Protection.zoneLimited   
## -13.50   
## Protection.zoneUnspecified   
## 119.74   
## Response.categoryModified   
## -43.14   
## Response.categoryNone   
## -42.49   
## Response.categoryUnspecified   
## 23.94

lmStepAIC\_Mod$modelType

## [1] "Regression"

############################################

## 23.

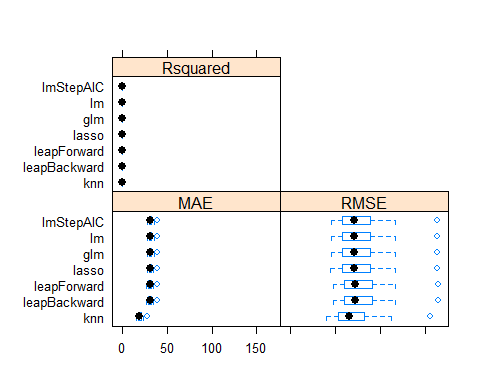
## Evaluation of techniques

## View the results of the models

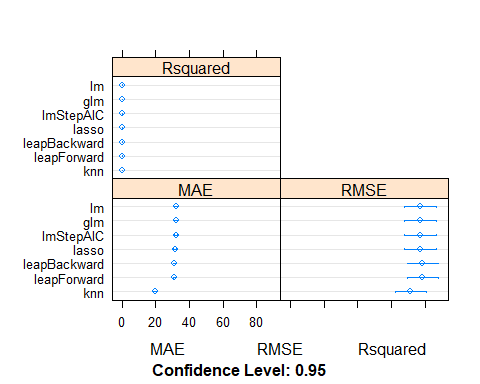
# Evaluation of techniques  
results <- resamples(list(lm=lm\_model, glm=glm\_model,lasso=lasso\_Mod, knn=knn\_model, leapForward=LF\_model,leapBackward=LB\_model, lmStepAIC=lmStepAIC\_Mod))  
summary(results)

##   
## Call:  
## summary.resamples(object = results)  
##   
## Models: lm, glm, lasso, knn, leapForward, leapBackward, lmStepAIC   
## Number of resamples: 30   
##   
## MAE   
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's  
## lm 28.58164 30.40722 31.53622 31.98198 32.86749 39.50340 0  
## glm 28.58164 30.40722 31.53622 31.98198 32.86749 39.50340 0  
## lasso 28.00965 29.88669 30.98968 31.45668 32.37587 39.10188 0  
## knn 15.63077 17.60095 19.58295 19.52759 21.30790 27.65263 0  
## leapForward 27.18411 29.63931 30.92311 31.12262 32.13530 38.99185 0  
## leapBackward 27.18411 29.63931 30.92311 31.12262 32.13530 38.99185 0  
## lmStepAIC 28.58038 30.38066 31.53729 31.97654 32.86789 39.49668 0  
##   
## RMSE   
## Min. 1st Qu. Median Mean 3rd Qu. Max. NA's  
## lm 44.97586 59.27926 71.43239 77.22247 88.57518 163.7933 0  
## glm 44.97586 59.27926 71.43239 77.22247 88.57518 163.7933 0  
## lasso 44.70632 59.23576 71.34364 77.21586 88.58968 163.9009 0  
## knn 39.46829 53.83996 66.06778 71.39146 82.26606 155.3784 0  
## leapForward 47.18711 61.05156 72.08204 78.67288 90.45263 164.8756 0  
## leapBackward 47.18711 61.05156 72.08204 78.67288 90.45263 164.8756 0  
## lmStepAIC 44.97774 59.25866 71.42787 77.21136 88.57438 163.7840 0  
##   
## Rsquared   
## Min. 1st Qu. Median Mean 3rd Qu. Max.  
## lm 0.1291107 0.1724644 0.1902165 0.1928973 0.2190105 0.2817280  
## glm 0.1291107 0.1724644 0.1902165 0.1928973 0.2190105 0.2817280  
## lasso 0.1267764 0.1701873 0.1917980 0.1924205 0.2181093 0.2833346  
## knn 0.1574098 0.2710675 0.3538846 0.3370965 0.3979361 0.4970909  
## leapForward 0.1137441 0.1347978 0.1608636 0.1592308 0.1822116 0.2069403  
## leapBackward 0.1137441 0.1347978 0.1608636 0.1592308 0.1822116 0.2069403  
## lmStepAIC 0.1291071 0.1723888 0.1907934 0.1931339 0.2205432 0.2816704  
## NA's  
## lm 0  
## glm 0  
## lasso 0  
## knn 0  
## leapForward 0  
## leapBackward 0  
## lmStepAIC 0

# Compare results with boxplots   
bwplot(results)



# Compare results with dot plots   
dotplot(results)



## 24.

## Find the best results for each model.

get\_best\_result = function(caret\_fit) {  
 best = which(rownames(caret\_fit$results) == rownames(caret\_fit$bestTune))  
 best\_result = caret\_fit$results[best, ]  
 rownames(best\_result) = NULL  
 best\_result  
}  
  
###################################################################################  
lm\_best <- data.frame(get\_best\_result(lm\_model) %>%  
 dplyr::select(2:4))  
lm\_model$finalModel

##   
## Call:  
## lm(formula = .outcome ~ ., data = dat)  
##   
## Coefficients:  
## (Intercept)   
## 154.34909   
## `Juris\_LongBritish Columbia`   
## 41.81671   
## Juris\_LongManitoba   
## -30.91666   
## `Juris\_LongNational parks`   
## -42.37293   
## `Juris\_LongNew Brunswick`   
## -35.00041   
## `Juris\_LongNewfoundland and Labrador`   
## -36.23266   
## `Juris\_LongNorthwest Territories`   
## -36.25666   
## `Juris\_LongNova Scotia`   
## -32.67640   
## Juris\_LongOntario   
## -14.47370   
## `Juris\_LongPrince Edward Island`   
## -54.14775   
## Juris\_LongQuebec   
## -26.29163   
## Juris\_LongSaskatchewan   
## -24.83616   
## Juris\_LongYukon   
## -38.39054   
## Year   
## -0.04347   
## Fire\_Cause\_HumanLightning   
## 63.25427   
## Fire\_Cause\_HumanUnspecified   
## -6.50454   
## Protection.zoneLimited   
## -13.44123   
## Protection.zoneUnspecified   
## 120.37435   
## Response.categoryModified   
## -43.14013   
## Response.categoryNone   
## -42.51983   
## Response.categoryUnspecified   
## 23.40792

###################################################################################  
glm\_best <- data.frame(get\_best\_result(glm\_model) %>%   
 dplyr::select(2:4))  
glm\_model$finalModel

##   
## Call: NULL  
##   
## Coefficients:  
## (Intercept)   
## 154.34909   
## `Juris\_LongBritish Columbia`   
## 41.81671   
## Juris\_LongManitoba   
## -30.91666   
## `Juris\_LongNational parks`   
## -42.37293   
## `Juris\_LongNew Brunswick`   
## -35.00041   
## `Juris\_LongNewfoundland and Labrador`   
## -36.23266   
## `Juris\_LongNorthwest Territories`   
## -36.25666   
## `Juris\_LongNova Scotia`   
## -32.67640   
## Juris\_LongOntario   
## -14.47370   
## `Juris\_LongPrince Edward Island`   
## -54.14775   
## Juris\_LongQuebec   
## -26.29163   
## Juris\_LongSaskatchewan   
## -24.83616   
## Juris\_LongYukon   
## -38.39054   
## Year   
## -0.04347   
## Fire\_Cause\_HumanLightning   
## 63.25427   
## Fire\_Cause\_HumanUnspecified   
## -6.50454   
## Protection.zoneLimited   
## -13.44123   
## Protection.zoneUnspecified   
## 120.37435   
## Response.categoryModified   
## -43.14013   
## Response.categoryNone   
## -42.51983   
## Response.categoryUnspecified   
## 23.40792   
##   
## Degrees of Freedom: 8062 Total (i.e. Null); 8042 Residual  
## Null Deviance: 63740000   
## Residual Deviance: 52370000 AIC: 93710

###################################################################################  
lasso\_best <- data.frame(get\_best\_result(lasso\_Mod) %>%   
 dplyr::select(2:4))  
lasso\_Mod$finalModel

##   
## Call:  
## elasticnet::enet(x = as.matrix(x), y = y, lambda = 0)  
## Cp statistics of the Lasso fit   
## Cp: 1726.166 1579.967 1146.320 1128.205 859.369 721.493 332.227 296.328 266.146 262.880 257.602 230.616 174.415 153.688 112.116 113.737 90.479 79.546 65.367 43.739 40.769 35.819 21.000   
## DF: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 19 19 20 21   
## Sequence of moves:  
## Fire\_Cause\_HumanLightning Juris\_LongBritish Columbia  
## Var 14 1  
## Step 1 2  
## Response.categoryNone Response.categoryModified  
## Var 19 18  
## Step 3 4  
## Protection.zoneUnspecified Protection.zoneLimited Juris\_LongOntario  
## Var 17 16 8  
## Step 5 6 7  
## Juris\_LongPrince Edward Island Juris\_LongNewfoundland and Labrador  
## Var 9 5  
## Step 8 9  
## Juris\_LongYukon Response.categoryUnspecified Juris\_LongNational parks  
## Var 12 20 3  
## Step 10 11 12  
## Fire\_Cause\_HumanUnspecified Juris\_LongNorthwest Territories  
## Var 15 6  
## Step 13 14  
## Juris\_LongManitoba Juris\_LongNova Scotia Juris\_LongNew Brunswick  
## Var 2 7 4  
## Step 15 16 17  
## Juris\_LongQuebec Juris\_LongSaskatchewan Juris\_LongOntario Year  
## Var 10 11 -8 13  
## Step 18 19 20 21  
## Juris\_LongOntario   
## Var 8 23  
## Step 22 23

###################################################################################  
knn\_best <- data.frame(get\_best\_result(knn\_model) %>%   
 dplyr::select(2:4))  
knn\_model$finalModel

## 5-nearest neighbor regression model

###################################################################################  
LF\_best <- data.frame(get\_best\_result(LF\_model) %>%   
 dplyr::select(2:4))  
LF\_model$finalModel

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: forward

###################################################################################  
LB\_best <- data.frame(get\_best\_result(LB\_model) %>%   
 dplyr::select(2:4))  
LB\_model$finalModel

## Subset selection object  
## 20 Variables (and intercept)  
## Forced in Forced out  
## Juris\_LongBritish Columbia FALSE FALSE  
## Juris\_LongManitoba FALSE FALSE  
## Juris\_LongNational parks FALSE FALSE  
## Juris\_LongNew Brunswick FALSE FALSE  
## Juris\_LongNewfoundland and Labrador FALSE FALSE  
## Juris\_LongNorthwest Territories FALSE FALSE  
## Juris\_LongNova Scotia FALSE FALSE  
## Juris\_LongOntario FALSE FALSE  
## Juris\_LongPrince Edward Island FALSE FALSE  
## Juris\_LongQuebec FALSE FALSE  
## Juris\_LongSaskatchewan FALSE FALSE  
## Juris\_LongYukon FALSE FALSE  
## Year FALSE FALSE  
## Fire\_Cause\_HumanLightning FALSE FALSE  
## Fire\_Cause\_HumanUnspecified FALSE FALSE  
## Protection.zoneLimited FALSE FALSE  
## Protection.zoneUnspecified FALSE FALSE  
## Response.categoryModified FALSE FALSE  
## Response.categoryNone FALSE FALSE  
## Response.categoryUnspecified FALSE FALSE  
## 1 subsets of each size up to 4  
## Selection Algorithm: backward

###################################################################################  
lmStep\_best <- data.frame(get\_best\_result(lmStepAIC\_Mod) %>%   
 dplyr::select(2:4))  
lmStepAIC\_Mod$finalModel

##   
## Call:  
## lm(formula = .outcome ~ `Juris\_LongBritish Columbia` + Juris\_LongManitoba +   
## `Juris\_LongNational parks` + `Juris\_LongNew Brunswick` +   
## `Juris\_LongNewfoundland and Labrador` + `Juris\_LongNorthwest Territories` +   
## `Juris\_LongNova Scotia` + Juris\_LongOntario + `Juris\_LongPrince Edward Island` +   
## Juris\_LongQuebec + Juris\_LongSaskatchewan + Juris\_LongYukon +   
## Fire\_Cause\_HumanLightning + Fire\_Cause\_HumanUnspecified +   
## Protection.zoneLimited + Protection.zoneUnspecified + Response.categoryModified +   
## Response.categoryNone + Response.categoryUnspecified, data = dat)  
##   
## Coefficients:  
## (Intercept)   
## 67.25   
## `Juris\_LongBritish Columbia`   
## 41.90   
## Juris\_LongManitoba   
## -30.98   
## `Juris\_LongNational parks`   
## -42.42   
## `Juris\_LongNew Brunswick`   
## -35.00   
## `Juris\_LongNewfoundland and Labrador`   
## -36.21   
## `Juris\_LongNorthwest Territories`   
## -36.30   
## `Juris\_LongNova Scotia`   
## -32.68   
## Juris\_LongOntario   
## -14.39   
## `Juris\_LongPrince Edward Island`   
## -54.03   
## Juris\_LongQuebec   
## -26.26   
## Juris\_LongSaskatchewan   
## -24.89   
## Juris\_LongYukon   
## -38.47   
## Fire\_Cause\_HumanLightning   
## 63.25   
## Fire\_Cause\_HumanUnspecified   
## -6.51   
## Protection.zoneLimited   
## -13.50   
## Protection.zoneUnspecified   
## 119.74   
## Response.categoryModified   
## -43.14   
## Response.categoryNone   
## -42.49   
## Response.categoryUnspecified   
## 23.94

###################################################################################  
total <- rbind(lm\_best, glm\_best, lasso\_best, knn\_best, LF\_best, LB\_best, lmStep\_best)  
total\_best\_train <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 total,  
 Model\_Time)%>%   
 dplyr::select(-5)  
total\_best\_train

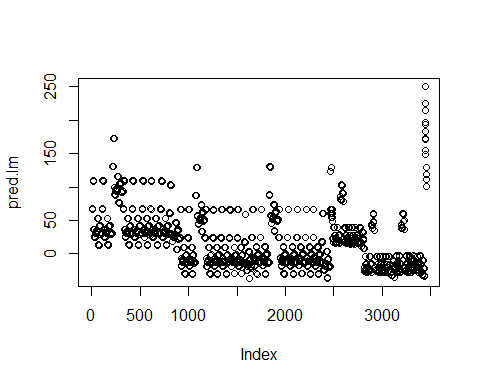
## Name RMSE Rsquared MAE Time\_train  
## 1 lm\_model 77.22247 0.1928973 31.98198 1.670344 secs  
## 2 glm\_model 77.22247 0.1928973 31.98198 2.069697 secs  
## 3 lasso\_Mod 77.21586 0.1924205 31.45668 3.104741 secs  
## 4 knn\_model 71.39146 0.3370965 19.52759 11.295562 secs  
## 5 LF\_model 78.67288 0.1592308 31.12262 1.355139 secs  
## 6 LB\_model 78.67288 0.1592308 31.12262 1.226130 secs  
## 7 lmStepAIC\_Mod 77.21136 0.1931339 31.97654 9.528383 secs

## 25. Predict on test set

#############################################################################################################################################  
# Model 1: lm model  
start.time <- Sys.time()  
  
set.seed(123)   
pred.lm = predict(lm\_model, newdata = test.set)  
output <- cbind(test.set, pred.lm)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.lm  
## 1 Human 67.80157  
## 2 Human 67.75810  
## 3 Human 67.41035  
## 4 Human 67.14953  
## 5 Human 67.10606  
## 6 Human 66.97565

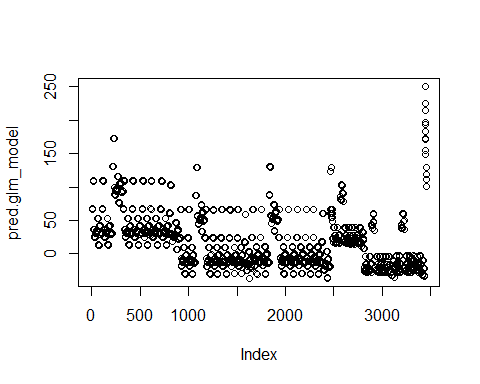
plot(pred.lm)



# Stop the clock  
end.time <- Sys.time()  
  
pre.lm\_model\_time.taken <- end.time - start.time  
#############################################################################################################################################  
# Model 2: glm model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.glm\_model = predict(glm\_model, newdata = test.set)  
output <- cbind(test.set, pred.glm\_model)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.glm\_model  
## 1 Human 67.80157  
## 2 Human 67.75810  
## 3 Human 67.41035  
## 4 Human 67.14953  
## 5 Human 67.10606  
## 6 Human 66.97565

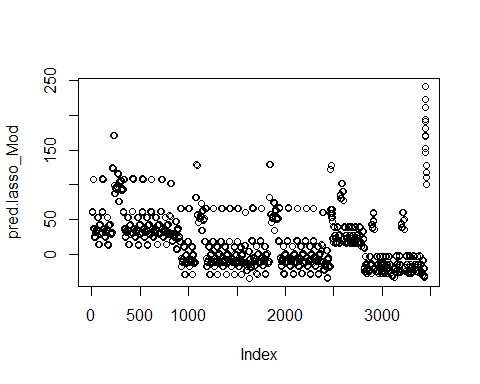
plot(pred.glm\_model)



# Stop the clock  
end.time <- Sys.time()  
  
pre.glm\_model\_time.taken <- end.time - start.time  
#glm\_model\_time.taken  
  
#############################################################################################################################################  
# Model 3: lasso model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.lasso\_Mod = predict(lasso\_Mod, newdata = test.set)  
output <- cbind(test.set, pred.lasso\_Mod)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.lasso\_Mod  
## 1 Human 61.51035  
## 2 Human 61.48249  
## 3 Human 61.25969  
## 4 Human 61.09258  
## 5 Human 61.06473  
## 6 Human 60.98118

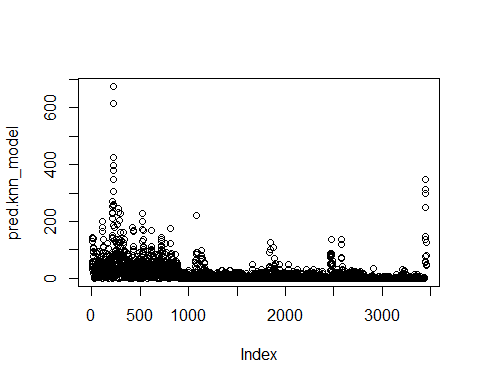
plot(pred.lasso\_Mod)



# Stop the clock  
end.time <- Sys.time()  
  
pre.lasso\_Mod\_time.taken <- end.time - start.time  
#lasso\_Mod\_time.taken  
#############################################################################################################################################  
# Model 4: knn model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.knn\_model = predict(knn\_model, newdata = test.set)  
output <- cbind(test.set, pred.knn\_model)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.knn\_model  
## 1 Human 49.92208  
## 2 Human 50.76812  
## 3 Human 37.36585  
## 4 Human 41.06329  
## 5 Human 37.12941  
## 6 Human 130.80000

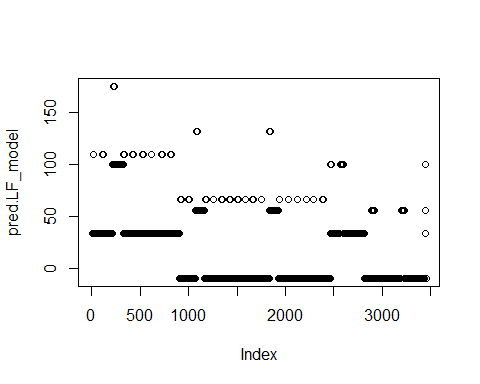
plot(pred.knn\_model)



# Stop the clock  
end.time <- Sys.time()  
  
pre.knn\_model\_time.taken <- end.time - start.time  
#knn\_model\_time.taken  
#############################################################################################################################################  
# Model 5: leapForward model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.LF\_model = predict(LF\_model, newdata = test.set)  
output <- cbind(test.set, pred.LF\_model)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.LF\_model  
## 1 Human 34.02526  
## 2 Human 34.02526  
## 3 Human 34.02526  
## 4 Human 34.02526  
## 5 Human 34.02526  
## 6 Human 34.02526

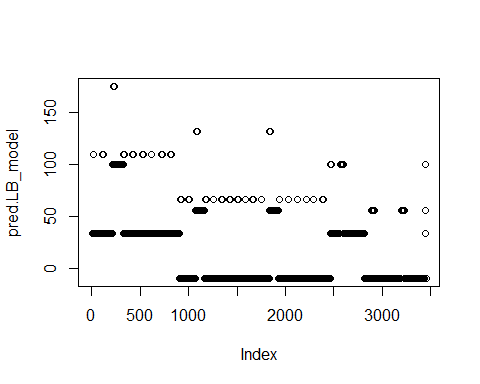
plot(pred.LF\_model)



# Stop the clock  
end.time <- Sys.time()  
  
pre.LF\_model\_time.taken <- end.time - start.time  
#LF\_model\_time.taken  
#############################################################################################################################################  
# Model 6: leapBackward model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.LB\_model = predict(LB\_model, newdata = test.set)  
output <- cbind(test.set, pred.LB\_model)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.LB\_model  
## 1 Human 34.02526  
## 2 Human 34.02526  
## 3 Human 34.02526  
## 4 Human 34.02526  
## 5 Human 34.02526  
## 6 Human 34.02526

