Tournament of doom solution

2023-04-24

knitr::opts\_chunk$set(echo = TRUE)

## R Markdown

library(readxl)  
TD <- read\_excel("D:/Google Drive/SCRANTON/Other/Data contest/Tournament of doom/Tournament of Doom.xlsx")

#################################  
#data prep  
TD$sex=factor(TD$sex)  
library(dplyr)

##   
## Attaching package: 'dplyr'

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

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

TD$sex=recode(TD$sex, "1"= "Males", "0"= "Females")  
  
  
TD$mohawk=factor(TD$mohawk)  
TD$weapon=factor(TD$weapon)  
##########################  
#data exploration   
library(GGally)

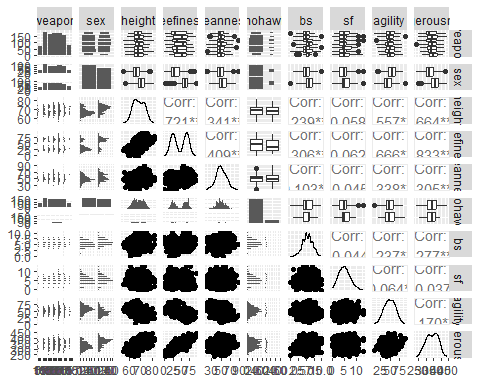
## Loading required package: ggplot2

## Registered S3 method overwritten by 'GGally':  
## method from   
## +.gg ggplot2

ggpairs(TD, columns = 2:11)

## `stat\_bin()` using `bins = 30`. Pick better value with `binwidth`.

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#############################  
#sex differences   
  
  
  
cor.test(as.numeric(TD$sex), TD$height) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$height  
## t = 13.482, df = 998, p-value < 2.2e-16  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## 0.3387639 0.4437100  
## sample estimates:  
## cor   
## 0.3925138

cor.test(as.numeric(TD$sex), TD$dangerousness) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$dangerousness  
## t = 15.571, df = 998, p-value < 2.2e-16  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## 0.3908243 0.4906514  
## sample estimates:  
## cor   
## 0.4421059

cor.test(as.numeric(TD$sex), TD$beefiness) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$beefiness  
## t = 18.645, df = 998, p-value < 2.2e-16  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## 0.4607913 0.5528390  
## sample estimates:  
## cor   
## 0.5082653

cor.test(as.numeric(TD$sex), TD$meanness) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$meanness  
## t = 7.9826, df = 998, p-value = 3.92e-15  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## 0.1858140 0.3023857  
## sample estimates:  
## cor   
## 0.2449851

cor.test(as.numeric(TD$sex), as.numeric(TD$mohawk)) #no association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and as.numeric(TD$mohawk)  
## t = 0.86548, df = 998, p-value = 0.387  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## -0.03466592 0.08922762  
## sample estimates:  
## cor   
## 0.02738602

cor.test(as.numeric(TD$sex), TD$bs) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$bs  
## t = 7.8566, df = 998, p-value = 1.017e-14  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## 0.1820751 0.2988655  
## sample estimates:  
## cor   
## 0.241344

cor.test(as.numeric(TD$sex), TD$sf) #no association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$sf  
## t = 0.87879, df = 998, p-value = 0.3797  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## -0.03424525 0.08964542  
## sample estimates:  
## cor   
## 0.02780687

cor.test(as.numeric(TD$sex), TD$agility) #yes association

##   
## Pearson's product-moment correlation  
##   
## data: as.numeric(TD$sex) and TD$agility  
## t = -13.469, df = 998, p-value < 2.2e-16  
## alternative hypothesis: true correlation is not equal to 0  
## 95 percent confidence interval:  
## -0.4433968 -0.3384186  
## sample estimates:  
## cor   
## -0.3921838