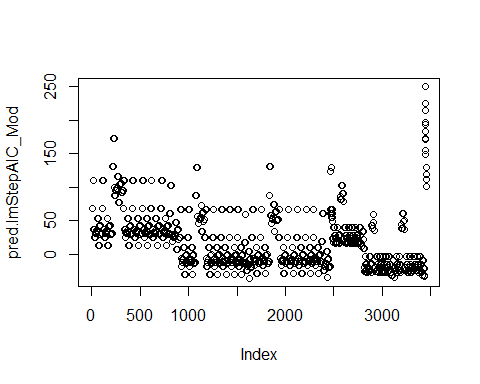
plot(pred.LB\_model)



# Stop the clock  
end.time <- Sys.time()  
  
pre.LB\_model\_time.taken <- end.time - start.time  
#LB\_model\_time.taken  
#############################################################################################################################################  
# Model 7: lmStepAIC model  
# Start the clock  
start.time <- Sys.time()  
  
set.seed(123)   
pred.lmStepAIC\_Mod = predict(lmStepAIC\_Mod, newdata = test.set)  
output <- cbind(test.set, pred.lmStepAIC\_Mod)  
head(output)

## Cause Jurisdiction Number Protection.zone Response.category  
## 1 Forest industry AB 14 Intensive Full  
## 2 Forest industry AB 12 Intensive Full  
## 3 Forest industry AB 10 Intensive Full  
## 4 Forest industry AB 26 Intensive Full  
## 5 Forest industry AB 19 Intensive Full  
## 6 Forest industry AB 22 Intensive Full  
## Year Juris\_Long Cause\_Grouped Time1 Time2 Region  
## 1 1991 Alberta People Early 90s 1990s Prairie Region  
## 2 1992 Alberta People Early 90s 1990s Prairie Region  
## 3 2000 Alberta People Late 90s 2000s Prairie Region  
## 4 2006 Alberta People Late 10s 2000s Prairie Region  
## 5 2007 Alberta People Late 10s 2000s Prairie Region  
## 6 2010 Alberta People Late 10s 2010s Prairie Region  
## Fire\_Cause\_Human pred.lmStepAIC\_Mod  
## 1 Human 67.24912  
## 2 Human 67.24912  
## 3 Human 67.24912  
## 4 Human 67.24912  
## 5 Human 67.24912  
## 6 Human 67.24912

plot(pred.lmStepAIC\_Mod)



# Stop the clock  
end.time <- Sys.time()  
  
pre.lmStepAIC\_Mod\_time.taken <- end.time - start.time  
#lmStepAIC\_Mod\_time.taken  
#############################################################################################################################################

## 26. Time taken for prediction

Model\_TimePred <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 Predict\_Time=c(pre.lm\_model\_time.taken, pre.glm\_model\_time.taken, pre.lasso\_Mod\_time.taken, pre.knn\_model\_time.taken, pre.LF\_model\_time.taken, pre.LB\_model\_time.taken, pre.lmStepAIC\_Mod\_time.taken))  
Model\_TimePred

## Name Predict\_Time  
## 1 lm\_model 0.13870001 secs  
## 2 glm\_model 0.10936308 secs  
## 3 lasso\_Mod 0.11048102 secs  
## 4 knn\_model 0.63588595 secs  
## 5 LF\_model 0.09868097 secs  
## 6 LB\_model 0.12181211 secs  
## 7 lmStepAIC\_Mod 0.12989306 secs

## 27. Compare correlation between actual and predicted

#############################################################################################################################################  
# Formula to calculate correlation   
corr\_lm\_model <- round(cor(test.set$Number, predict(lm\_model, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_glm\_model <- round(cor(test.set$Number, predict(glm\_model, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_lasso\_Mod <- round(cor(test.set$Number, predict(lasso\_Mod, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_knn\_model <- round(cor(test.set$Number, predict(knn\_model, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_LF\_model <- round(cor(test.set$Number, predict(LF\_model, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_LB\_model <- round(cor(test.set$Number, predict(LB\_model, test.set), method = c("pearson", "kendall", "spearman")),2)  
corr\_lmStepAIC\_Mod <- round(cor(test.set$Number, predict(lmStepAIC\_Mod, test.set), method = c("pearson", "kendall", "spearman")),2)  
  
total\_corr <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 corr\_pred=c(corr\_lm\_model, corr\_glm\_model, corr\_lasso\_Mod, corr\_knn\_model, corr\_LF\_model, corr\_LB\_model, corr\_lmStepAIC\_Mod))  
total\_corr

## Name corr\_pred  
## 1 lm\_model 0.43  
## 2 glm\_model 0.43  
## 3 lasso\_Mod 0.42  
## 4 knn\_model 0.62  
## 5 LF\_model 0.39  
## 6 LB\_model 0.39  
## 7 lmStepAIC\_Mod 0.43

## 27. RMSE between actual and predicted

#############################################################################################################################################  
# Formula to calculate RMSE on test set  
calc\_rmse = function(actual, predicted) {  
 sqrt(mean((actual - predicted) ^ 2))  
}  
  
# RMSE value on test set  
rmse\_lm\_model <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(lm\_model, test.set))  
  
# RMSE value on test set  
rmse\_glm\_model <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(glm\_model, test.set))  
  
# RMSE value on test set  
rmse\_lasso\_Mod <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(lasso\_Mod, test.set))  
  
# RMSE value on test set  
rmse\_knn\_model <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(knn\_model, test.set))  
  
# RMSE value on test set  
rmse\_LF\_model <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(LF\_model, test.set))  
  
# RMSE value on test set  
rmse\_LB\_model <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(LB\_model, test.set))  
  
# RMSE value on test set  
rmse\_lmStepAIC\_Mod <- calc\_rmse(actual = test.set$Number,  
 predicted = predict(lmStepAIC\_Mod, test.set))  
  
total\_RMSE <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 RMSE\_Pred=c(rmse\_lm\_model, rmse\_glm\_model, rmse\_lasso\_Mod, rmse\_knn\_model, rmse\_LF\_model, rmse\_LB\_model, rmse\_lmStepAIC\_Mod))  
total\_RMSE

## Name RMSE\_Pred  
## 1 lm\_model 77.97836  
## 2 glm\_model 77.97836  
## 3 lasso\_Mod 78.03065  
## 4 knn\_model 69.64118  
## 5 LF\_model 79.18198  
## 6 LB\_model 79.18198  
## 7 lmStepAIC\_Mod 77.98879

## 28. MAE between actual and predicted

#############################################################################################################################################  
  
MAE\_test\_lm\_model <- MAE(test.set$Number, predict(lm\_model, test.set))  
MAE\_test\_glm\_model <- MAE(test.set$Number, predict(glm\_model, test.set))  
MAE\_test\_lasso\_Mod <- MAE(test.set$Number, predict(lasso\_Mod, test.set))  
MAE\_test\_knn\_model <- MAE(test.set$Number, predict(knn\_model, test.set))  
MAE\_test\_LF\_model <- MAE(test.set$Number, predict(LF\_model, test.set))  
MAE\_test\_LB\_model <- MAE(test.set$Number, predict(LB\_model, test.set))  
MAE\_test\_lmStepAIC\_Mod <- MAE(test.set$Number, predict(lmStepAIC\_Mod, test.set))  
  
total\_MAE <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 MAE\_Pred=c(MAE\_test\_lm\_model, MAE\_test\_glm\_model, MAE\_test\_lasso\_Mod, MAE\_test\_knn\_model, MAE\_test\_LF\_model, MAE\_test\_LB\_model, MAE\_test\_lmStepAIC\_Mod))  
total\_MAE

## Name MAE\_Pred  
## 1 lm\_model 32.67233  
## 2 glm\_model 32.67233  
## 3 lasso\_Mod 32.15075  
## 4 knn\_model 18.93720  
## 5 LF\_model 31.74232  
## 6 LB\_model 31.74232  
## 7 lmStepAIC\_Mod 32.68862

## 29. r squared between actual and predicted

calc\_rss = function(actual, predicted) {  
 sum((predicted - actual) ^ 2) ## residual sum of squares  
}  
  
calc\_tss = function(actual, predicted) {  
 sum((actual - mean(actual)) ^ 2) ## total sum of squares  
}  
  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(lm\_model, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(lm\_model, test.set))  
  
rsq\_lm\_model <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(glm\_model, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(glm\_model, test.set))  
  
rsq\_glm\_model <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(lasso\_Mod, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(lasso\_Mod, test.set))  
  
rsq\_lasso\_Mod <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(knn\_model, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(knn\_model, test.set))  
  
rsq\_knn\_model <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(LF\_model, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(LF\_model, test.set))  
  
rsq\_LF\_model <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(LB\_model, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(LB\_model, test.set))  
  
rsq\_LB\_model <- 1 - calrss/caltss  
#######################################################  
# rss calculation  
calrss <- calc\_rss(actual = test.set$Number,  
 predicted = predict(lmStepAIC\_Mod, test.set))  
  
caltss <- calc\_tss(actual = test.set$Number,  
 predicted = predict(lmStepAIC\_Mod, test.set))  
  
rsq\_lmStepAIC\_Mod <- 1 - calrss/caltss  
#######################################################  
  
total\_rsq <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 R\_squared\_Pred=c(rsq\_lm\_model, rsq\_glm\_model, rsq\_lasso\_Mod, rsq\_knn\_model, rsq\_LF\_model, rsq\_LB\_model, rsq\_lmStepAIC\_Mod))  
total\_rsq

## Name R\_squared\_Pred  
## 1 lm\_model 0.1809568  
## 2 glm\_model 0.1809568  
## 3 lasso\_Mod 0.1798580  
## 4 knn\_model 0.3467329  
## 5 LF\_model 0.1554773  
## 6 LB\_model 0.1554773  
## 7 lmStepAIC\_Mod 0.1807377

## 30. Combine predicted RMSE, MAE R squared, time

total\_combALLpred <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 Model\_TimePred,  
 total\_RMSE,  
 total\_MAE,  
 total\_rsq) %>%   
 dplyr::select(-2,-4,-6,-8)  
total\_combALLpred

## Name Predict\_Time RMSE\_Pred MAE\_Pred R\_squared\_Pred  
## 1 lm\_model 0.13870001 secs 77.97836 32.67233 0.1809568  
## 2 glm\_model 0.10936308 secs 77.97836 32.67233 0.1809568  
## 3 lasso\_Mod 0.11048102 secs 78.03065 32.15075 0.1798580  
## 4 knn\_model 0.63588595 secs 69.64118 18.93720 0.3467329  
## 5 LF\_model 0.09868097 secs 79.18198 31.74232 0.1554773  
## 6 LB\_model 0.12181211 secs 79.18198 31.74232 0.1554773  
## 7 lmStepAIC\_Mod 0.12989306 secs 77.98879 32.68862 0.1807377

## 31. Compare the two sets of RMSE, MAE, r squared, time

total\_setscomp <- data.frame(Name=c("lm\_model","glm\_model","lasso\_Mod", "knn\_model","LF\_model","LB\_model","lmStepAIC\_Mod"),  
 total\_combALLpred,  
 total\_best\_train) %>%   
 dplyr::select(-2,-7)  
# Reorder columns  
total\_setscomp2 <- total\_setscomp[,c(1,6,3,8,4,7,5,9,2)]  
  
# Change name of column in data.frame  
total\_setscomp2 %>%   
 rename(  
 RMSE\_Train = RMSE,  
 MAE\_Train = MAE,  
 Rsquared\_Train = Rsquared  
 )

## Name RMSE\_Train RMSE\_Pred MAE\_Train MAE\_Pred Rsquared\_Train  
## 1 lm\_model 77.22247 77.97836 31.98198 32.67233 0.1928973  
## 2 glm\_model 77.22247 77.97836 31.98198 32.67233 0.1928973  
## 3 lasso\_Mod 77.21586 78.03065 31.45668 32.15075 0.1924205  
## 4 knn\_model 71.39146 69.64118 19.52759 18.93720 0.3370965  
## 5 LF\_model 78.67288 79.18198 31.12262 31.74232 0.1592308  
## 6 LB\_model 78.67288 79.18198 31.12262 31.74232 0.1592308  
## 7 lmStepAIC\_Mod 77.21136 77.98879 31.97654 32.68862 0.1931339  
## R\_squared\_Pred Time\_train Predict\_Time  
## 1 0.1809568 1.670344 secs 0.13870001 secs  
## 2 0.1809568 2.069697 secs 0.10936308 secs  
## 3 0.1798580 3.104741 secs 0.11048102 secs  
## 4 0.3467329 11.295562 secs 0.63588595 secs  
## 5 0.1554773 1.355139 secs 0.09868097 secs  
## 6 0.1554773 1.226130 secs 0.12181211 secs  
## 7 0.1807377 9.528383 secs 0.12989306 secs

## 32. RMSE, Rsquared MAE on training set

# RMSE, Rsquared MAE on training set  
lm\_model$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 77.22 0.19 31.98

# RMSE, Rsquared MAE on training set  
glm\_model$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 77.22 0.19 31.98

# RMSE, Rsquared MAE on training set  
lasso\_Mod$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 82.07 0.10 27.47  
## 2 77.64 0.18 27.85  
## 3 77.22 0.19 31.46

# RMSE, Rsquared MAE on training set  
knn\_model$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 71.39 0.34 19.53  
## 2 72.66 0.32 20.54  
## 3 74.58 0.27 21.00

# RMSE, Rsquared MAE on training set  
LF\_model$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 81.45 0.10 26.85  
## 2 80.76 0.11 29.93  
## 3 78.67 0.16 31.12

# RMSE, Rsquared MAE on training set  
LB\_model$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 82.35 0.07 28.60  
## 2 80.67 0.11 28.85  
## 3 78.67 0.16 31.12

# RMSE, Rsquared MAE on training set  
lmStepAIC\_Mod$results[c("RMSE","Rsquared","MAE")] %>%  
 round(2)

## RMSE Rsquared MAE  
## 1 77.21 0.19 31.98

## 32.

## Model below is separate from models above

## Additional for testing: Decision Tree

summary(data)

## Cause Jurisdiction Number   
## Lightning :1325 QC :1516 Min. : 0.00   
## Unspecified :1290 NL :1486 1st Qu.: 0.00   
## Miscellaneous known causes:1279 ON :1368 Median : 0.00   
## Recreation :1274 MB :1304 Mean : 18.64   
## Incendiary :1271 YT :1059 3rd Qu.: 4.00   
## Residents :1268 NT : 773 Max. :2913.00   
## (Other) :3812 (Other):4013   
## Protection.zone Response.category Year   
## Intensive :8190 Full :4204 Min. :1990   
## Limited :3281 Modified :3521 1st Qu.:1997   
## Unspecified: 48 None :3681 Median :2004   
## Unspecified: 113 Mean :2004   
## 3rd Qu.:2011   
## Max. :2018   
##   
## Juris\_Long Cause\_Grouped Time1   
## Quebec :1516 Length:11519 Length:11519   
## Newfoundland and Labrador:1486 Class :character Class :character   
## Ontario :1368 Mode :character Mode :character   
## Manitoba :1304   
## Yukon :1059   
## Northwest Territories : 773   
## (Other) :4013   
## Time2 Region Fire\_Cause\_Human   
## Length:11519 Length:11519 Length:11519   
## Class :character Class :character Class :character   
## Mode :character Mode :character Mode :character   
##   
##   
##   
##

class(data$Fire\_Cause\_Human) # [1] "factor"

## [1] "character"

unique(data$Fire\_Cause\_Human)

## [1] "Human" "Lightning" "Unspecified"

data$Fire\_Cause\_Human <- as.factor(data$Fire\_Cause\_Human) #Change to factor  
class(data$Fire\_Cause\_Human)

## [1] "factor"

unique(data$Fire\_Cause\_Human)

## [1] Human Lightning Unspecified  
## Levels: Human Lightning Unspecified

names(data)

## [1] "Cause" "Jurisdiction" "Number"   
## [4] "Protection.zone" "Response.category" "Year"   
## [7] "Juris\_Long" "Cause\_Grouped" "Time1"   
## [10] "Time2" "Region" "Fire\_Cause\_Human"

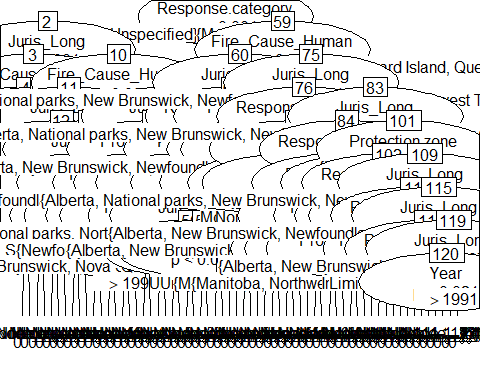
str(data)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 11519 obs. of 12 variables:  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "AB","BC","MB",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Cause\_Grouped : chr "People" "People" "People" "People" ...  
## $ Time1 : chr "Early 90s" "Early 90s" "Early 90s" "Early 90s" ...  
## $ Time2 : chr "1990s" "1990s" "1990s" "1990s" ...  
## $ Region : chr "Prairie Region" "Prairie Region" "Prairie Region" "Prairie Region" ...  
## $ Fire\_Cause\_Human : Factor w/ 3 levels "Human","Lightning",..: 1 1 1 1 1 1 1 1 1 1 ...

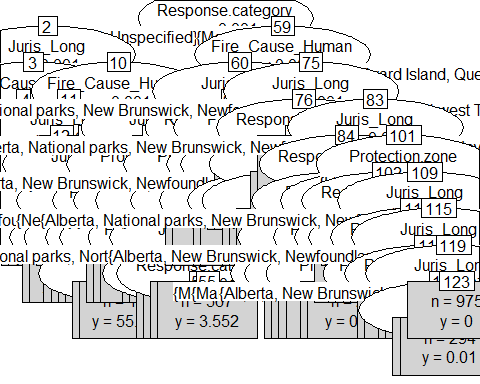
# Partition data into Training and Validation datasets  
set.seed(123)  
pd <- sample(2,nrow(data),replace = TRUE, prob = c(0.7,0.3))  
train <- data[pd==1,]  
validate <- data[pd==2,]  
  
# Decision Tree with party  
tree <- ctree(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone +   
 Response.category, data = train, controls = ctree\_control(mincriterion = 0.99, minsplit=900))  
  
tree <- ctree(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train)  
tree

##   
## Conditional inference tree with 62 terminal nodes  
##   
## Response: Number   
## Inputs: Juris\_Long, Year, Fire\_Cause\_Human, Protection.zone, Response.category   
## Number of observations: 8096   
##   
## 1) Response.category == {Full, Unspecified}; criterion = 1, statistic = 481.536  
## 2) Juris\_Long == {Alberta, British Columbia}; criterion = 1, statistic = 433.086  
## 3) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 179.974  
## 4) Juris\_Long == {British Columbia}; criterion = 0.994, statistic = 10.431  
## 5)\* weights = 15   
## 4) Juris\_Long == {Alberta}  
## 6)\* weights = 26   
## 3) Fire\_Cause\_Human == {Human, Unspecified}  
## 7) Fire\_Cause\_Human == {Human}; criterion = 0.999, statistic = 18.398  
## 8)\* weights = 271   
## 7) Fire\_Cause\_Human == {Unspecified}  
## 9)\* weights = 38   
## 2) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon}  
## 10) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 236.66  
## 11) Juris\_Long == {Ontario, Saskatchewan}; criterion = 1, statistic = 91.478  
## 12) Protection.zone == {Intensive}; criterion = 0.995, statistic = 13.65  
## 13) Juris\_Long == {Ontario}; criterion = 0.974, statistic = 7.814  
## 14)\* weights = 19   
## 13) Juris\_Long == {Saskatchewan}  
## 15)\* weights = 22   
## 12) Protection.zone == {Limited, Unspecified}  
## 16)\* weights = 21   
## 11) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Prince Edward Island, Quebec, Yukon}  
## 17) Juris\_Long == {Manitoba, Northwest Territories, Quebec}; criterion = 1, statistic = 61.577  
## 18) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 38.85  
## 19) Year <= 2006; criterion = 0.994, statistic = 10.433  
## 20)\* weights = 35   
## 19) Year > 2006  
## 21)\* weights = 32   
## 18) Protection.zone == {Limited}  
## 22)\* weights = 39   
## 17) Juris\_Long == {National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 23) Juris\_Long == {National parks, New Brunswick, Yukon}; criterion = 1, statistic = 38.584  
## 24) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 19.765  
## 25)\* weights = 62   
## 24) Protection.zone == {Limited}  
## 26)\* weights = 10   
## 23) Juris\_Long == {Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 27) Juris\_Long == {Newfoundland and Labrador, Nova Scotia}; criterion = 0.972, statistic = 10.362  
## 28)\* weights = 66   
## 27) Juris\_Long == {Prince Edward Island}  
## 29)\* weights = 16   
## 10) Fire\_Cause\_Human == {Human, Unspecified}  
## 30) Juris\_Long == {New Brunswick, Nova Scotia, Ontario, Quebec, Saskatchewan}; criterion = 1, statistic = 283.778  
## 31) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 197.338  
## 32) Fire\_Cause\_Human == {Human}; criterion = 1, statistic = 45.479  
## 33) Juris\_Long == {Ontario, Quebec}; criterion = 1, statistic = 40.351  
## 34) Year <= 1999; criterion = 1, statistic = 31.7  
## 35)\* weights = 97   
## 34) Year > 1999  
## 36)\* weights = 179   
## 33) Juris\_Long == {New Brunswick, Nova Scotia, Saskatchewan}  
## 37)\* weights = 408   
## 32) Fire\_Cause\_Human == {Unspecified}  
## 38) Juris\_Long == {New Brunswick, Nova Scotia, Ontario, Saskatchewan}; criterion = 1, statistic = 28.002  
## 39)\* weights = 73   
## 38) Juris\_Long == {Quebec}  
## 40)\* weights = 20   
## 31) Protection.zone == {Limited}  
## 41) Juris\_Long == {Ontario}; criterion = 1, statistic = 44.606  
## 42)\* weights = 154   
## 41) Juris\_Long == {Quebec, Saskatchewan}  
## 43)\* weights = 161   
## 30) Juris\_Long == {Manitoba, National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 44) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 152.211  
## 45) Juris\_Long == {Manitoba}; criterion = 1, statistic = 147.863  
## 46) Fire\_Cause\_Human == {Human}; criterion = 0.975, statistic = 20.921  
## 47)\* weights = 135   
## 46) Fire\_Cause\_Human == {Unspecified}  
## 48)\* weights = 18   
## 45) Juris\_Long == {National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 49) Juris\_Long == {Newfoundland and Labrador}; criterion = 1, statistic = 73.155  
## 50) Fire\_Cause\_Human == {Human}; criterion = 0.968, statistic = 24.227  
## 51)\* weights = 136   
## 50) Fire\_Cause\_Human == {Unspecified}  
## 52)\* weights = 18   
## 49) Juris\_Long == {National parks, Northwest Territories, Prince Edward Island, Yukon}  
## 53) Response.category == {Unspecified}; criterion = 1, statistic = 20.326  
## 54)\* weights = 11   
## 53) Response.category == {Full}  
## 55)\* weights = 567   
## 44) Protection.zone == {Limited}  
## 56) Juris\_Long == {Manitoba}; criterion = 1, statistic = 49.814  
## 57)\* weights = 130   
## 56) Juris\_Long == {Newfoundland and Labrador, Northwest Territories, Yukon}  
## 58)\* weights = 253   
## 1) Response.category == {Modified, None}  
## 59) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 715.107  
## 60) Juris\_Long == {Northwest Territories, Saskatchewan}; criterion = 1, statistic = 71.005  
## 61) Response.category == {Modified}; criterion = 1, statistic = 38.338  
## 62)\* weights = 26   
## 61) Response.category == {None}  
## 63)\* weights = 39   
## 60) Juris\_Long == {Alberta, British Columbia, Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 64) Protection.zone == {Limited, Unspecified}; criterion = 1, statistic = 54.234  
## 65) Response.category == {None}; criterion = 1, statistic = 40.013  
## 66) Juris\_Long == {Manitoba, Ontario, Quebec, Yukon}; criterion = 0.997, statistic = 19.625  
## 67)\* weights = 69   
## 66) Juris\_Long == {Newfoundland and Labrador}  
## 68)\* weights = 21   
## 65) Response.category == {Modified}  
## 69)\* weights = 95   
## 64) Protection.zone == {Intensive}  
## 70) Juris\_Long == {British Columbia, Manitoba, National parks, Ontario, Quebec, Yukon}; criterion = 0.994, statistic = 28.989  
## 71)\* weights = 205   
## 70) Juris\_Long == {Alberta, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 72) Juris\_Long == {Newfoundland and Labrador}; criterion = 1, statistic = 30.84  
## 73)\* weights = 38   
## 72) Juris\_Long == {Alberta, New Brunswick, Nova Scotia, Prince Edward Island}  
## 74)\* weights = 91   
## 59) Fire\_Cause\_Human == {Human, Unspecified}  
## 75) Juris\_Long == {Saskatchewan}; criterion = 1, statistic = 318.02  
## 76) Response.category == {Modified}; criterion = 1, statistic = 37.679  
## 77) Year <= 2014; criterion = 1, statistic = 17.532  
## 78) Year <= 2007; criterion = 0.996, statistic = 11.425  
## 79)\* weights = 47   
## 78) Year > 2007  
## 80)\* weights = 35   
## 77) Year > 2014  
## 81)\* weights = 11   
## 76) Response.category == {None}  
## 82)\* weights = 107   
## 75) Juris\_Long == {Alberta, British Columbia, Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 83) Juris\_Long == {British Columbia, Manitoba, Northwest Territories, Ontario}; criterion = 1, statistic = 124.796  
## 84) Response.category == {Modified}; criterion = 0.993, statistic = 10.097  
## 85) Protection.zone == {Intensive}; criterion = 0.999, statistic = 13.6  
## 86) Year <= 2012; criterion = 0.996, statistic = 11.109  
## 87) Juris\_Long == {Manitoba, Northwest Territories, Ontario}; criterion = 0.993, statistic = 15.672  
## 88)\* weights = 326   
## 87) Juris\_Long == {British Columbia}  
## 89)\* weights = 103   
## 86) Year > 2012  
## 90) Juris\_Long == {British Columbia}; criterion = 1, statistic = 32.398  
## 91)\* weights = 14   
## 90) Juris\_Long == {Manitoba, Northwest Territories, Ontario}  
## 92)\* weights = 64   
## 85) Protection.zone == {Limited}  
## 93)\* weights = 262   
## 84) Response.category == {None}  
## 94) Juris\_Long == {Manitoba, Ontario}; criterion = 1, statistic = 44.257  
## 95) Fire\_Cause\_Human == {Human}; criterion = 0.976, statistic = 7.957  
## 96) Protection.zone == {Intensive}; criterion = 0.964, statistic = 7.183  
## 97)\* weights = 260   
## 96) Protection.zone == {Limited}  
## 98)\* weights = 226   
## 95) Fire\_Cause\_Human == {Unspecified}  
## 99)\* weights = 66   
## 94) Juris\_Long == {British Columbia, Northwest Territories}  
## 100)\* weights = 293   
## 83) Juris\_Long == {Alberta, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon}  
## 101) Protection.zone == {Limited, Unspecified}; criterion = 1, statistic = 549.358  
## 102) Response.category == {None}; criterion = 0.996, statistic = 242.223  
## 103) Juris\_Long == {Quebec, Yukon}; criterion = 0.998, statistic = 16.058  
## 104)\* weights = 239   
## 103) Juris\_Long == {Newfoundland and Labrador}  
## 105)\* weights = 149   
## 102) Response.category == {Modified}  
## 106) Year <= 2016; criterion = 0.977, statistic = 296.971  
## 107)\* weights = 386   
## 106) Year > 2016  
## 108)\* weights = 21   
## 101) Protection.zone == {Intensive}  
## 109) Juris\_Long == {Quebec}; criterion = 1, statistic = 138.717  
## 110) Response.category == {None}; criterion = 1, statistic = 45.574  
## 111) Fire\_Cause\_Human == {Human}; criterion = 0.954, statistic = 6.756  
## 112)\* weights = 143   
## 111) Fire\_Cause\_Human == {Unspecified}  
## 113)\* weights = 18   
## 110) Response.category == {Modified}  
## 114)\* weights = 159   
## 109) Juris\_Long == {Alberta, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 115) Juris\_Long == {National parks}; criterion = 1, statistic = 39.843  
## 116) Response.category == {Modified}; criterion = 0.986, statistic = 8.966  
## 117)\* weights = 144   
## 116) Response.category == {None}  
## 118)\* weights = 115   
## 115) Juris\_Long == {Alberta, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 119) Juris\_Long == {Newfoundland and Labrador}; criterion = 0.993, statistic = 19.767  
## 120) Year <= 1991; criterion = 0.979, statistic = 8.219  
## 121)\* weights = 23   
## 120) Year > 1991  
## 122)\* weights = 294   
## 119) Juris\_Long == {Alberta, New Brunswick, Nova Scotia, Prince Edward Island, Yukon}  
## 123)\* weights = 975

plot(tree)



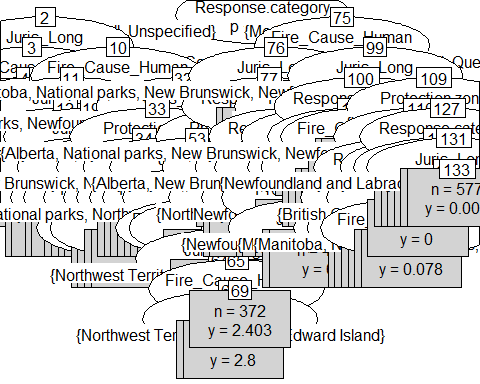
plot(tree, type="simple")



fire\_ctree <- ctree(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = data)  
  
print(fire\_ctree)

##   
## Conditional inference tree with 67 terminal nodes  
##   
## Response: Number   
## Inputs: Juris\_Long, Year, Fire\_Cause\_Human, Protection.zone, Response.category   
## Number of observations: 11519   
##   
## 1) Response.category == {Full, Unspecified}; criterion = 1, statistic = 688.349  
## 2) Juris\_Long == {Alberta, British Columbia}; criterion = 1, statistic = 665.926  
## 3) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 281.612  
## 4) Juris\_Long == {British Columbia}; criterion = 0.999, statistic = 13.588  
## 5)\* weights = 29   
## 4) Juris\_Long == {Alberta}  
## 6)\* weights = 29   
## 3) Fire\_Cause\_Human == {Human, Unspecified}  
## 7) Fire\_Cause\_Human == {Human}; criterion = 1, statistic = 53.383  
## 8)\* weights = 394   
## 7) Fire\_Cause\_Human == {Unspecified}  
## 9)\* weights = 56   
## 2) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon}  
## 10) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 356.913  
## 11) Juris\_Long == {Ontario, Saskatchewan}; criterion = 1, statistic = 113.941  
## 12) Protection.zone == {Intensive, Unspecified}; criterion = 0.999, statistic = 18.185  
## 13) Juris\_Long == {Ontario}; criterion = 0.987, statistic = 9.036  
## 14)\* weights = 29   
## 13) Juris\_Long == {Saskatchewan}  
## 15) Year <= 2003; criterion = 0.981, statistic = 8.341  
## 16)\* weights = 14   
## 15) Year > 2003  
## 17)\* weights = 15   
## 12) Protection.zone == {Limited}  
## 18)\* weights = 29   
## 11) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Prince Edward Island, Quebec, Yukon}  
## 19) Juris\_Long == {Manitoba, Northwest Territories, Quebec}; criterion = 1, statistic = 80.329  
## 20) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 46.103  
## 21) Year <= 2007; criterion = 0.998, statistic = 13.069  
## 22)\* weights = 54   
## 21) Year > 2007  
## 23)\* weights = 33   
## 20) Protection.zone == {Limited}  
## 24)\* weights = 51   
## 19) Juris\_Long == {National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 25) Juris\_Long == {National parks, New Brunswick, Yukon}; criterion = 1, statistic = 51.811  
## 26) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 23.643  
## 27)\* weights = 83   
## 26) Protection.zone == {Limited}  
## 28)\* weights = 16   
## 25) Juris\_Long == {Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 29) Juris\_Long == {Newfoundland and Labrador, Nova Scotia}; criterion = 0.996, statistic = 14.45  
## 30)\* weights = 86   
## 29) Juris\_Long == {Prince Edward Island}  
## 31)\* weights = 25   
## 10) Fire\_Cause\_Human == {Human, Unspecified}  
## 32) Juris\_Long == {New Brunswick, Nova Scotia, Ontario, Quebec, Saskatchewan}; criterion = 1, statistic = 403.349  
## 33) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 257.364  
## 34) Juris\_Long == {Ontario, Quebec}; criterion = 1, statistic = 51.242  
## 35) Fire\_Cause\_Human == {Human}; criterion = 1, statistic = 37.708  
## 36) Year <= 2001; criterion = 1, statistic = 34.011  
## 37)\* weights = 168   
## 36) Year > 2001  
## 38)\* weights = 226   
## 35) Fire\_Cause\_Human == {Unspecified}  
## 39) Juris\_Long == {Ontario}; criterion = 1, statistic = 39.384  
## 40)\* weights = 28   
## 39) Juris\_Long == {Quebec}  
## 41)\* weights = 28   
## 34) Juris\_Long == {New Brunswick, Nova Scotia, Saskatchewan}  
## 42) Year <= 2002; criterion = 1, statistic = 17.017  
## 43)\* weights = 318   
## 42) Year > 2002  
## 44)\* weights = 350   
## 33) Protection.zone == {Limited}  
## 45) Juris\_Long == {Ontario}; criterion = 1, statistic = 58.864  
## 46) Fire\_Cause\_Human == {Human}; criterion = 0.957, statistic = 6.859  
## 47)\* weights = 181   
## 46) Fire\_Cause\_Human == {Unspecified}  
## 48)\* weights = 27   
## 45) Juris\_Long == {Quebec, Saskatchewan}  
## 49) Fire\_Cause\_Human == {Human}; criterion = 0.996, statistic = 11.431  
## 50)\* weights = 203   
## 49) Fire\_Cause\_Human == {Unspecified}  
## 51)\* weights = 29   
## 32) Juris\_Long == {Manitoba, National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 52) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 164.258  
## 53) Juris\_Long == {Manitoba}; criterion = 1, statistic = 216.552  
## 54) Fire\_Cause\_Human == {Human}; criterion = 0.999, statistic = 26.419  
## 55)\* weights = 197   
## 54) Fire\_Cause\_Human == {Unspecified}  
## 56)\* weights = 27   
## 53) Juris\_Long == {National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 57) Juris\_Long == {Newfoundland and Labrador}; criterion = 1, statistic = 101.806  
## 58) Fire\_Cause\_Human == {Human}; criterion = 0.998, statistic = 23.186  
## 59)\* weights = 197   
## 58) Fire\_Cause\_Human == {Unspecified}  
## 60)\* weights = 28   
## 57) Juris\_Long == {National parks, Northwest Territories, Prince Edward Island, Yukon}  
## 61) Year <= 1998; criterion = 1, statistic = 18.349  
## 62)\* weights = 267   
## 61) Year > 1998  
## 63) Juris\_Long == {National parks}; criterion = 1, statistic = 26.485  
## 64)\* weights = 137   
## 63) Juris\_Long == {Northwest Territories, Prince Edward Island, Yukon}  
## 65) Fire\_Cause\_Human == {Unspecified}; criterion = 0.996, statistic = 33.371  
## 66) Juris\_Long == {Yukon}; criterion = 0.997, statistic = 14.959  
## 67)\* weights = 19   
## 66) Juris\_Long == {Northwest Territories, Prince Edward Island}  
## 68)\* weights = 35   
## 65) Fire\_Cause\_Human == {Human}  
## 69)\* weights = 372   
## 52) Protection.zone == {Limited}  
## 70) Juris\_Long == {Manitoba}; criterion = 1, statistic = 89.964  
## 71)\* weights = 177   
## 70) Juris\_Long == {Newfoundland and Labrador, Northwest Territories, Yukon}  
## 72) Juris\_Long == {Newfoundland and Labrador}; criterion = 0.971, statistic = 10.271  
## 73)\* weights = 224   
## 72) Juris\_Long == {Northwest Territories, Yukon}  
## 74)\* weights = 136   
## 1) Response.category == {Modified, None}  
## 75) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 1031.941  
## 76) Juris\_Long == {Northwest Territories, Saskatchewan}; criterion = 1, statistic = 132.153  
## 77) Response.category == {Modified}; criterion = 1, statistic = 57.155  
## 78)\* weights = 47   
## 77) Response.category == {None}  
## 79)\* weights = 50   
## 76) Juris\_Long == {Alberta, British Columbia, Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 80) Protection.zone == {Limited, Unspecified}; criterion = 1, statistic = 102.629  
## 81) Response.category == {None}; criterion = 1, statistic = 66.737  
## 82) Juris\_Long == {Ontario, Yukon}; criterion = 1, statistic = 34.416  
## 83)\* weights = 50   
## 82) Juris\_Long == {Manitoba, Newfoundland and Labrador, Quebec}  
## 84) Juris\_Long == {Manitoba, Quebec}; criterion = 1, statistic = 19.943  
## 85)\* weights = 50   
## 84) Juris\_Long == {Newfoundland and Labrador}  
## 86)\* weights = 28   
## 81) Response.category == {Modified}  
## 87) Juris\_Long == {British Columbia, Manitoba, National parks}; criterion = 1, statistic = 83.653  
## 88)\* weights = 25   
## 87) Juris\_Long == {Alberta, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 89) Protection.zone == {Unspecified}; criterion = 1, statistic = 19.388  
## 90)\* weights = 8   
## 89) Protection.zone == {Limited}  
## 91) Juris\_Long == {Newfoundland and Labrador, Ontario}; criterion = 1, statistic = 21.72  
## 92)\* weights = 55   
## 91) Juris\_Long == {Quebec, Yukon}  
## 93)\* weights = 44   
## 80) Protection.zone == {Intensive}  
## 94) Juris\_Long == {British Columbia, Manitoba, National parks, Ontario, Quebec, Yukon}; criterion = 1, statistic = 37.154  
## 95)\* weights = 290   
## 94) Juris\_Long == {Alberta, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 96) Juris\_Long == {Newfoundland and Labrador}; criterion = 1, statistic = 37.031  
## 97)\* weights = 55   
## 96) Juris\_Long == {Alberta, New Brunswick, Nova Scotia, Prince Edward Island}  
## 98)\* weights = 130   
## 75) Fire\_Cause\_Human == {Human, Unspecified}  
## 99) Juris\_Long == {Saskatchewan}; criterion = 1, statistic = 413.701  
## 100) Response.category == {Modified}; criterion = 1, statistic = 40.914  
## 101) Year <= 2014; criterion = 1, statistic = 16.136  
## 102) Year <= 1997; criterion = 0.958, statistic = 6.924  
## 103)\* weights = 30   
## 102) Year > 1997  
## 104)\* weights = 88   
## 101) Year > 2014  
## 105)\* weights = 19   
## 100) Response.category == {None}  
## 106) Fire\_Cause\_Human == {Unspecified}; criterion = 0.955, statistic = 6.8  
## 107)\* weights = 20   
## 106) Fire\_Cause\_Human == {Human}  
## 108)\* weights = 136   
## 99) Juris\_Long == {Alberta, British Columbia, Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 109) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 630.182  
## 110) Juris\_Long == {British Columbia, Manitoba, Northwest Territories, Ontario}; criterion = 1, statistic = 484.52  
## 111) Response.category == {Modified}; criterion = 1, statistic = 248.662  
## 112) Year <= 2012; criterion = 1, statistic = 130.797  
## 113) Juris\_Long == {Manitoba, Northwest Territories, Ontario}; criterion = 1, statistic = 29.379  
## 114)\* weights = 475   
## 113) Juris\_Long == {British Columbia}  
## 115)\* weights = 152   
## 112) Year > 2012  
## 116) Juris\_Long == {British Columbia}; criterion = 1, statistic = 45.072  
## 117)\* weights = 17   
## 116) Juris\_Long == {Manitoba, Northwest Territories, Ontario}  
## 118)\* weights = 98   
## 111) Response.category == {None}  
## 119) Juris\_Long == {Manitoba, Ontario}; criterion = 1, statistic = 86.878  
## 120) Fire\_Cause\_Human == {Human}; criterion = 0.989, statistic = 9.336  
## 121)\* weights = 369   
## 120) Fire\_Cause\_Human == {Unspecified}  
## 122)\* weights = 51   
## 119) Juris\_Long == {British Columbia, Northwest Territories}  
## 123)\* weights = 399   
## 110) Juris\_Long == {Alberta, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon}  
## 124) Juris\_Long == {National parks, Quebec}; criterion = 1, statistic = 625.901  
## 125)\* weights = 818   
## 124) Juris\_Long == {Alberta, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 126)\* weights = 1805   
## 109) Protection.zone == {Limited}  
## 127) Response.category == {None}; criterion = 1, statistic = 39.767  
## 128) Juris\_Long == {Manitoba, Ontario, Quebec, Yukon}; criterion = 0.998, statistic = 22.397  
## 129)\* weights = 728   
## 128) Juris\_Long == {Newfoundland and Labrador, Northwest Territories}  
## 130)\* weights = 225   
## 127) Response.category == {Modified}  
## 131) Juris\_Long == {Manitoba, Ontario}; criterion = 1, statistic = 52.421  
## 132)\* weights = 363   
## 131) Juris\_Long == {Newfoundland and Labrador, Northwest Territories, Quebec, Yukon}  
## 133)\* weights = 577

plot(fire\_ctree, type="simple")



train\_index <- sample(1:nrow(data), 0.7 \* nrow(data))  
train.set <- data[train\_index,]  
test.set <- data[-train\_index,]  
  
fire\_ctree\_model <- ctree(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data=train.set)  
fire\_ctree\_model

##   
## Conditional inference tree with 72 terminal nodes  
##   
## Response: Number   
## Inputs: Juris\_Long, Year, Fire\_Cause\_Human, Protection.zone, Response.category   
## Number of observations: 8063   
##   
## 1) Juris\_Long == {Alberta, British Columbia}; criterion = 1, statistic = 512.048  
## 2) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 201.252  
## 3) Response.category == {Full}; criterion = 1, statistic = 61.679  
## 4) Juris\_Long == {British Columbia}; criterion = 0.997, statistic = 11.779  
## 5)\* weights = 24   
## 4) Juris\_Long == {Alberta}  
## 6)\* weights = 22   
## 3) Response.category == {Modified, None}  
## 7) Year <= 2012; criterion = 0.975, statistic = 42.427  
## 8)\* weights = 55   
## 7) Year > 2012  
## 9)\* weights = 9   
## 2) Fire\_Cause\_Human == {Human, Unspecified}  
## 10) Response.category == {Full}; criterion = 1, statistic = 295.657  
## 11) Fire\_Cause\_Human == {Human}; criterion = 0.998, statistic = 55.25  
## 12)\* weights = 278   
## 11) Fire\_Cause\_Human == {Unspecified}  
## 13)\* weights = 37   
## 10) Response.category == {Modified, None}  
## 14) Year <= 2012; criterion = 1, statistic = 105.88  
## 15)\* weights = 462   
## 14) Year > 2012  
## 16) Juris\_Long == {British Columbia}; criterion = 1, statistic = 15.144  
## 17) Response.category == {Modified}; criterion = 0.993, statistic = 11.455  
## 18)\* weights = 15   
## 17) Response.category == {None}  
## 19)\* weights = 14   
## 16) Juris\_Long == {Alberta}  
## 20)\* weights = 49   
## 1) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan, Yukon}  
## 21) Response.category == {Full, Unspecified}; criterion = 1, statistic = 565.488  
## 22) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 241.23  
## 23) Juris\_Long == {Manitoba, Northwest Territories, Ontario, Quebec, Saskatchewan}; criterion = 1, statistic = 75.676  
## 24) Protection.zone == {Intensive}; criterion = 1, statistic = 28.853  
## 25) Juris\_Long == {Ontario}; criterion = 0.988, statistic = 16.523  
## 26)\* weights = 18   
## 25) Juris\_Long == {Manitoba, Northwest Territories, Quebec, Saskatchewan}  
## 27) Year <= 2006; criterion = 0.999, statistic = 14.268  
## 28)\* weights = 48   
## 27) Year > 2006  
## 29)\* weights = 35   
## 24) Protection.zone == {Limited, Unspecified}  
## 30) Juris\_Long == {Ontario}; criterion = 0.97, statistic = 12.42  
## 31)\* weights = 18   
## 30) Juris\_Long == {Manitoba, Quebec, Saskatchewan}  
## 32) Year <= 2015; criterion = 0.969, statistic = 24.948  
## 33)\* weights = 27   
## 32) Year > 2015  
## 34)\* weights = 7   
## 23) Juris\_Long == {National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 35) Juris\_Long == {National parks, New Brunswick, Yukon}; criterion = 1, statistic = 37.561  
## 36) Protection.zone == {Intensive, Unspecified}; criterion = 0.999, statistic = 17.83  
## 37)\* weights = 67   
## 36) Protection.zone == {Limited}  
## 38)\* weights = 9   
## 35) Juris\_Long == {Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 39) Juris\_Long == {Newfoundland and Labrador, Nova Scotia}; criterion = 0.99, statistic = 12.435  
## 40)\* weights = 62   
## 39) Juris\_Long == {Prince Edward Island}  
## 41)\* weights = 19   
## 22) Fire\_Cause\_Human == {Human, Unspecified}  
## 42) Juris\_Long == {New Brunswick, Nova Scotia, Ontario, Quebec, Saskatchewan}; criterion = 1, statistic = 298.657  
## 43) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 180.943  
## 44) Juris\_Long == {Ontario, Quebec}; criterion = 1, statistic = 39.076  
## 45) Fire\_Cause\_Human == {Human}; criterion = 1, statistic = 35.735  
## 46) Year <= 1991; criterion = 0.998, statistic = 32.218  
## 47)\* weights = 19   
## 46) Year > 1991  
## 48)\* weights = 257   
## 45) Fire\_Cause\_Human == {Unspecified}  
## 49) Juris\_Long == {Ontario}; criterion = 1, statistic = 28.932  
## 50)\* weights = 20   
## 49) Juris\_Long == {Quebec}  
## 51)\* weights = 19   
## 44) Juris\_Long == {New Brunswick, Nova Scotia, Saskatchewan}  
## 52) Year <= 1991; criterion = 0.999, statistic = 14.897  
## 53)\* weights = 36   
## 52) Year > 1991  
## 54)\* weights = 425   
## 43) Protection.zone == {Limited}  
## 55) Juris\_Long == {Ontario}; criterion = 1, statistic = 41.753  
## 56)\* weights = 135   
## 55) Juris\_Long == {Quebec, Saskatchewan}  
## 57) Fire\_Cause\_Human == {Human}; criterion = 0.966, statistic = 7.306  
## 58)\* weights = 141   
## 57) Fire\_Cause\_Human == {Unspecified}  
## 59)\* weights = 19   
## 42) Juris\_Long == {Manitoba, National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 60) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 125.035  
## 61) Juris\_Long == {Manitoba}; criterion = 1, statistic = 167.234  
## 62) Fire\_Cause\_Human == {Human}; criterion = 0.993, statistic = 21.548  
## 63)\* weights = 141   
## 62) Fire\_Cause\_Human == {Unspecified}  
## 64)\* weights = 18   
## 61) Juris\_Long == {National parks, Newfoundland and Labrador, Northwest Territories, Prince Edward Island, Yukon}  
## 65) Juris\_Long == {Newfoundland and Labrador}; criterion = 1, statistic = 72.422  
## 66) Fire\_Cause\_Human == {Human}; criterion = 0.995, statistic = 28.991  
## 67)\* weights = 137   
## 66) Fire\_Cause\_Human == {Unspecified}  
## 68)\* weights = 20   
## 65) Juris\_Long == {National parks, Northwest Territories, Prince Edward Island, Yukon}  
## 69) Response.category == {Unspecified}; criterion = 0.997, statistic = 11.77  
## 70)\* weights = 13   
## 69) Response.category == {Full}  
## 71) Juris\_Long == {National parks, Yukon}; criterion = 0.985, statistic = 13.882  
## 72)\* weights = 303   
## 71) Juris\_Long == {Northwest Territories, Prince Edward Island}  
## 73) Year <= 1995; criterion = 0.995, statistic = 10.797  
## 74)\* weights = 64   
## 73) Year > 1995  
## 75)\* weights = 239   
## 60) Protection.zone == {Limited}  
## 76) Juris\_Long == {Manitoba}; criterion = 1, statistic = 60.402  
## 77)\* weights = 114   
## 76) Juris\_Long == {Newfoundland and Labrador, Northwest Territories, Yukon}  
## 78)\* weights = 250   
## 21) Response.category == {Modified, None}  
## 79) Fire\_Cause\_Human == {Lightning}; criterion = 1, statistic = 741.47  
## 80) Juris\_Long == {Northwest Territories, Saskatchewan}; criterion = 1, statistic = 69.278  
## 81) Response.category == {Modified}; criterion = 1, statistic = 41.742  
## 82)\* weights = 35   
## 81) Response.category == {None}  
## 83)\* weights = 41   
## 80) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 84) Protection.zone == {Limited, Unspecified}; criterion = 1, statistic = 59.676  
## 85) Response.category == {None}; criterion = 1, statistic = 42.807  
## 86) Juris\_Long == {Ontario, Yukon}; criterion = 0.999, statistic = 22.754  
## 87)\* weights = 33   
## 86) Juris\_Long == {Manitoba, Newfoundland and Labrador, Quebec}  
## 88) Juris\_Long == {Manitoba, Quebec}; criterion = 0.989, statistic = 12.261  
## 89)\* weights = 33   
## 88) Juris\_Long == {Newfoundland and Labrador}  
## 90)\* weights = 15   
## 85) Response.category == {Modified}  
## 91) Protection.zone == {Unspecified}; criterion = 1, statistic = 27.922  
## 92)\* weights = 8   
## 91) Protection.zone == {Limited}  
## 93) Juris\_Long == {Manitoba}; criterion = 0.999, statistic = 22.351  
## 94)\* weights = 14   
## 93) Juris\_Long == {Newfoundland and Labrador, Ontario, Quebec, Yukon}  
## 95) Juris\_Long == {Newfoundland and Labrador, Ontario}; criterion = 0.994, statistic = 15.91  
## 96)\* weights = 35   
## 95) Juris\_Long == {Quebec, Yukon}  
## 97)\* weights = 32   
## 84) Protection.zone == {Intensive}  
## 98) Juris\_Long == {Manitoba, National parks, Ontario, Quebec, Yukon}; criterion = 0.994, statistic = 25.534  
## 99)\* weights = 174   
## 98) Juris\_Long == {New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island}  
## 100) Juris\_Long == {Newfoundland and Labrador}; criterion = 0.999, statistic = 19.198  
## 101)\* weights = 38   
## 100) Juris\_Long == {New Brunswick, Nova Scotia, Prince Edward Island}  
## 102)\* weights = 53   
## 79) Fire\_Cause\_Human == {Human, Unspecified}  
## 103) Juris\_Long == {Saskatchewan}; criterion = 1, statistic = 343.378  
## 104) Response.category == {Modified}; criterion = 1, statistic = 28.028  
## 105) Year <= 2014; criterion = 0.998, statistic = 12.322  
## 106)\* weights = 87   
## 105) Year > 2014  
## 107)\* weights = 14   
## 104) Response.category == {None}  
## 108) Fire\_Cause\_Human == {Unspecified}; criterion = 0.975, statistic = 7.833  
## 109)\* weights = 12   
## 108) Fire\_Cause\_Human == {Human}  
## 110)\* weights = 94   
## 103) Juris\_Long == {Manitoba, National parks, New Brunswick, Newfoundland and Labrador, Northwest Territories, Nova Scotia, Ontario, Prince Edward Island, Quebec, Yukon}  
## 111) Protection.zone == {Intensive, Unspecified}; criterion = 1, statistic = 156.059  
## 112) Juris\_Long == {Manitoba, Northwest Territories, Ontario}; criterion = 1, statistic = 155.188  
## 113) Response.category == {Modified}; criterion = 1, statistic = 39.353  
## 114)\* weights = 404   
## 113) Response.category == {None}  
## 115) Juris\_Long == {Manitoba, Ontario}; criterion = 1, statistic = 43.034  
## 116) Fire\_Cause\_Human == {Human}; criterion = 0.954, statistic = 6.738  
## 117)\* weights = 260   
## 116) Fire\_Cause\_Human == {Unspecified}  
## 118)\* weights = 34   
## 115) Juris\_Long == {Northwest Territories}  
## 119)\* weights = 176   
## 112) Juris\_Long == {National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Quebec, Yukon}  
## 120) Juris\_Long == {Quebec}; criterion = 1, statistic = 298.809  
## 121) Response.category == {None}; criterion = 1, statistic = 74.094  
## 122) Fire\_Cause\_Human == {Human}; criterion = 0.971, statistic = 7.596  
## 123) Year <= 1991; criterion = 0.974, statistic = 7.815  
## 124)\* weights = 11   
## 123) Year > 1991  
## 125)\* weights = 129   
## 122) Fire\_Cause\_Human == {Unspecified}  
## 126)\* weights = 21   
## 121) Response.category == {Modified}  
## 127)\* weights = 154   
## 120) Juris\_Long == {National parks, New Brunswick, Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 128) Response.category == {Modified}; criterion = 0.998, statistic = 283.796  
## 129) Year <= 2016; criterion = 0.998, statistic = 142.644  
## 130) Juris\_Long == {National parks}; criterion = 1, statistic = 49.347  
## 131) Year <= 2007; criterion = 0.988, statistic = 9.21  
## 132)\* weights = 79   
## 131) Year > 2007  
## 133)\* weights = 56   
## 130) Juris\_Long == {Newfoundland and Labrador, Nova Scotia, Prince Edward Island, Yukon}  
## 134)\* weights = 412   
## 129) Year > 2016  
## 135)\* weights = 34   
## 128) Response.category == {None}  
## 136)\* weights = 611   
## 111) Protection.zone == {Limited}  
## 137) Response.category == {None}; criterion = 1, statistic = 27.592  
## 138) Juris\_Long == {Manitoba, Ontario, Quebec, Yukon}; criterion = 0.956, statistic = 15.339  
## 139)\* weights = 504   
## 138) Juris\_Long == {Newfoundland and Labrador, Northwest Territories}  
## 140)\* weights = 158   
## 137) Response.category == {Modified}  
## 141) Juris\_Long == {Manitoba, Ontario}; criterion = 1, statistic = 36.876  
## 142)\* weights = 259   
## 141) Juris\_Long == {Newfoundland and Labrador, Northwest Territories, Quebec, Yukon}  
## 143)\* weights = 398

fire\_ctree\_prediction <- predict(fire\_ctree\_model, test.set)   
# gives the probability for each class  
head(fire\_ctree\_prediction)

## Number  
## [1,] 103.9856  
## [2,] 103.9856  
## [3,] 103.9856  
## [4,] 103.9856  
## [5,] 103.9856  
## [6,] 103.9856

table(fire\_ctree\_prediction, test.set$Number)

##   
## fire\_ctree\_prediction 0 1 2 3 4 5 6 7 8 9 10 11 12  
## 0 461 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 197 2 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 271 2 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 178 1 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 66 1 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 71 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 105 5 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 6 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 15 2 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 31 1 1 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 94 6 4 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 186 25 9 3 1 0 0 0 0 0 0 0 0  
## 0.392857142857143 14 1 0 1 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 11 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 36 12 3 2 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 72 20 10 3 2 1 0 0 0 1 0 0 0  
## 0.684210526315789 14 2 1 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 117 23 17 7 2 1 0 0 0 0 0 1 0  
## 1.08333333333333 8 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 30 15 1 5 4 3 2 1 0 0 0 1 0  
## 1.27272727272727 1 0 1 0 0 1 0 0 0 0 0 0 0  
## 1.92105263157895 35 14 4 4 2 0 0 0 0 0 0 0 0  
## 2.47698744769874 46 8 6 3 2 0 4 2 1 0 2 0 0  
## 3.3448275862069 17 4 0 1 3 0 0 1 1 1 1 0 1  
## 4.67741935483871 2 1 1 5 1 0 3 1 2 0 0 0 0  
## 4.984375 10 0 3 1 0 2 0 2 0 0 0 1 1  
## 5.17142857142857 4 5 1 4 2 0 0 1 2 0 0 0 1  
## 5.48844884488449 50 8 5 9 7 1 2 4 2 2 4 5 1  
## 7.38518518518519 14 18 3 4 3 4 2 1 3 1 1 4 0  
## 8.11111111111111 1 1 2 2 2 0 1 1 2 0 0 0 0  
## 8.61494252873563 36 6 1 5 3 3 1 4 1 0 0 1 0  
## 9.33333333333333 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 1 0 3 0 1 1 1 0 0 3 1 0 0  
## 11.6428571428571 3 0 0 0 0 0 0 1 0 0 0 0 0  
## 11.9285714285714 2 1 1 0 0 0 1 0 0 1 0 1 0  
## 12.7692307692308 0 2 0 0 0 1 0 0 0 0 0 0 0  
## 15.6350364963504 7 2 9 3 5 5 3 0 0 3 2 3 3  
## 19.8 0 0 0 0 0 0 1 0 0 1 0 0 1  
## 33.7801418439716 0 5 3 4 5 0 1 0 2 2 1 0 2  
## 35.6865671641791 0 0 0 0 0 0 1 0 0 1 0 0 0  
## 36.1082352941176 24 9 7 5 6 6 5 4 6 3 5 6 4  
## 37.4848484848485 0 1 0 0 0 0 1 1 0 0 0 0 1  
## 39.7837837837838 2 0 0 0 0 0 0 0 0 0 1 1 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 7 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 1 0 1 0 0 1  
## 65.0555555555556 1 0 0 0 0 0 0 0 1 0 1 0 0  
## 66.0544747081712 1 3 0 1 3 0 6 2 2 3 3 2 2  
## 71.4166666666667 2 0 2 0 0 1 0 1 0 0 0 0 0  
## 95.2857142857143 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 103.985611510791 2 0 0 0 1 1 0 1 2 2 4 4 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 13 14 15 16 17 18 19 20 21 22 23 24 25  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 1 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 1 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 1 2 0 0 0 0 0 0 0 1 0 0 0  
## 2.47698744769874 1 1 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 4 0 1 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 1 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 1 0 0 1 1 0 1 0 0 0 1 0  
## 7.38518518518519 1 0 1 3 0 2 2 2 0 0 0 0 0  
## 8.11111111111111 0 2 0 2 0 0 0 0 1 0 0 0 1  
## 8.61494252873563 1 0 0 0 0 1 1 0 0 2 0 1 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 1 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 1 0 0 1 1 0 0 0 0 0 1 0  
## 19.8 0 0 1 0 0 0 0 0 0 1 1 0 0  
## 33.7801418439716 0 1 1 1 0 2 1 0 2 1 0 0 2  
## 35.6865671641791 0 1 0 0 0 0 0 0 0 3 0 0 0  
## 36.1082352941176 2 3 4 2 2 1 4 0 1 0 2 1 1  
## 37.4848484848485 1 2 0 0 0 0 0 0 1 0 0 0 0  
## 39.7837837837838 0 0 0 0 2 0 1 1 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 1 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 1 0 0 0 1 1 0 0 1 1 0 1 0  
## 65.0555555555556 0 0 0 0 1 0 0 0 0 0 0 0 1  
## 66.0544747081712 2 1 0 1 1 1 0 0 1 6 1 4 1  
## 71.4166666666667 0 1 0 0 0 1 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 1 0 0 0 0 0 0 0 0 0  
## 103.985611510791 3 2 1 0 1 3 2 3 2 0 0 1 1  
## 138.105263157895 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 26 27 28 29 30 31 32 33 34 35 36 37 38  
## 0 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 1 0 0 0 0 0 0 0 0 0 0 1  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 1 0 0 0 0 0 0 0 0 1 0 0 2  
## 7.38518518518519 1 0 0 0 0 0 0 1 0 0 0 0 0  
## 8.11111111111111 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 1 0 0 0 0 0 1 0 0 1 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 1 0 0 0 0 0 0 0 0 0 1 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 1 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 1 0 1  
## 33.7801418439716 1 0 0 2 1 0 0 1 1 1 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 1 2 1 0 0 0 1  
## 36.1082352941176 4 2 4 1 0 0 2 1 1 1 3 1 1  
## 37.4848484848485 0 0 0 0 1 1 0 0 1 0 0 1 1  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 1 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 1 1 1 0 0 0 0 0 2 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 1 0 3 1 1 1 1 1 1 2 1 1  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 1 1 1 2 0 1 0 0 1 1 0 0 0  
## 138.105263157895 0 0 0 0 1 0 0 1 0 0 1 0 0  
## 236.145833333333 0 0 0 0 0 1 0 0 0 0 0 0 1  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 39 40 41 42 43 44 45 46 47 48 49 52 53  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 1 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 1 0 0 1 0 0 0 0 0 0 0 1 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 1 0 1 0 0 1 0 0 0 0 0 1  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 1 0 0 0 1 1 0 0 1 0 1 0 0  
## 35.6865671641791 0 0 0 1 0 0 0 0 0 1 0 0 0  
## 36.1082352941176 1 1 1 0 1 2 1 1 1 2 1 0 0  
## 37.4848484848485 0 2 0 0 0 0 0 2 0 0 0 0 0  
## 39.7837837837838 0 0 0 1 2 0 0 0 1 0 1 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 1 0 0 1 1 0 0 0 0 0 0  
## 66.0544747081712 0 0 1 1 1 1 0 1 0 1 0 2 0  
## 71.4166666666667 1 0 0 0 0 1 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 1 0 0 1 1 1 0 1 1 0 0 1 1  
## 138.105263157895 0 1 0 0 0 0 1 0 0 0 1 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 54 55 56 57 58 59 60 61 62 64 65 66 67  
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## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 1 0 0 1 0 0 0 0 0 1 0 1 0  
## 35.6865671641791 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 36.1082352941176 1 1 1 0 1 0 1 1 0 1 0 1 1  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 1 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 0 0 0 0 1 2 0 0 0 1  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 1 0 0 0 0 0 0 0 0 0 0 1  
## 103.985611510791 0 0 0 0 0 1 0 0 0 0 0 0 1  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 68 69 70 71 72 73 74 76 77 78 79 80 81  
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## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 1 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 1  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 1 0 2 0 0 1 0 0 0 0 1 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 1 0 0 0 0 0 1 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 1 0 0 0 0 0 0 2 0 1  
## 71.4166666666667 0 0 0 0 1 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 2 0 0 0 0 0 0 0 0 0 0 0  
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## 103.985611510791 0 0 0 1 1 1 1 2 0 0 0 0 1  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 82 83 84 85 86 87 88 89 90 91 92 93 94  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 1 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 1 0 0 3 0 1 0 1 0 1  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 66.0544747081712 1 0 0 0 1 0 0 0 0 1 0 0 0  
## 71.4166666666667 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 103.171428571429 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 1 1 0 0 2 0 1 1 0 1 1 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 236.145833333333 0 0 0 0 0 0 0 1 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 95 96 97 98 99 100 101 102 103 104 105 106 107  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 15.6350364963504 1 0 0 1 0 0 0 0 1 0 0 0 0  
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## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 1 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 1 1 2 0 1 3 1 0 0 0 0 1 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
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## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 1 0 0 0 0 0 0  
## 103.985611510791 0 0 1 0 1 1 0 0 0 2 0 1 1  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 1 0 0 1 0 0  
## 389.055555555556 0 0 0 1 0 0 0 0 1 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 108 109 110 111 112 113 114 115 116 119 120 121 123  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 1 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 1 1 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 0 1 0 0 1 0 0 1 1 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 1 0 1 0 0 0 0  
## 66.0544747081712 0 1 1 0 0 1 0 0 0 0 0 0 0  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 1 0 0 0 0 0 0 0 0 2  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 1 0 0 0 0 3 1 0 0 0 0 0 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 1 0 1 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 124 125 127 128 129 130 131 133 136 137 138 139 140  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 1 0 0 1 0 0 0 1 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 1 1 0 1 0 0 0 0 0 0 1 1  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 1 0 0 3 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 0 0 0 0 0 0 1 1 1 0 0 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 141 142 145 146 147 148 149 151 153 154 157 158 159  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 1 0 1 0 0 0 0 0 0 2 1 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 1  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 1 0 0 0 1 0 0 0 0 0 0 1 1  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 2 0 1 1 0 2 1 1 0 0 1 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 161 162 163 164 165 166 168 172 173 176 178 179 181  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 1 0 0 0 0 1 0 0 1 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 1 1 0 1 0 0 1 0 0 1 0  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 1  
## 95.2857142857143 0 0 0 0 1 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 1 0 0 0  
## 103.985611510791 1 1 0 0 0 0 1 0 0 0 0 0 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 1 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 185 188 194 200 202 204 209 216 217 225 226 228 235  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 0 0 0 0 1 0 0 0 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 0 1 1 0 0 0 0 0 0 0  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 1 0 1 1 0 0 0 0 0 1 0 1 1  
## 138.105263157895 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0 1 0 1 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 1 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 1 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 238 241 244 249 256 257 258 262 269 270 276 290 292  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 1 0 0 0 0 0 0 0 0 0 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 1 1 0 0 1 0 0 1 0 0 1  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 1 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 0 0 0 1 1 0 0 0 0 0 1 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 1 0 0 0 0 0 0 1 1 0 1 0 0  
## 389.055555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 299 302 317 342 344 347 355 377 381 388 403 407 417  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 0 0 1 0 0 0 0 0 0 0  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 1 0 1 0 0 1 1 1 1 1 1 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 1 0 1 0 0 0 1 0 0 0 0 0 0  
## 389.055555555556 0 0 0 0 1 0 0 0 0 0 0 0 1  
## 545.090909090909 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
##   
## fire\_ctree\_prediction 421 429 451 460 467 499 505 514 533 580 726 746 759  
## 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 65.0555555555556 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 71.4166666666667 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 103.985611510791 0 0 0 1 1 0 1 0 0 0 0 0 0  
## 138.105263157895 0 0 0 0 0 0 0 0 0 0 0 0 0  
## 236.145833333333 1 0 0 0 0 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 1 0 0 0 0 0 1 1 0 0 0  
## 545.090909090909 0 1 0 0 0 1 0 1 0 0 0 1 0  
## 1114.66666666667 0 0 0 0 0 0 0 0 0 0 1 0 1  
##   
## fire\_ctree\_prediction 787 868 988 1141 1192 1249 1536 2184  
## 0 0 0 0 0 0 0 0 0  
## 0.00485436893203883 0 0 0 0 0 0 0 0  
## 0.00654664484451719 0 0 0 0 0 0 0 0  
## 0.0100502512562814 0 0 0 0 0 0 0 0  
## 0.0379746835443038 0 0 0 0 0 0 0 0  
## 0.038961038961039 0 0 0 0 0 0 0 0  
## 0.052 0 0 0 0 0 0 0 0  
## 0.0526315789473684 0 0 0 0 0 0 0 0  
## 0.0588235294117647 0 0 0 0 0 0 0 0  
## 0.0759493670886076 0 0 0 0 0 0 0 0  
## 0.150579150579151 0 0 0 0 0 0 0 0  
## 0.337301587301587 0 0 0 0 0 0 0 0  
## 0.392857142857143 0 0 0 0 0 0 0 0  
## 0.411764705882353 0 0 0 0 0 0 0 0  
## 0.426356589147287 0 0 0 0 0 0 0 0  
## 0.519230769230769 0 0 0 0 0 0 0 0  
## 0.684210526315789 0 0 0 0 0 0 0 0  
## 0.698019801980198 0 0 0 0 0 0 0 0  
## 1.08333333333333 0 0 0 0 0 0 0 0  
## 1.15602836879433 0 0 0 0 0 0 0 0  
## 1.27272727272727 0 0 0 0 0 0 0 0  
## 1.92105263157895 0 0 0 0 0 0 0 0  
## 2.47698744769874 0 0 0 0 0 0 0 0  
## 3.3448275862069 0 0 0 0 0 0 0 0  
## 4.67741935483871 0 0 0 0 0 0 0 0  
## 4.984375 0 0 0 0 0 0 0 0  
## 5.17142857142857 0 0 0 0 0 0 0 0  
## 5.48844884488449 0 0 0 0 0 0 0 0  
## 7.38518518518519 0 0 0 0 0 0 0 0  
## 8.11111111111111 0 0 0 0 0 0 0 0  
## 8.61494252873563 0 0 0 0 0 0 0 0  
## 9.33333333333333 0 0 0 0 0 0 0 0  
## 10.7333333333333 0 0 0 0 0 0 0 0  
## 11.6428571428571 0 0 0 0 0 0 0 0  
## 11.9285714285714 0 0 0 0 0 0 0 0  
## 12.7692307692308 0 0 0 0 0 0 0 0  
## 15.6350364963504 0 0 0 0 0 0 0 0  
## 19.8 0 0 0 0 0 0 0 0  
## 33.7801418439716 0 0 0 0 0 0 0 0  
## 35.6865671641791 0 0 0 0 0 0 0 0  
## 36.1082352941176 0 0 0 0 0 0 0 0  
## 37.4848484848485 0 0 0 0 0 0 0 0  
## 39.7837837837838 0 0 0 0 0 0 0 0  
## 46.875 0 0 0 0 0 0 0 0  
## 53.5555555555556 0 0 0 0 0 0 0 0  
## 64.7272727272727 0 0 0 0 0 0 0 0  
## 65.0555555555556 1 0 0 0 0 0 0 0  
## 66.0544747081712 0 0 0 0 0 0 0 0  
## 71.4166666666667 0 0 0 0 0 0 0 0  
## 95.2857142857143 0 0 0 0 0 0 0 0  
## 103.171428571429 0 0 0 0 0 0 0 0  
## 103.985611510791 0 0 0 0 0 0 0 0  
## 138.105263157895 0 0 0 0 0 0 0 0  
## 236.145833333333 0 0 0 0 0 0 0 0  
## 389.055555555556 0 0 1 1 0 1 0 0  
## 545.090909090909 0 1 0 0 1 0 0 0  
## 1114.66666666667 0 0 0 0 0 0 1 1

## 32.

## Model below is separate from models above

## Additional for testing: Random Forest

# Check data before Random Forest  
summary(data)

## Cause Jurisdiction Number   
## Lightning :1325 QC :1516 Min. : 0.00   
## Unspecified :1290 NL :1486 1st Qu.: 0.00   
## Miscellaneous known causes:1279 ON :1368 Median : 0.00   
## Recreation :1274 MB :1304 Mean : 18.64   
## Incendiary :1271 YT :1059 3rd Qu.: 4.00   
## Residents :1268 NT : 773 Max. :2913.00   
## (Other) :3812 (Other):4013   
## Protection.zone Response.category Year   
## Intensive :8190 Full :4204 Min. :1990   
## Limited :3281 Modified :3521 1st Qu.:1997   
## Unspecified: 48 None :3681 Median :2004   
## Unspecified: 113 Mean :2004   
## 3rd Qu.:2011   
## Max. :2018   
##   
## Juris\_Long Cause\_Grouped Time1   
## Quebec :1516 Length:11519 Length:11519   
## Newfoundland and Labrador:1486 Class :character Class :character   
## Ontario :1368 Mode :character Mode :character   
## Manitoba :1304   
## Yukon :1059   
## Northwest Territories : 773   
## (Other) :4013   
## Time2 Region Fire\_Cause\_Human  
## Length:11519 Length:11519 Human :8904   
## Class :character Class :character Lightning :1325   
## Mode :character Mode :character Unspecified:1290   
##   
##   
##   
##

class(data$Fire\_Cause\_Human) # [1] "factor"

## [1] "factor"

unique(data$Fire\_Cause\_Human)

## [1] Human Lightning Unspecified  
## Levels: Human Lightning Unspecified

data$Fire\_Cause\_Human <- as.factor(data$Fire\_Cause\_Human) #Change to factor  
class(data$Fire\_Cause\_Human)

## [1] "factor"

unique(data$Fire\_Cause\_Human)

## [1] Human Lightning Unspecified  
## Levels: Human Lightning Unspecified

names(data)

## [1] "Cause" "Jurisdiction" "Number"   
## [4] "Protection.zone" "Response.category" "Year"   
## [7] "Juris\_Long" "Cause\_Grouped" "Time1"   
## [10] "Time2" "Region" "Fire\_Cause\_Human"

str(data)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 11519 obs. of 12 variables:  
## $ Cause : Factor w/ 10 levels "Forest industry",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Jurisdiction : Factor w/ 13 levels "AB","BC","MB",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Cause\_Grouped : chr "People" "People" "People" "People" ...  
## $ Time1 : chr "Early 90s" "Early 90s" "Early 90s" "Early 90s" ...  
## $ Time2 : chr "1990s" "1990s" "1990s" "1990s" ...  
## $ Region : chr "Prairie Region" "Prairie Region" "Prairie Region" "Prairie Region" ...  
## $ Fire\_Cause\_Human : Factor w/ 3 levels "Human","Lightning",..: 1 1 1 1 1 1 1 1 1 1 ...

train\_index <- sample(1:nrow(data), 0.7 \* nrow(data))  
train.set <- data[train\_index,]  
test.set <- data[-train\_index,]  
  
rf1 <- randomForest(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set)  
rf1

##   
## Call:  
## randomForest(formula = Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set)   
## Type of random forest: regression  
## Number of trees: 500  
## No. of variables tried at each split: 1  
##   
## Mean of squared residuals: 4906.385  
## % Var explained: 38.21

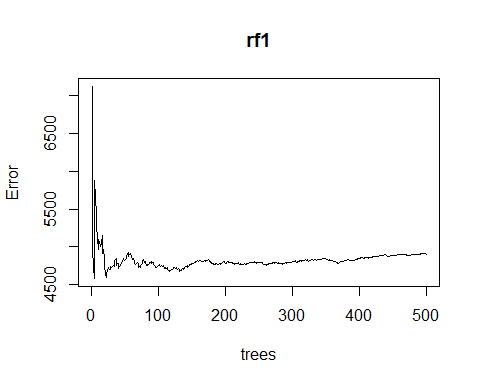
print(rf1)

##   
## Call:  
## randomForest(formula = Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set)   
## Type of random forest: regression  
## Number of trees: 500  
## No. of variables tried at each split: 1  
##   
## Mean of squared residuals: 4906.385  
## % Var explained: 38.21

randomForest::importance(rf1) # Higher the value, the greater the importance.

## IncNodePurity  
## Juris\_Long 6045741  
## Year 1157469  
## Fire\_Cause\_Human 5983763  
## Protection.zone 1290343  
## Response.category 4795376

plot(rf1) # Error levels of output



table(train.set$Number)/nrow(train.set)

##   
## 0 1 2 3 4   
## 0.6445491752 0.0610194717 0.0251767332 0.0179833809 0.0157509612   
## 5 6 7 8 9   
## 0.0115341684 0.0106660052 0.0093017487 0.0094257720 0.0060771425   
## 10 11 12 13 14   
## 0.0064492125 0.0060771425 0.0055810492 0.0049609327 0.0047128860   
## 15 16 17 18 19   
## 0.0050849560 0.0045888627 0.0029765596 0.0032246062 0.0033486295   
## 20 21 22 23 24   
## 0.0027285130 0.0033486295 0.0033486295 0.0021083964 0.0024804663   
## 25 26 27 28 29   
## 0.0021083964 0.0029765596 0.0017363264 0.0023564430 0.0022324197   
## 30 31 32 33 34   
## 0.0014882798 0.0016123031 0.0027285130 0.0016123031 0.0014882798   
## 35 36 37 38 39   
## 0.0013642565 0.0021083964 0.0009921865 0.0009921865 0.0021083964   
## 40 41 42 43 44   
## 0.0019843731 0.0016123031 0.0007441399 0.0014882798 0.0014882798   
## 45 46 47 48 49   
## 0.0017363264 0.0017363264 0.0013642565 0.0021083964 0.0006201166   
## 50 51 52 53 54   
## 0.0013642565 0.0008681632 0.0009921865 0.0008681632 0.0012402332   
## 55 56 57 58 59   
## 0.0007441399 0.0014882798 0.0002480466 0.0011162098 0.0007441399   
## 60 61 62 63 64   
## 0.0008681632 0.0006201166 0.0012402332 0.0004960933 0.0012402332   
## 65 66 67 68 69   
## 0.0004960933 0.0009921865 0.0004960933 0.0004960933 0.0009921865   
## 70 71 72 73 74   
## 0.0009921865 0.0012402332 0.0003720699 0.0009921865 0.0002480466   
## 75 76 77 78 79   
## 0.0006201166 0.0009921865 0.0006201166 0.0006201166 0.0011162098   
## 80 81 82 83 84   
## 0.0003720699 0.0008681632 0.0006201166 0.0004960933 0.0007441399   
## 85 86 87 88 89   
## 0.0006201166 0.0003720699 0.0007441399 0.0007441399 0.0003720699   
## 90 91 92 93 94   
## 0.0013642565 0.0006201166 0.0003720699 0.0003720699 0.0002480466   
## 95 96 97 98 99   
## 0.0007441399 0.0004960933 0.0004960933 0.0002480466 0.0006201166   
## 100 101 102 103 104   
## 0.0006201166 0.0002480466 0.0009921865 0.0004960933 0.0002480466   
## 105 106 107 108 109   
## 0.0004960933 0.0003720699 0.0006201166 0.0006201166 0.0003720699   
## 110 111 112 113 114   
## 0.0002480466 0.0001240233 0.0002480466 0.0006201166 0.0002480466   
## 115 116 117 118 119   
## 0.0002480466 0.0008681632 0.0002480466 0.0003720699 0.0003720699   
## 120 121 123 124 125   
## 0.0004960933 0.0004960933 0.0004960933 0.0002480466 0.0002480466   
## 126 127 128 129 130   
## 0.0002480466 0.0002480466 0.0004960933 0.0003720699 0.0006201166   
## 131 132 133 134 135   
## 0.0004960933 0.0002480466 0.0003720699 0.0002480466 0.0004960933   
## 136 137 138 139 140   
## 0.0006201166 0.0006201166 0.0001240233 0.0004960933 0.0002480466   
## 141 142 143 145 146   
## 0.0003720699 0.0002480466 0.0006201166 0.0003720699 0.0001240233   
## 147 148 149 150 151   
## 0.0001240233 0.0003720699 0.0002480466 0.0002480466 0.0001240233   
## 152 153 154 155 156   
## 0.0002480466 0.0001240233 0.0002480466 0.0002480466 0.0004960933   
## 157 158 159 160 161   
## 0.0001240233 0.0004960933 0.0003720699 0.0002480466 0.0002480466   
## 162 163 164 165 166   
## 0.0002480466 0.0001240233 0.0001240233 0.0003720699 0.0001240233   
## 167 168 170 171 172   
## 0.0002480466 0.0001240233 0.0002480466 0.0001240233 0.0001240233   
## 173 174 176 178 179   
## 0.0001240233 0.0001240233 0.0001240233 0.0003720699 0.0001240233   
## 180 181 183 184 186   
## 0.0002480466 0.0001240233 0.0001240233 0.0001240233 0.0002480466   
## 187 188 190 191 194   
## 0.0002480466 0.0001240233 0.0002480466 0.0002480466 0.0002480466   
## 195 196 197 198 200   
## 0.0002480466 0.0002480466 0.0001240233 0.0003720699 0.0003720699   
## 201 202 203 204 207   
## 0.0001240233 0.0002480466 0.0001240233 0.0001240233 0.0001240233   
## 208 209 211 213 215   
## 0.0001240233 0.0003720699 0.0002480466 0.0002480466 0.0002480466   
## 216 217 218 219 220   
## 0.0002480466 0.0002480466 0.0002480466 0.0001240233 0.0002480466   
## 222 225 226 228 232   
## 0.0002480466 0.0002480466 0.0001240233 0.0002480466 0.0003720699   
## 233 235 238 239 240   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 241 242 243 244 247   
## 0.0001240233 0.0002480466 0.0001240233 0.0002480466 0.0001240233   
## 249 250 253 256 257   
## 0.0001240233 0.0001240233 0.0001240233 0.0002480466 0.0001240233   
## 262 263 272 273 276   
## 0.0003720699 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 282 285 287 288 289   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 290 292 296 302 305   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 315 321 322 323 327   
## 0.0001240233 0.0002480466 0.0001240233 0.0001240233 0.0001240233   
## 337 338 340 342 343   
## 0.0001240233 0.0001240233 0.0001240233 0.0002480466 0.0001240233   
## 347 352 355 357 361   
## 0.0001240233 0.0001240233 0.0002480466 0.0001240233 0.0001240233   
## 362 373 377 381 384   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0002480466   
## 388 392 398 403 407   
## 0.0001240233 0.0002480466 0.0001240233 0.0001240233 0.0001240233   
## 416 421 429 432 440   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 458 460 466 467 478   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 486 493 495 499 505   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 511 514 517 527 530   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 545 566 585 626 683   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 723 726 732 741 759   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 772 777 780 787 842   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 868 870 886 890 914   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 944 988 992 1141 1151   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 1175 1192 1237 1249 1290   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 1433 1513 1716 1773 2015   
## 0.0001240233 0.0001240233 0.0001240233 0.0001240233 0.0001240233   
## 2913   
## 0.0001240233

## 33.

## Model below is separate from models above

## Additional for testing: Linear Regression for Predicting Forest Fires.

# Create total forest fires per year variable.   
require(dplyr)  
  
print(unique(data[, 1])) #Print column 1, "Cause"

## # A tibble: 10 x 1  
## Cause   
## <fct>   
## 1 Forest industry   
## 2 Incendiary   
## 3 Lightning   
## 4 Miscellaneous known causes   
## 5 Other industry   
## 6 Railways   
## 7 Recreation   
## 8 Residents   
## 9 Unspecified   
## 10 Unspecified human activities

# Cause  
 # <fctr>  
 # Forest industry   
 # Incendiary   
 # Lightning   
 # Miscellaneous known causes   
 # Other industry   
 # Railways   
 # Recreation   
 # Residents   
 # Unspecified   
 # Unspecified human activities  
  
data$Fire\_Cause\_Human = as.character(data$Cause)  
#character is easier to use than factor  
#difference between factor and character  
  
data$Fire\_Cause\_Human[ data$Fire\_Cause\_Human != "Lightning" & data$Fire\_Cause\_Human != "Unspecified" ] = "Human"  
# There are three types of fire causes, Lightning, Human and Unspecified.   
# We don't know what unspecified is. Unspecified could be Lightning or Human cause.  
  
unique(data$Fire\_Cause\_Human)

## [1] "Human" "Lightning" "Unspecified"

#[1] "Human" "Lightning" "Unspecified"  
  
names(data)

## [1] "Cause" "Jurisdiction" "Number"   
## [4] "Protection.zone" "Response.category" "Year"   
## [7] "Juris\_Long" "Cause\_Grouped" "Time1"   
## [10] "Time2" "Region" "Fire\_Cause\_Human"

# [1] "Cause" "Jurisdiction" "Number" "Protection.zone" "Response.category" "Year" "Juris\_Long" "Cause\_Grouped" "Time1" "Time2"   
# [11] "Region" "Fire\_Cause\_Human"   
  
unique(data$Cause\_Grouped)

## [1] "People" "Lightning"

#[1] "People" "Lightning"  
  
unique(data$Year)

## [1] 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003  
## [15] 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017  
## [29] 2018

#[1] 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018  
############################  
fm1 = Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Response.category  
#class(fm1) #[1] "formula"  
#str(fm1)  
 # Class 'formula' language Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Response.category  
 # ..- attr(\*, ".Environment")=<environment: R\_GlobalEnv>   
  
model1 = lm(fm1, data = data)  
#class(model1) #[1] "lm"  
#str(model1) #Output is too long  
summary(model1)

##   
## Call:  
## lm(formula = fm1, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -129.23 -27.39 0.16 16.86 2740.08   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 226.05347 190.23602 1.188 0.23475  
## Juris\_LongBritish Columbia 36.31642 4.32305 8.401 < 2e-16  
## Juris\_LongManitoba -39.30700 3.68226 -10.675 < 2e-16  
## Juris\_LongNational parks -45.09698 4.31909 -10.441 < 2e-16  
## Juris\_LongNew Brunswick -38.33090 5.78814 -6.622 3.69e-11  
## Juris\_LongNewfoundland and Labrador -46.29485 3.58016 -12.931 < 2e-16  
## Juris\_LongNorthwest Territories -40.44122 4.10710 -9.847 < 2e-16  
## Juris\_LongNova Scotia -37.21587 4.16929 -8.926 < 2e-16  
## Juris\_LongOntario -25.30748 3.63396 -6.964 3.48e-12  
## Juris\_LongPrince Edward Island -56.22543 4.97999 -11.290 < 2e-16  
## Juris\_LongQuebec -34.83754 3.56814 -9.764 < 2e-16  
## Juris\_LongSaskatchewan -27.01072 4.43673 -6.088 1.18e-09  
## Juris\_LongYukon -47.24102 3.82322 -12.356 < 2e-16  
## Year -0.07714 0.09492 -0.813 0.41644  
## Fire\_Cause\_HumanLightning 64.36514 2.36423 27.225 < 2e-16  
## Fire\_Cause\_HumanUnspecified -7.04797 2.39209 -2.946 0.00322  
## Response.categoryModified -44.00517 1.86045 -23.653 < 2e-16  
## Response.categoryNone -44.07735 1.84119 -23.940 < 2e-16  
## Response.categoryUnspecified 20.61424 7.91526 2.604 0.00922  
##   
## (Intercept)   
## Juris\_LongBritish Columbia \*\*\*  
## Juris\_LongManitoba \*\*\*  
## Juris\_LongNational parks \*\*\*  
## Juris\_LongNew Brunswick \*\*\*  
## Juris\_LongNewfoundland and Labrador \*\*\*  
## Juris\_LongNorthwest Territories \*\*\*  
## Juris\_LongNova Scotia \*\*\*  
## Juris\_LongOntario \*\*\*  
## Juris\_LongPrince Edward Island \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Year   
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*\*   
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 80.28 on 11500 degrees of freedom  
## Multiple R-squared: 0.1709, Adjusted R-squared: 0.1696   
## F-statistic: 131.7 on 18 and 11500 DF, p-value: < 2.2e-16

############################  
  
model1 = lm(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = data)  
#class(model1) #[1] "lm"  
#all years  
  
summary(model1)

##   
## Call:  
## lm(formula = Number ~ Juris\_Long + Year + Fire\_Cause\_Human +   
## Protection.zone + Response.category, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -185.37 -27.16 0.44 14.72 2741.73   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 331.0932 190.7816 1.735 0.08269  
## Juris\_LongBritish Columbia 36.1393 4.3004 8.404 < 2e-16  
## Juris\_LongManitoba -32.4533 3.7679 -8.613 < 2e-16  
## Juris\_LongNational parks -45.1380 4.2963 -10.506 < 2e-16  
## Juris\_LongNew Brunswick -39.0378 5.7585 -6.779 1.27e-11  
## Juris\_LongNewfoundland and Labrador -39.0149 3.6881 -10.579 < 2e-16  
## Juris\_LongNorthwest Territories -39.3198 4.0867 -9.621 < 2e-16  
## Juris\_LongNova Scotia -37.2304 4.1473 -8.977 < 2e-16  
## Juris\_LongOntario -18.2214 3.7371 -4.876 1.10e-06  
## Juris\_LongPrince Edward Island -56.7625 4.9545 -11.457 < 2e-16  
## Juris\_LongQuebec -27.5689 3.6763 -7.499 6.89e-14  
## Juris\_LongSaskatchewan -25.7759 4.4169 -5.836 5.50e-09  
## Juris\_LongYukon -41.0647 3.8860 -10.567 < 2e-16  
## Year -0.1298 0.0952 -1.364 0.17263  
## Fire\_Cause\_HumanLightning 62.9286 2.3584 26.683 < 2e-16  
## Fire\_Cause\_HumanUnspecified -6.7846 2.3797 -2.851 0.00437  
## Protection.zoneLimited -14.0857 1.9217 -7.330 2.46e-13  
## Protection.zoneUnspecified 94.5828 11.6949 8.088 6.70e-16  
## Response.categoryModified -43.9075 1.8512 -23.718 < 2e-16  
## Response.categoryNone -43.6226 1.8321 -23.810 < 2e-16  
## Response.categoryUnspecified 17.1594 7.8833 2.177 0.02952  
##   
## (Intercept) .   
## Juris\_LongBritish Columbia \*\*\*  
## Juris\_LongManitoba \*\*\*  
## Juris\_LongNational parks \*\*\*  
## Juris\_LongNew Brunswick \*\*\*  
## Juris\_LongNewfoundland and Labrador \*\*\*  
## Juris\_LongNorthwest Territories \*\*\*  
## Juris\_LongNova Scotia \*\*\*  
## Juris\_LongOntario \*\*\*  
## Juris\_LongPrince Edward Island \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Year   
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*\*   
## Protection.zoneLimited \*\*\*  
## Protection.zoneUnspecified \*\*\*  
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 79.86 on 11498 degrees of freedom  
## Multiple R-squared: 0.1798, Adjusted R-squared: 0.1784   
## F-statistic: 126 on 20 and 11498 DF, p-value: < 2.2e-16

# avg of the reference category for  
# (Alberta)  
# (cause is human)  
# (response category is Full)  
# (protection.zone is Intensive)  
#Start with 331.0932 and add or subtract items to calculate specific query.  
  
#Three \*\*\*, evidence there is an effect on y variable  
# Unit of measure is number of fires  
# predict y is number of fires  
# Year variable has zero linear effect, no asterix \*  
# asterix \*, Evaluating P value if there is a linear effect or not  
#Estimate column is important  
#Multiple R-squared: 0.1798  
#R-squared: percentage of variation explained by the model. 18%  
#Adjusted R-squared: takes into account how many variables in model total.  
#p value for entire model: p-value: < 2.2e-16  
#p value: we reject the NULL. All the coefficients are zero.  
#p value comes from F-statistic  
  
unique(data$Response.category)

## [1] Full Modified None Unspecified  
## Levels: Full Modified None Unspecified

# [1] Full Modified None Unspecified  
# Levels: Full Modified None Unspecified  
  
unique(data$Protection.zone)

## [1] Intensive Limited Unspecified  
## Levels: Intensive Limited Unspecified

# [1] Intensive Limited Unspecified  
# Levels: Intensive Limited Unspecified

## 34.

## Model below is separate from models above

## Additional for testing: prediction

#Prediction for year 2018  
  
#Line below is for 2018  
#Train set  
data2018 = filter(data, Year == 2018)  
  
#Line below is everything except 2018  
#Test set  
datarm2018 = filter(data, Year != 2018)  
  
#Linear model for all years except 2018?  
modelrm2018 = lm(fm1, data = datarm2018)  
#Summary on Test set  
summary(modelrm2018)

##   
## Call:  
## lm(formula = fm1, data = datarm2018)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -127.08 -26.70 0.73 16.04 2743.53   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 413.99423 188.82655 2.192 0.02837  
## Juris\_LongBritish Columbia 34.90878 4.26057 8.193 2.81e-16  
## Juris\_LongManitoba -38.07578 3.62666 -10.499 < 2e-16  
## Juris\_LongNational parks -43.72007 4.25649 -10.271 < 2e-16  
## Juris\_LongNew Brunswick -36.87495 5.72484 -6.441 1.23e-10  
## Juris\_LongNewfoundland and Labrador -44.99968 3.52573 -12.763 < 2e-16  
## Juris\_LongNorthwest Territories -38.90683 4.07636 -9.545 < 2e-16  
## Juris\_LongNova Scotia -35.93674 4.10797 -8.748 < 2e-16  
## Juris\_LongOntario -24.91407 3.57872 -6.962 3.55e-12  
## Juris\_LongPrince Edward Island -54.81433 4.91482 -11.153 < 2e-16  
## Juris\_LongQuebec -33.83135 3.51387 -9.628 < 2e-16  
## Juris\_LongSaskatchewan -25.91140 4.37326 -5.925 3.21e-09  
## Juris\_LongYukon -45.65426 3.76580 -12.123 < 2e-16  
## Year -0.17184 0.09422 -1.824 0.06821  
## Fire\_Cause\_HumanLightning 63.20913 2.34469 26.958 < 2e-16  
## Fire\_Cause\_HumanUnspecified -6.79209 2.35367 -2.886 0.00391  
## Response.categoryModified -43.08178 1.83678 -23.455 < 2e-16  
## Response.categoryNone -43.16625 1.81365 -23.801 < 2e-16  
## Response.categoryUnspecified 20.27430 7.77966 2.606 0.00917  
##   
## (Intercept) \*   
## Juris\_LongBritish Columbia \*\*\*  
## Juris\_LongManitoba \*\*\*  
## Juris\_LongNational parks \*\*\*  
## Juris\_LongNew Brunswick \*\*\*  
## Juris\_LongNewfoundland and Labrador \*\*\*  
## Juris\_LongNorthwest Territories \*\*\*  
## Juris\_LongNova Scotia \*\*\*  
## Juris\_LongOntario \*\*\*  
## Juris\_LongPrince Edward Island \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Year .   
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*\*   
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*\*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 78.89 on 11425 degrees of freedom  
## Multiple R-squared: 0.1687, Adjusted R-squared: 0.1674   
## F-statistic: 128.8 on 18 and 11425 DF, p-value: < 2.2e-16

#Predicting on (Train Set)  
number\_predict\_2018 = predict(modelrm2018, newdata = dplyr::select(data2018, Juris\_Long, Year, Fire\_Cause\_Human, Response.category), type = "response" )  
  
print(number\_predict\_2018) #estimating y values, how many data points in new data.

## 1 2 3 4 5 6   
## 28.3230758 28.3230758 91.5322075 28.3230758 28.3230758 28.3230758   
## 7 8 9 10 11 12   
## 28.3230758 28.3230758 21.5309841 -14.7587091 -14.7587091 48.4504225   
## 13 14 15 16 17 18   
## -14.7587091 -14.7587091 -14.7587091 -14.7587091 -14.7587091 -21.5508009   
## 19 20 21 22 23 24   
## -14.8431751 -14.8431751 48.3659565 -14.8431751 -14.8431751 -14.8431751   
## 25 26 27 28 29 30   
## -14.8431751 -14.8431751 -21.6352669 130.4390409 165.3478193 92.3632654   
## 31 32 33 34 35 36   
## 86.7189661 93.5640908 85.4393577 94.5023057 105.5249741 75.6247112   
## 37 38 39 40 41 42   
## 96.6076917 104.5276416 84.7847832 67.2299093 102.1386877 29.1541337   
## 43 44 45 46 47 48   
## 23.5098345 30.3549592 22.2302261 31.2931740 42.3158425 12.4155795   
## 49 50 51 52 53 54   
## 33.3985601 41.3185099 21.5756515 87.3572560 122.2660343 49.2814804   
## 55 56 57 58 59 60   
## 43.6371812 50.4823059 42.3575728 51.4205207 62.4431892 32.5429262   
## 61 62 63 64 65 66   
## 53.5259068 61.4458566 41.7029982 24.1481243 59.0569027 -13.9276512   
## 67 68 69 70 71 72   
## -19.5719504 -12.7268258 -20.8515589 -11.7886109 -0.7659424 -30.6662054   
## 73 74 75   
## -9.6832249 -1.7632750 -21.5061334

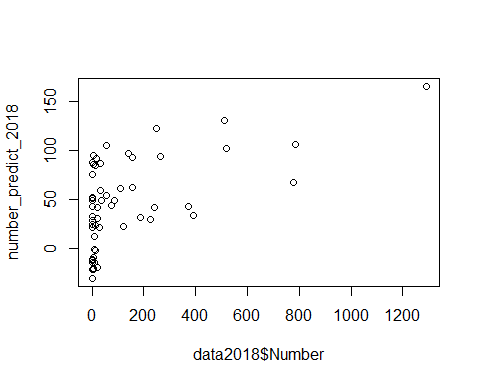
length(number\_predict\_2018) #75 data points for 2018

## [1] 75

length(data2018$Number) #75 data points in 2018

## [1] 75

plot(data2018$Number, number\_predict\_2018) #comparing prediction with actual results



#plotting (actual y values of 2018) vs the (estimated y values of 2018)  
#We are predicting less number of forest fires.  
#Model only captures 18% of the variation.  
#We are over estimating.  
  
# The MSE of the model.   
mse\_18 = mean((number\_predict\_2018 - data2018$Number)^2)  
mse\_18 #[1] 40489.22

## [1] 40489.22

# The RMSE of the model. ORIGINAL UNITS, NUMBER OF FIRES  
# How many forest fires we are off by.  
# We most likely overpredicted by 200 fires  
rmse\_18 = sqrt(mean((number\_predict\_2018 - data2018$Number)^2))  
rmse\_18 #[1] 201.2193

## [1] 201.2193

# The RMSE of the model. ORIGINAL UNITS, NUMBER OF FIRES  
# How many forest fires we are off by.  
# We most likely overpredicted by 200 fires  
rmse\_18\_v2 = (mean((number\_predict\_2018 - data2018$Number)^2))^.5  
rmse\_18\_v2 #[1] 201.2193

## [1] 201.2193

## 35.

## RMSE Prediction for Years

# Function that calculates the rmse for the year specified. The rmse is calculated as the number of predicted fires minus the actual number of fires in that year and taking the squared mean of the differnce.   
rmse\_year\_function = function(data\_set, year\_predict, model\_formula = Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Response.category ) {  
   
 data\_test = filter(data\_set, Year == year\_predict)  
 data\_train = filter(data\_set, Year < year\_predict)  
   
 model = lm( model\_formula, data = data\_train )  
   
 RMSE = sqrt(mean((predict(model, newdata = dplyr::select(data\_test, Juris\_Long, Year, Fire\_Cause\_Human, Response.category)) - data\_test$Number)^2) )  
   
 return(data.frame( Year = year\_predict, RMSE = RMSE))  
   
}  
   
result18 = rmse\_year\_function(data\_set = data, year\_predict = 2018)   
result18

## Year RMSE  
## 1 2018 201.2193

result17 = rmse\_year\_function(data\_set = data, year\_predict = 2017)   
result17

## Year RMSE  
## 1 2017 46.09691

result16 = rmse\_year\_function(data\_set = data, year\_predict = 2016)   
result16

## Year RMSE  
## 1 2016 44.43549

final\_result = rbind(result18, rmse\_year\_function(data\_set = data, year\_predict = 2017) )  
final\_result

## Year RMSE  
## 1 2018 201.21932  
## 2 2017 46.09691

class(rmse\_year\_function(data\_set = data, year\_predict = 2018))

## [1] "data.frame"

rmse\_year\_function(data\_set = data, year\_predict = 2017)

## Year RMSE  
## 1 2017 46.09691

rmse\_year\_function(data\_set = data, year\_predict = 2016)

## Year RMSE  
## 1 2016 44.43549

final\_result = NULL  
class(final\_result)

## [1] "NULL"

for( i in 1991:2018){  
   
 rmse\_i = rmse\_year\_function(data\_set = data, year\_predict = i)   
   
 final\_result = rbind(final\_result, rmse\_i)  
   
}

## Warning in predict.lm(model, newdata = dplyr::select(data\_test,  
## Juris\_Long, : prediction from a rank-deficient fit may be misleading

dim(final\_result)

## [1] 28 2

class(final\_result)

## [1] "data.frame"

final\_result

## Year RMSE  
## 1 1991 76.09586  
## 2 1992 120.59318  
## 3 1993 52.57477  
## 4 1994 147.28320  
## 5 1995 64.81554  
## 6 1996 53.45090  
## 7 1997 50.71129  
## 8 1998 123.27760  
## 9 1999 63.30460  
## 10 2000 54.85529  
## 11 2001 62.75889  
## 12 2002 70.21400  
## 13 2003 81.67327  
## 14 2004 88.99145  
## 15 2005 76.61250  
## 16 2006 104.14469  
## 17 2007 59.30258  
## 18 2008 68.97695  
## 19 2009 107.81176  
## 20 2010 64.48858  
## 21 2011 43.75223  
## 22 2012 66.30571  
## 23 2013 62.14653  
## 24 2014 52.52352  
## 25 2015 76.63914  
## 26 2016 44.43549  
## 27 2017 46.09691  
## 28 2018 201.21932

## 36.

## Prepare Time Series Analysis.

# install.packages("tseries")  
require(forecast) #for forecast function

## Loading required package: forecast

## Warning: package 'forecast' was built under R version 3.5.3

##   
## Attaching package: 'forecast'

## The following object is masked from 'package:caretEnsemble':  
##   
## autoplot

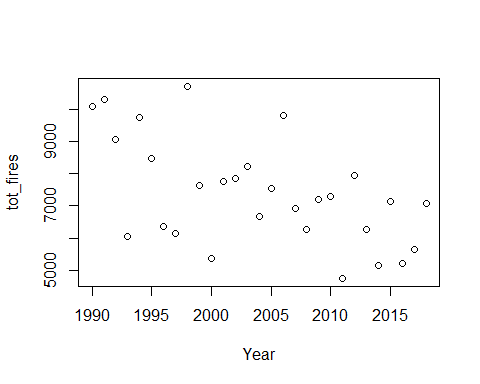
## The following object is masked from 'package:ggpubr':  
##   
## gghistogram

require(tseries)

## Loading required package: tseries

## Warning: package 'tseries' was built under R version 3.5.3

time\_s = data %>% group\_by(Year) %>% summarise(tot\_fires = sum(Number))  
plot(time\_s) # Plot ALL, group by years



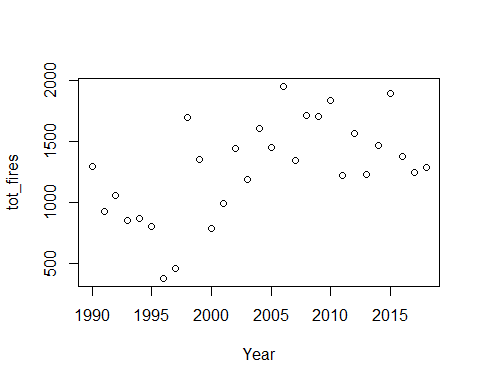
length(unique(data$Year)) #[1] 29

## [1] 29

###################################################################################################################################  
# Subset data for Alberta  
time\_s\_alberta = subset(data, Juris\_Long == "Alberta")  
head(time\_s\_alberta)

## # A tibble: 6 x 12  
## Cause Jurisdiction Number Protection.zone Response.catego~ Year  
## <fct> <fct> <int> <fct> <fct> <int>  
## 1 Fore~ AB 22 Intensive Full 1990  
## 2 Fore~ AB 14 Intensive Full 1991  
## 3 Fore~ AB 12 Intensive Full 1992  
## 4 Fore~ AB 11 Intensive Full 1993  
## 5 Fore~ AB 13 Intensive Full 1994  
## 6 Fore~ AB 14 Intensive Full 1995  
## # ... with 6 more variables: Juris\_Long <fct>, Cause\_Grouped <chr>,  
## # Time1 <chr>, Time2 <chr>, Region <chr>, Fire\_Cause\_Human <chr>

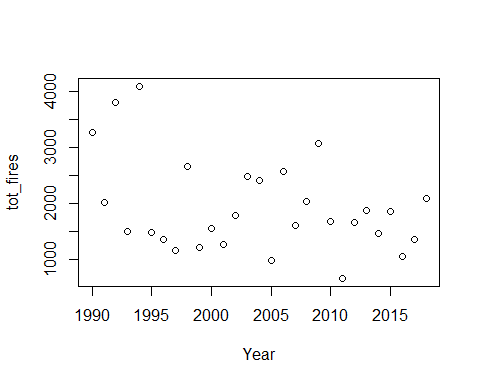
# Group subsetted data for Alberta  
plot\_time\_s\_alberta = time\_s\_alberta %>% group\_by(Year) %>% summarise(tot\_fires = sum(Number))  
plot(plot\_time\_s\_alberta) # Plot Alberta



###################################################################################################################################  
# Subset data for BC  
time\_s\_BC = subset(data, Juris\_Long == "British Columbia")  
head(time\_s\_BC)

## # A tibble: 6 x 12  
## Cause Jurisdiction Number Protection.zone Response.catego~ Year  
## <fct> <fct> <int> <fct> <fct> <int>  
## 1 Fore~ BC 185 Intensive Full 1990  
## 2 Fore~ BC 143 Intensive Full 1991  
## 3 Fore~ BC 152 Intensive Full 1992  
## 4 Fore~ BC 149 Intensive Full 1993  
## 5 Fore~ BC 113 Intensive Full 1994  
## 6 Fore~ BC 134 Intensive Full 1995  
## # ... with 6 more variables: Juris\_Long <fct>, Cause\_Grouped <chr>,  
## # Time1 <chr>, Time2 <chr>, Region <chr>, Fire\_Cause\_Human <chr>

# Group subsetted data for Alberta  
plot\_time\_s\_BC = time\_s\_BC %>% group\_by(Year) %>% summarise(tot\_fires = sum(Number))  
plot(plot\_time\_s\_BC) # Plot Alberta



###################################################################################################################################

## 37.

## Model: Time Series Analysis.

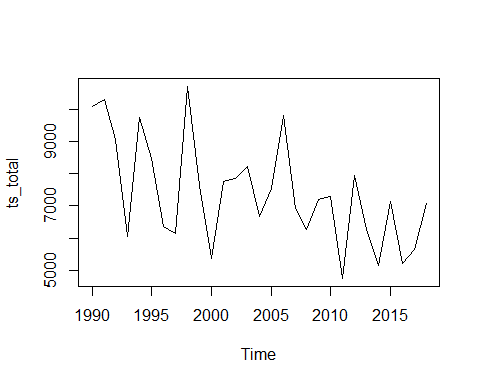
# One liner below replaces the four lines below.  
time\_s$y = time\_s$tot\_fires  
time\_series\_data = time\_s  
y = "Number of Total Fires"  
y\_time\_series = time\_series\_data$y  
  
y\_time\_series = time\_s$tot\_fires  
class(y\_time\_series) # [1] "integer"

## [1] "integer"

#ts\_total = ts(y\_time\_series, start = 1990, end = 2018, frequency = 1)  
ts\_total = ts(y\_time\_series, start = 1990, frequency = 1)  
str(ts\_total)

## Time-Series [1:29] from 1990 to 2018: 10111 10327 9068 6043 9763 8486 6349 6148 10723 7633 ...

plot(ts\_total)



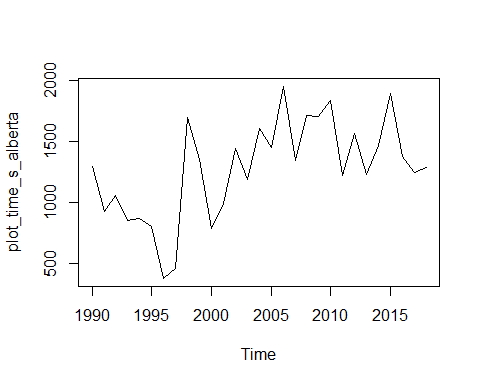
###################################################################################################################################  
# Alberta  
y\_time\_series <- plot\_time\_s\_alberta$tot\_fires  
class(y\_time\_series) # [1] "integer"

## [1] "integer"

#ts\_total = ts(y\_time\_series, start = 1990, end = 2018, frequency = 1)  
plot\_time\_s\_alberta <- ts(y\_time\_series, start = 1990, frequency = 1)  
str(plot\_time\_s\_alberta)

## Time-Series [1:29] from 1990 to 2018: 1296 923 1055 848 872 803 376 456 1698 1355 ...

plot(plot\_time\_s\_alberta)



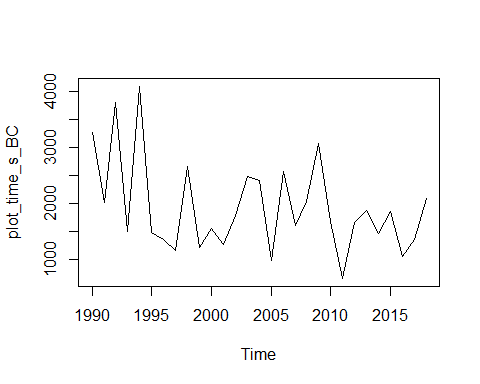
###################################################################################################################################  
# BC  
y\_time\_series <- plot\_time\_s\_BC$tot\_fires  
class(y\_time\_series) # [1] "integer"

## [1] "integer"

#ts\_total = ts(y\_time\_series, start = 1990, end = 2018, frequency = 1)  
plot\_time\_s\_BC <- ts(y\_time\_series, start = 1990, frequency = 1)  
str(plot\_time\_s\_BC)

## Time-Series [1:29] from 1990 to 2018: 3255 2013 3805 1497 4088 1474 1346 1161 2662 1214 ...

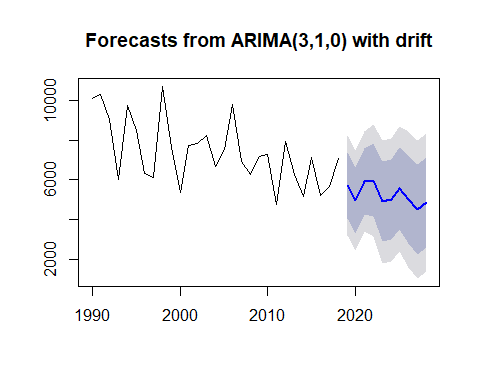
plot(plot\_time\_s\_BC)



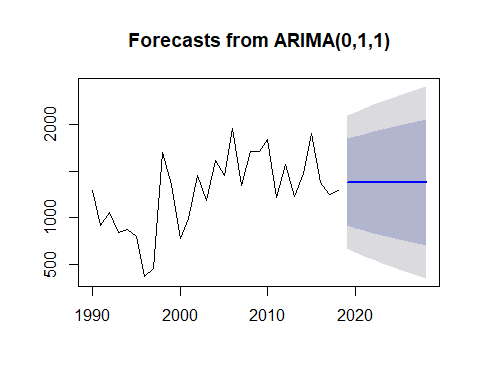
## 38.

## Model: Forecasting Time Series ARIMA Analysis.

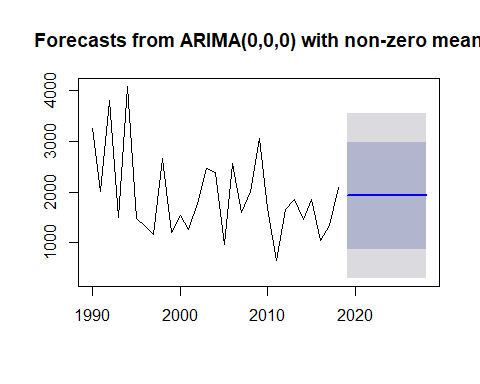
# Directly plotting a forecast of a model  
plot(forecast(auto.arima(ts\_total)))



# Forecast for Alberta  
plot(forecast(auto.arima(plot\_time\_s\_alberta)))



# Forecast for BC  
plot(forecast(auto.arima(plot\_time\_s\_BC)))



In time series analysis, an autoregressive integrated moving average (ARIMA) model is a generalization of an autoregressive moving average (ARMA) model. Both of these models are fitted to time series data either to better understand the data or to predict future points in the series (forecasting). ARIMA models are applied in some cases where data show evidence of non-stationarity, where an initial differencing step (corresponding to the “integrated” part of the model) can be applied one or more times to eliminate the non-stationarity.[1]

The AR part of ARIMA indicates that the evolving variable of interest is regressed on its own lagged (i.e., prior) values. The MA part indicates that the regression error is actually a linear combination of error terms whose values occurred contemporaneously and at various times in the past. The I (for “integrated”) indicates that the data values have been replaced with the difference between their values and the previous values (and this differencing process may have been performed more than once). The purpose of each of these features is to make the model fit the data as well as possible.

Non-seasonal ARIMA models are generally denoted ARIMA(p,d,q) where parameters p, d, and q are non-negative integers, p is the order (number of time lags) of the autoregressive model, d is the degree of differencing (the number of times the data have had past values subtracted), and q is the order of the moving-average model. Seasonal ARIMA models are usually denoted ARIMA(p,d,q)(P,D,Q)m, where m refers to the number of periods in each season, and the uppercase P,D,Q refer to the autoregressive, differencing, and moving average terms for the seasonal part of the ARIMA model.[2][3]

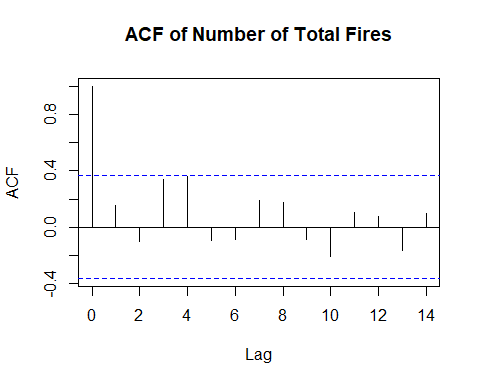
When two out of the three terms are zeros, the model may be referred to based on the non-zero parameter, dropping “AR”, “I” or “MA” from the acronym describing the model. For example, ARIMA (1,0,0) is AR(1), ARIMA(0,1,0) is I(1), and ARIMA(0,0,1) is MA(1).

## 39.

## Analysis of Stationarity

## Autocorrelation function (ACF) of the time series

#checking for asumptions of model.  
acf(time\_series\_data$y, main = paste("ACF of", y)) #Autocorrelation (lags outside 95% confidence bands) implies stochastic or deterministic trend

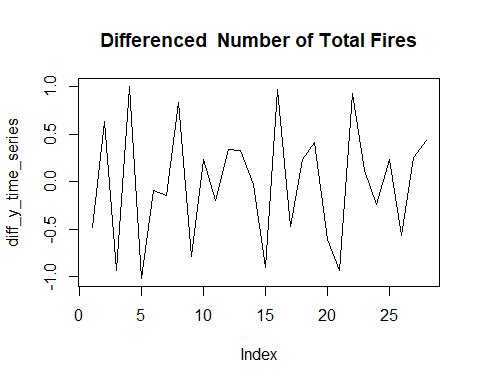


## 40.

## Plot of the differenced time series

diff\_y\_time\_series = diff(log(y\_time\_series))  
plot(diff\_y\_time\_series, type = "line", main = paste('Differenced ', y)) #Visual proof of weakly stationary mean and variance

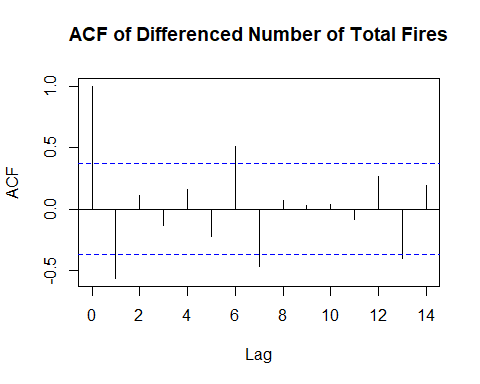
## Warning in plot.xy(xy, type, ...): plot type 'line' will be truncated to  
## first character



## 41.

## Autocorrelation function (ACF) of the differenced time series

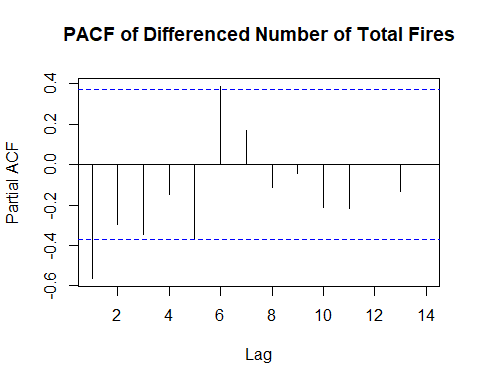
acf(na.omit(diff\_y\_time\_series), main = paste('ACF of Differenced', y)) #Lags within the 95% confidence bands are considered noise and are statistically insignificant (trend removed). Lags outside 95% confidence bands determine the order of the MA(q) process -- an MA process of the order q has an ACF that cuts off after q lags.



## 42.

## Partial autocorrelation function (PACF) of the differenced time series

pacf(na.omit(diff\_y\_time\_series), main = paste('PACF of Differenced', y)) #Lags within the 95% confidence bands are considered noise and are statistically insignificant (trend removed). Lags outside 95% confidence bands determine the order of the AR(p) process -- an AR process of the order p has a PACF that cuts off after p lags.



## 43.

## Ljung-Box test of autocorrelation

Box.test(diff\_y\_time\_series, lag = log(length(diff\_y\_time\_series)), type = "Ljung-Box") #Formal test of autocorrelation and/or associated trend. The null hypothesis is that there is no autocorrelation (confirmed by p-value > 5%)

##   
## Box-Ljung test  
##   
## data: diff\_y\_time\_series  
## X-squared = 10.856, df = 3.3322, p-value = 0.01676

## 44.

## Augmented Dickey-Fuller test of stationarity

library(tseries)  
adf.test(na.omit(diff\_y\_time\_series)) #Formal test of stationarity. The null hypothesis is that the process is NOT stationary. We look for a p-value < 5% to reject the null hypothesis in favor of the alternative hypothesis (in which case the process is stationary)

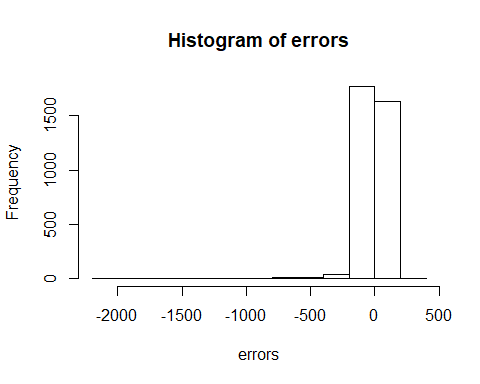
##   
## Augmented Dickey-Fuller Test  
##   
## data: na.omit(diff\_y\_time\_series)  
## Dickey-Fuller = -3.9787, Lag order = 3, p-value = 0.02356  
## alternative hypothesis: stationary

## 40.

## Additional testing

## Variable Selection for Multiple Linear Regression in R

# Split the dataset to 70% of training and 30% of test sets.   
# We want to make sure that the training set and the test set do not have any common data points.  
set.seed(123)  
  
train\_index <- sample(1:nrow(data), 0.7 \* nrow(data))  
train.set <- data[train\_index,]  
test.set <- data[-train\_index,]  
  
# Train our model on the training set  
model2 = lm(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = train.set)  
#summary(model2)  
  
# Prediction on the test set  
prediction <- predict(model2, interval="prediction", newdata =test.set)  
#model2  
  
# Calculate error (prediction Number - test Number) in predictions and show the histogram of error  
errors <- prediction[,"fit"] - test.set$Number  
hist(errors)



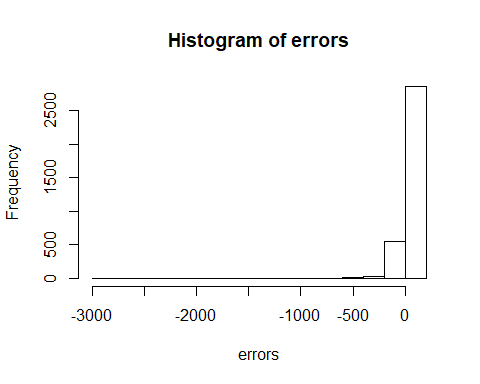
# Compute the root mean square error and find the percentage of cases with less than 25% error.  
# Calculate mean square error (mse) and find the percentage of cases with less than 25% error.  
  
rmse <- sqrt(sum((prediction[,"fit"] - test.set$Number)^2)/nrow(test.set))  
rel\_change <- 1 - ((test.set$Number - abs(errors)) / test.set$Number)  
  
pred25 <- table(rel\_change<0.25)["TRUE"] / nrow(test.set)  
paste("RMSE:", rmse)

## [1] "RMSE: 77.9783605409196"

paste("PRED(25):", pred25)

## [1] "PRED(25): 0.0300925925925926"

# Use simple linear regression model by using 'Juris\_Long' as an independent variable. Compare the results with the multiple linear regression.  
  
rn\_train <- sample(nrow(data), floor(nrow(data)\*0.7))  
train <- data[rn\_train,c("Number","Juris\_Long")]  
test <- data[-rn\_train,c("Number","Juris\_Long")]  
model\_ulm <- lm(Number~Juris\_Long, data=train)  
prediction <- predict(model\_ulm, interval="prediction", newdata =test)  
errors <- prediction[,"fit"] - test$Number  
hist(errors)



rmse <- sqrt(sum((prediction[,"fit"] - test$Number)^2)/nrow(test))  
rel\_change <- 1 - ((test$Number - abs(errors)) / test$Number)  
pred25 <- table(rel\_change<0.25)["TRUE"] / nrow(test)  
paste("RMSE:", rmse)

## [1] "RMSE: 90.4986212885367"

paste("PRED(25):", pred25)

## [1] "PRED(25): 0.0347222222222222"

# Both Pred(25) and RMSE values are better for multiple linear regression.

## 41.

## Additional testing

## Forward and Backward selection algorithm

library(MASS) # stepwise regression

## Warning: package 'MASS' was built under R version 3.5.3

##   
## Attaching package: 'MASS'

## The following object is masked from 'package:dplyr':  
##   
## select

#install.packages('leaps')  
library(leaps) # all subsets regression

## Warning: package 'leaps' was built under R version 3.5.3

#install.packages('FNN')  
library(FNN)

## Warning: package 'FNN' was built under R version 3.5.3

# Forward selection   
full <- lm(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = data)  
null <- lm(Number~1,data=data)  
stepF <- stepAIC(null, scope=list(lower=null, upper=full), direction= "forward", trace=TRUE)

## Start: AIC=103176.1  
## Number ~ 1  
##   
## Df Sum of Sq RSS AIC  
## + Response.category 3 5342703 84055596 102472  
## + Fire\_Cause\_Human 2 5023926 84374373 102514  
## + Juris\_Long 12 5043747 84354553 102531  
## + Protection.zone 2 1813104 87585195 102944  
## + Year 1 41537 89356763 103173  
## <none> 89398300 103176  
##   
## Step: AIC=102472.2  
## Number ~ Response.category  
##   
## Df Sum of Sq RSS AIC  
## + Fire\_Cause\_Human 2 5041208 79014389 101764  
## + Juris\_Long 12 4889175 79166421 101806  
## + Protection.zone 2 1511519 82544077 102267  
## + Year 1 36667 84018930 102469  
## <none> 84055596 102472  
##   
## Step: AIC=101763.8  
## Number ~ Response.category + Fire\_Cause\_Human  
##   
## Df Sum of Sq RSS AIC  
## + Juris\_Long 12 4892653 74121736 101051  
## + Protection.zone 2 1260564 77753824 101583  
## + Year 1 49320 78965069 101759  
## <none> 79014389 101764  
##   
## Step: AIC=101051.5  
## Number ~ Response.category + Fire\_Cause\_Human + Juris\_Long  
##   
## Df Sum of Sq RSS AIC  
## + Protection.zone 2 784684 73337051 100933  
## <none> 74121736 101051  
## + Year 1 4256 74117479 101053  
##   
## Step: AIC=100932.9  
## Number ~ Response.category + Fire\_Cause\_Human + Juris\_Long +   
## Protection.zone  
##   
## Df Sum of Sq RSS AIC  
## <none> 73337051 100933  
## + Year 1 11863 73325189 100933

summary(stepF)

##   
## Call:  
## lm(formula = Number ~ Response.category + Fire\_Cause\_Human +   
## Juris\_Long + Protection.zone, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -185.32 -27.04 0.46 14.45 2742.77   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 70.923 3.108 22.820 < 2e-16  
## Response.categoryModified -43.883 1.851 -23.705 < 2e-16  
## Response.categoryNone -43.520 1.831 -23.773 < 2e-16  
## Response.categoryUnspecified 18.787 7.793 2.411 0.01593  
## Fire\_Cause\_HumanLightning 62.918 2.358 26.678 < 2e-16  
## Fire\_Cause\_HumanUnspecified -6.763 2.380 -2.842 0.00449  
## Juris\_LongBritish Columbia 36.385 4.297 8.468 < 2e-16  
## Juris\_LongManitoba -32.682 3.764 -8.682 < 2e-16  
## Juris\_LongNational parks -45.256 4.296 -10.535 < 2e-16  
## Juris\_LongNew Brunswick -39.076 5.759 -6.786 1.21e-11  
## Juris\_LongNewfoundland and Labrador -38.951 3.688 -10.562 < 2e-16  
## Juris\_LongNorthwest Territories -39.494 4.085 -9.669 < 2e-16  
## Juris\_LongNova Scotia -37.242 4.147 -8.980 < 2e-16  
## Juris\_LongOntario -18.003 3.734 -4.822 1.44e-06  
## Juris\_LongPrince Edward Island -56.388 4.947 -11.398 < 2e-16  
## Juris\_LongQuebec -27.496 3.676 -7.480 7.98e-14  
## Juris\_LongSaskatchewan -25.936 4.415 -5.874 4.38e-09  
## Juris\_LongYukon -41.284 3.883 -10.632 < 2e-16  
## Protection.zoneLimited -14.232 1.919 -7.417 1.28e-13  
## Protection.zoneUnspecified 92.720 11.615 7.983 1.57e-15  
##   
## (Intercept) \*\*\*  
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*   
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*\*   
## Juris\_LongBritish Columbia \*\*\*  
## Juris\_LongManitoba \*\*\*  
## Juris\_LongNational parks \*\*\*  
## Juris\_LongNew Brunswick \*\*\*  
## Juris\_LongNewfoundland and Labrador \*\*\*  
## Juris\_LongNorthwest Territories \*\*\*  
## Juris\_LongNova Scotia \*\*\*  
## Juris\_LongOntario \*\*\*  
## Juris\_LongPrince Edward Island \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Protection.zoneLimited \*\*\*  
## Protection.zoneUnspecified \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 79.86 on 11499 degrees of freedom  
## Multiple R-squared: 0.1797, Adjusted R-squared: 0.1783   
## F-statistic: 132.5 on 19 and 11499 DF, p-value: < 2.2e-16

# We end up using all the variables. We set 'trace=TRUE' to see all the steps.  
  
# We can also use 'backward' elimination, which will start with 'full'.  
full <- lm(Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = data)  
stepB <- stepAIC(full, direction= "backward", trace=TRUE)

## Start: AIC=100933  
## Number ~ Juris\_Long + Year + Fire\_Cause\_Human + Protection.zone +   
## Response.category  
##   
## Df Sum of Sq RSS AIC  
## - Year 1 11863 73337051 100933  
## <none> 73325189 100933  
## - Protection.zone 2 792291 74117479 101053  
## - Juris\_Long 12 4369049 77694238 101576  
## - Fire\_Cause\_Human 2 4792069 78117257 101658  
## - Response.category 3 5105989 78431178 101702  
##   
## Step: AIC=100932.9  
## Number ~ Juris\_Long + Fire\_Cause\_Human + Protection.zone + Response.category  
##   
## Df Sum of Sq RSS AIC  
## <none> 73337051 100933  
## - Protection.zone 2 784684 74121736 101051  
## - Juris\_Long 12 4416773 77753824 101583  
## - Fire\_Cause\_Human 2 4789846 78126898 101658  
## - Response.category 3 5107444 78444495 101702

summary(stepB)

##   
## Call:  
## lm(formula = Number ~ Juris\_Long + Fire\_Cause\_Human + Protection.zone +   
## Response.category, data = data)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -185.32 -27.04 0.46 14.45 2742.77   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 70.923 3.108 22.820 < 2e-16  
## Juris\_LongBritish Columbia 36.385 4.297 8.468 < 2e-16  
## Juris\_LongManitoba -32.682 3.764 -8.682 < 2e-16  
## Juris\_LongNational parks -45.256 4.296 -10.535 < 2e-16  
## Juris\_LongNew Brunswick -39.076 5.759 -6.786 1.21e-11  
## Juris\_LongNewfoundland and Labrador -38.951 3.688 -10.562 < 2e-16  
## Juris\_LongNorthwest Territories -39.494 4.085 -9.669 < 2e-16  
## Juris\_LongNova Scotia -37.242 4.147 -8.980 < 2e-16  
## Juris\_LongOntario -18.003 3.734 -4.822 1.44e-06  
## Juris\_LongPrince Edward Island -56.388 4.947 -11.398 < 2e-16  
## Juris\_LongQuebec -27.496 3.676 -7.480 7.98e-14  
## Juris\_LongSaskatchewan -25.936 4.415 -5.874 4.38e-09  
## Juris\_LongYukon -41.284 3.883 -10.632 < 2e-16  
## Fire\_Cause\_HumanLightning 62.918 2.358 26.678 < 2e-16  
## Fire\_Cause\_HumanUnspecified -6.763 2.380 -2.842 0.00449  
## Protection.zoneLimited -14.232 1.919 -7.417 1.28e-13  
## Protection.zoneUnspecified 92.720 11.615 7.983 1.57e-15  
## Response.categoryModified -43.883 1.851 -23.705 < 2e-16  
## Response.categoryNone -43.520 1.831 -23.773 < 2e-16  
## Response.categoryUnspecified 18.787 7.793 2.411 0.01593  
##   
## (Intercept) \*\*\*  
## Juris\_LongBritish Columbia \*\*\*  
## Juris\_LongManitoba \*\*\*  
## Juris\_LongNational parks \*\*\*  
## Juris\_LongNew Brunswick \*\*\*  
## Juris\_LongNewfoundland and Labrador \*\*\*  
## Juris\_LongNorthwest Territories \*\*\*  
## Juris\_LongNova Scotia \*\*\*  
## Juris\_LongOntario \*\*\*  
## Juris\_LongPrince Edward Island \*\*\*  
## Juris\_LongQuebec \*\*\*  
## Juris\_LongSaskatchewan \*\*\*  
## Juris\_LongYukon \*\*\*  
## Fire\_Cause\_HumanLightning \*\*\*  
## Fire\_Cause\_HumanUnspecified \*\*   
## Protection.zoneLimited \*\*\*  
## Protection.zoneUnspecified \*\*\*  
## Response.categoryModified \*\*\*  
## Response.categoryNone \*\*\*  
## Response.categoryUnspecified \*   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 79.86 on 11499 degrees of freedom  
## Multiple R-squared: 0.1797, Adjusted R-squared: 0.1783   
## F-statistic: 132.5 on 19 and 11499 DF, p-value: < 2.2e-16

# We end up using all the variables.

## 42.

## Additional testing

## Variable selection using automatic methods

# Best combination of the 6 attributes.  
subsets<-regsubsets(Number ~ Jurisdiction + Year + Fire\_Cause\_Human + Protection.zone + Response.category, data = data, nbest=1)  
sub.sum <- summary(subsets)  
as.data.frame(sub.sum$outmat)

## JurisdictionBC JurisdictionMB JurisdictionNP JurisdictionNB  
## 1 ( 1 )   
## 2 ( 1 ) \*   
## 3 ( 1 )   
## 4 ( 1 ) \*   
## 5 ( 1 ) \*   
## 6 ( 1 ) \*   
## 7 ( 1 ) \*   
## 8 ( 1 ) \*   
## JurisdictionNL JurisdictionNT JurisdictionNS JurisdictionON  
## 1 ( 1 )   
## 2 ( 1 )   
## 3 ( 1 )   
## 4 ( 1 )   
## 5 ( 1 )   
## 6 ( 1 )   
## 7 ( 1 ) \*  
## 8 ( 1 ) \*  
## JurisdictionPE JurisdictionQC JurisdictionSK JurisdictionYT Year  
## 1 ( 1 )   
## 2 ( 1 )   
## 3 ( 1 )   
## 4 ( 1 )   
## 5 ( 1 )   
## 6 ( 1 )   
## 7 ( 1 )   
## 8 ( 1 ) \*   
## Fire\_Cause\_HumanLightning Fire\_Cause\_HumanUnspecified  
## 1 ( 1 ) \*   
## 2 ( 1 ) \*   
## 3 ( 1 ) \*   
## 4 ( 1 ) \*   
## 5 ( 1 ) \*   
## 6 ( 1 ) \*   
## 7 ( 1 ) \*   
## 8 ( 1 ) \*   
## Protection.zoneLimited Protection.zoneUnspecified  
## 1 ( 1 )   
## 2 ( 1 )   
## 3 ( 1 )   
## 4 ( 1 )   
## 5 ( 1 ) \*   
## 6 ( 1 ) \* \*  
## 7 ( 1 ) \* \*  
## 8 ( 1 ) \* \*  
## Response.categoryModified Response.categoryNone  
## 1 ( 1 )   
## 2 ( 1 )   
## 3 ( 1 ) \* \*  
## 4 ( 1 ) \* \*  
## 5 ( 1 ) \* \*  
## 6 ( 1 ) \* \*  
## 7 ( 1 ) \* \*  
## 8 ( 1 ) \* \*  
## Response.categoryUnspecified  
## 1 ( 1 )   
## 2 ( 1 )   
## 3 ( 1 )   
## 4 ( 1 )   
## 5 ( 1 )   
## 6 ( 1 )   
## 7 ( 1 )   
## 8 ( 1 )

# In the output \* denotes the included variables.   
# The best combination of 4 attributes is: 'Fire\_Cause\_HumanLightning', 'JurisdictionBC', 'Response.categoryModified' and 'Response.categoryNone'.   
# The best combination of 5 attributes is: 'Fire\_Cause\_HumanLightning', 'JurisdictionBC', 'Response.categoryModified', 'Response.categoryNone' and Protection.zoneLimited

## 43.

## Additional testing

# Prediction using k Nearest Neighbor Regression

unique(data$Fire\_Cause\_Human) # [1] Human Lightning Unspecified

## [1] "Human" "Lightning" "Unspecified"

unique(data$Juris\_Long) # [1] Alberta British Columbia ...

## [1] Alberta British Columbia   
## [3] Manitoba National parks   
## [5] New Brunswick Newfoundland and Labrador  
## [7] Nova Scotia Ontario   
## [9] Prince Edward Island Quebec   
## [11] Saskatchewan Yukon   
## [13] Northwest Territories   
## 13 Levels: Alberta British Columbia Manitoba ... Yukon

unique(data$Protection.zone) # [1] Intensive Limited Unspecified

## [1] Intensive Limited Unspecified  
## Levels: Intensive Limited Unspecified

unique(data$Response.category) # [1] Full Modified None Unspecified

## [1] Full Modified None Unspecified  
## Levels: Full Modified None Unspecified

unique(data$Year) # 1990 1991 1992 1993 1994 1995 1996

## [1] 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003  
## [15] 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017  
## [29] 2018

# rm(data1)  
# rm(dataset.numeric)  
data1 <- data[, c("Number","Fire\_Cause\_Human", "Juris\_Long", "Protection.zone", "Response.category", "Year")]  
head(data1)

## # A tibble: 6 x 6  
## Number Fire\_Cause\_Human Juris\_Long Protection.zone Response.catego~ Year  
## <int> <chr> <fct> <fct> <fct> <int>  
## 1 22 Human Alberta Intensive Full 1990  
## 2 14 Human Alberta Intensive Full 1991  
## 3 12 Human Alberta Intensive Full 1992  
## 4 11 Human Alberta Intensive Full 1993  
## 5 13 Human Alberta Intensive Full 1994  
## 6 14 Human Alberta Intensive Full 1995

tail(data1)

## # A tibble: 6 x 6  
## Number Fire\_Cause\_Human Juris\_Long Protection.zone Response.catego~ Year  
## <int> <chr> <fct> <fct> <fct> <int>  
## 1 0 Human Nova Scot~ Unspecified Modified 2018  
## 2 11 Human Ontario Unspecified Modified 2018  
## 3 0 Human Prince Ed~ Unspecified Modified 2018  
## 4 6 Human Quebec Unspecified Modified 2018  
## 5 13 Human Saskatche~ Unspecified Modified 2018  
## 6 6 Human Yukon Unspecified Modified 2018

str(data1)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 11519 obs. of 6 variables:  
## $ Number : int 22 14 12 11 13 14 8 29 10 20 ...  
## $ Fire\_Cause\_Human : chr "Human" "Human" "Human" "Human" ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : int 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 ...

summary(data1)

## Number Fire\_Cause\_Human Juris\_Long   
## Min. : 0.00 Length:11519 Quebec :1516   
## 1st Qu.: 0.00 Class :character Newfoundland and Labrador:1486   
## Median : 0.00 Mode :character Ontario :1368   
## Mean : 18.64 Manitoba :1304   
## 3rd Qu.: 4.00 Yukon :1059   
## Max. :2913.00 Northwest Territories : 773   
## (Other) :4013   
## Protection.zone Response.category Year   
## Intensive :8190 Full :4204 Min. :1990   
## Limited :3281 Modified :3521 1st Qu.:1997   
## Unspecified: 48 None :3681 Median :2004   
## Unspecified: 113 Mean :2004   
## 3rd Qu.:2011   
## Max. :2018   
##

# new\_fire <- fires[, c("Cause", "Jurisdiction", "Number", "Protection.zone", "Response.category", "Year")]  
  
# sum(is.na(data1$Number))  
# sum(is.na(data1$Fire\_Cause\_Human))  
# sum(is.na(data1$Juris\_Long))  
# sum(is.na(data1$Protection.zone))  
# sum(is.na(data1$Response.category))  
# sum(is.na(data1$Year))  
  
  
dataset <- rbind(data1, c(0,'Lightning','Alberta','Intensive','Full','1996'))  
  
str(dataset)

## Classes 'tbl\_df', 'tbl' and 'data.frame': 11520 obs. of 6 variables:  
## $ Number : chr "22" "14" "12" "11" ...  
## $ Fire\_Cause\_Human : chr "Human" "Human" "Human" "Human" ...  
## $ Juris\_Long : Factor w/ 13 levels "Alberta","British Columbia",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Protection.zone : Factor w/ 3 levels "Intensive","Limited",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Response.category: Factor w/ 4 levels "Full","Modified",..: 1 1 1 1 1 1 1 1 1 1 ...  
## $ Year : chr "1990" "1991" "1992" "1993" ...

unique(dataset$Number) # [1] Human Lightning Unspecified

## [1] "22" "14" "12" "11" "13" "8" "29" "10" "20" "18"   
## [11] "26" "19" "41" "48" "30" "15" "23" "32" "185" "143"   
## [21] "152" "149" "113" "134" "130" "62" "3" "7" "4" "5"   
## [31] "6" "21" "1" "0" "2" "24" "27" "17" "37" "16"   
## [41] "9" "38" "25" "53" "47" "33" "58" "49" "36" "59"   
## [51] "71" "66" "52" "81" "60" "34" "55" "40" "45" "50"   
## [61] "28" "73" "56" "42" "31" "46" "69" "39" "123" "121"   
## [71] "104" "146" "102" "94" "256" "145" "181" "93" "147" "133"   
## [81] "141" "125" "79" "257" "116" "266" "262" "300" "352" "202"   
## [91] "173" "302" "235" "250" "200" "107" "168" "76" "131" "87"   
## [101] "97" "99" "105" "64" "61" "327" "35" "67" "43" "83"   
## [111] "80" "91" "106" "63" "120" "84" "100" "88" "86" "96"   
## [121] "77" "115" "151" "44" "68" "914" "466" "626" "517" "499"   
## [131] "357" "217" "242" "1192" "890" "429" "490" "868" "527" "732"   
## [141] "432" "746" "513" "779" "566" "741" "215" "436" "287" "563"   
## [151] "772" "514" "416" "2015" "759" "2344" "609" "2913" "342" "723"   
## [161] "675" "1773" "585" "842" "479" "870" "1513" "1716" "384" "1536"  
## [171] "912" "1175" "2184" "992" "209" "944" "1151" "726" "1237" "486"   
## [181] "782" "213" "178" "361" "101" "323" "110" "176" "118" "161"   
## [191] "129" "197" "190" "451" "988" "191" "188" "831" "344" "545"   
## [201] "1141" "282" "167" "886" "533" "417" "98" "1249" "1433" "467"   
## [211] "70" "305" "580" "780" "103" "82" "135" "249" "211" "421"   
## [221] "89" "92" "446" "493" "299" "157" "220" "238" "119" "683"   
## [231] "241" "216" "244" "338" "201" "828" "495" "180" "317" "440"   
## [241] "289" "196" "225" "207" "136" "126" "75" "239" "74" "65"   
## [251] "276" "165" "226" "51" "78" "218" "306" "260" "460" "171"   
## [261] "156" "184" "195" "163" "272" "194" "273" "179" "72" "54"   
## [271] "95" "90" "108" "155" "142" "148" "224" "240" "243" "111"   
## [281] "124" "117" "219" "263" "158" "162" "138" "109" "232" "313"   
## [291] "275" "280" "355" "321" "290" "381" "403" "343" "515" "458"   
## [301] "392" "340" "315" "322" "407" "153" "85" "137" "114" "174"   
## [311] "159" "127" "285" "144" "292" "296" "198" "140" "252" "164"   
## [321] "222" "337" "221" "258" "170" "246" "347" "139" "166" "183"   
## [331] "204" "154" "426" "478" "505" "362" "398" "388" "150" "228"   
## [341] "377" "112" "187" "128" "172" "57" "233" "270" "160" "186"   
## [351] "132" "203" "208" "253" "288" "316" "396" "530" "269" "511"   
## [361] "1290" "787" "777" "518" "373" "247"

unique(dataset$Fire\_Cause\_Human) # [1] Human Lightning Unspecified

## [1] "Human" "Lightning" "Unspecified"

unique(dataset$Juris\_Long) # [1] Alberta British Columbia ...

## [1] Alberta British Columbia   
## [3] Manitoba National parks   
## [5] New Brunswick Newfoundland and Labrador  
## [7] Nova Scotia Ontario   
## [9] Prince Edward Island Quebec   
## [11] Saskatchewan Yukon   
## [13] Northwest Territories   
## 13 Levels: Alberta British Columbia Manitoba ... Yukon

unique(dataset$Protection.zone) # [1] Intensive Limited Unspecified

## [1] Intensive Limited Unspecified  
## Levels: Intensive Limited Unspecified

unique(dataset$Response.category) # [1] Full Modified None Unspecified

## [1] Full Modified None Unspecified  
## Levels: Full Modified None Unspecified

unique(dataset$Year) # 1990 1991 1992 1993 1994 1995 1996

## [1] "1990" "1991" "1992" "1993" "1994" "1995" "1996" "1997" "1998" "1999"  
## [11] "2000" "2001" "2002" "2003" "2004" "2005" "2006" "2007" "2008" "2009"  
## [21] "2010" "2011" "2012" "2013" "2014" "2015" "2016" "2017" "2018"

dataset[is.na(dataset)] <- 0  
dataset.numeric <- sapply( dataset[,1:6], as.numeric )

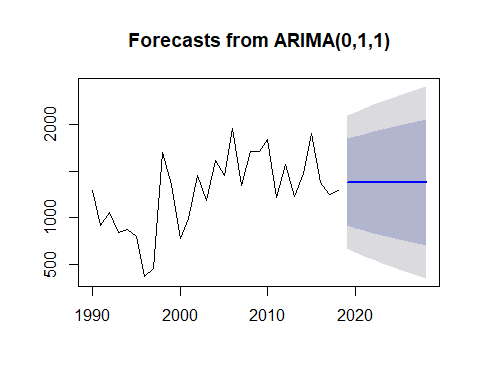
## Warning in lapply(X = X, FUN = FUN, ...): NAs introduced by coercion

#Should convert data to numeric to use knn.reg  
  
#Remove NAs from matrix, replace with zero  
dataset.numeric[is.na(dataset.numeric)] <- 0  
#Matrix now has NAs removed, now replaced with zero  
  
#unique(dataset.numeric$Fire\_Cause\_Human)   
  
dataset.numeric <- as.data.frame(dataset.numeric)  
prediction <- knn.reg(dataset.numeric[1:nrow(data1),-1],  
test = dataset.numeric[nrow(data1)+1,-1],  
 dataset.numeric[1:nrow(data1),]$Number, k = 7 , algorithm="kd\_tree")  
  
prediction$pred # [1] 498.4286

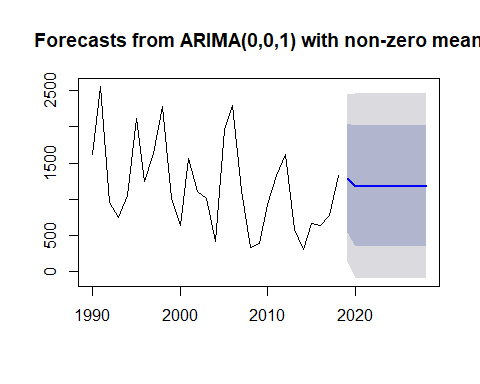
## [1] 49.28571

## Additional time series data

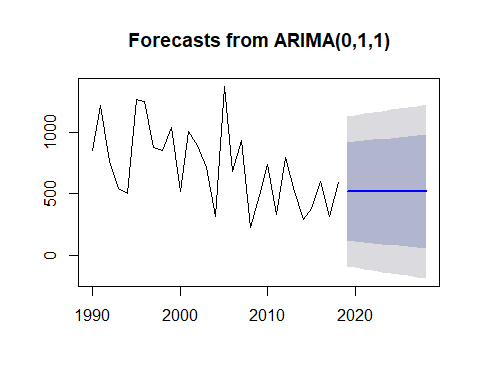
ts\_forecast\_cov = function(data, covariate , subset = "Province" ) {  
 # Subset = "Cause" or "Province"  
 # Covariate = "Human", "Lightning","Unspecified" or one of the Provinces.  
  
 if (subset == "Cause"){  
 time\_s = subset(data,Fire\_Cause\_Human == covariate) %>% group\_by(Year) %>% summarise(tot\_fires = sum(Number))  
 } else {  
 time\_s = subset(data, Juris\_Long == covariate) %>% group\_by(Year) %>% summarise(tot\_fires = sum(Number))  
 }  
 y\_time\_series = time\_s$tot\_fires  
 ts\_total = ts(y\_time\_series, start = 1990, frequency = 1)  
 plot(forecast(auto.arima(ts\_total)))  
}  
#y = "Number of Total Fires"  
# Different subsets and covariates of the data.  
ts\_forecast\_cov(data, covariate = "Alberta", subset = "Province" )



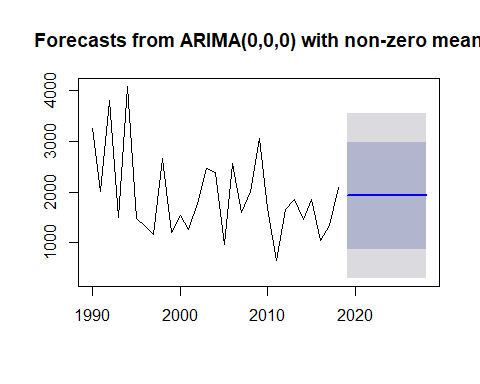
ts\_forecast\_cov(data, covariate = "Ontario", subset = "Province" )



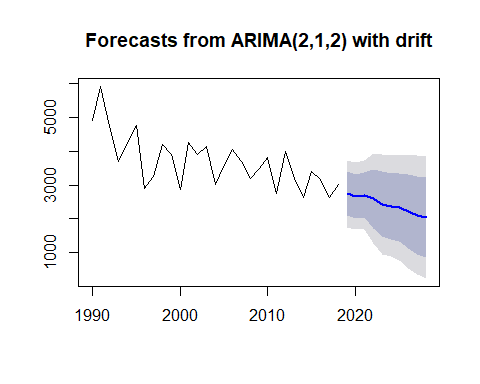
ts\_forecast\_cov(data, covariate = "Quebec", subset = "Province" )



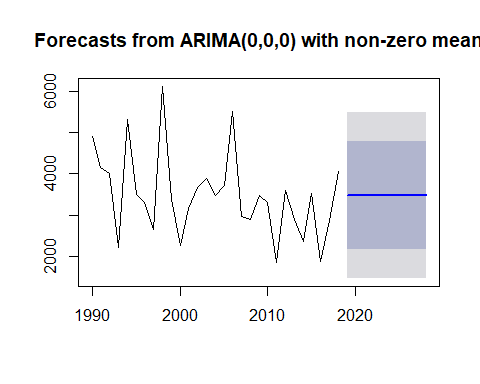
ts\_forecast\_cov(data, covariate = "British Columbia", subset = "Province" )



ts\_forecast\_cov(data, covariate = "Human", subset = "Cause" )



ts\_forecast\_cov(data, covariate = "Lightning", subset = "Cause" )



```

Notes for myself

RMSE

The RMSE is the square root of the variance of the residuals. It indicates the absolute fit of the model to the data-how close the observed data points are to the model’s predicted values. Whereas R-squared is a relative measure of fit, RMSE is an absolute measure of fit. As the square root of a variance, RMSE can be interpreted as the standard deviation of the unexplained variance, and has the useful property of being in the same units as the response variable. Lower values of RMSE indicate better fit. RMSE is a good measure of how accurately the model predicts the response, and it is the most important criterion for fit if the main purpose of the model is prediction.

The F-test

The F-test evaluates the null hypothesis that all regression coefficients are equal to zero versus the alternative that at least one is not. An equivalent null hypothesis is that R-squared equals zero. A significant F-test indicates that the observed R-squared is reliable and is not a spurious result of oddities in the data set. Thus the F-test determines whether the proposed relationship between the response variable and the set of predictors is statistically reliable and can be useful when the research objective is either prediction or explanation.

R-squared and Adjusted R-squared

The difference between SST and SSE is the improvement in prediction from the regression model, compared to the mean model. Dividing that difference by SST gives R-squared. It is the proportional improvement in prediction from the regression model, compared to the mean model. It indicates the goodness of fit of the model.

R-squared has the useful property that its scale is intuitive: it ranges from zero to one, with zero indicating that the proposed model does not improve prediction over the mean model, and one indicating perfect prediction. Improvement in the regression model results in proportional increases in R-squared.

One pitfall of R-squared is that it can only increase as predictors are added to the regression model. This increase is artificial when predictors are not actually improving the model’s fit. To remedy this, a related statistic, Adjusted R-squared, incorporates the model’s degrees of freedom. Adjusted R-squared will decrease as predictors are added if the increase in model fit does not make up for the loss of degrees of freedom. Likewise, it will increase as predictors are added if the increase in model fit is worthwhile. Adjusted R-squared should always be used with models with more than one predictor variable. It is interpreted as the proportion of total variance that is explained by the model.

There are situations in which a high R-squared is not necessary or relevant. When the interest is in the relationship between variables, not in prediction, the R-square is less important. An example is a study on how religiosity affects health outcomes. A good result is a reliable relationship between religiosity and health. No one would expect that religion explains a high percentage of the variation in health, as health is affected by many other factors. Even if the model accounts for other variables known to affect health, such as income and age, an R-squared in the range of 0.10 to 0.15 is reasonable.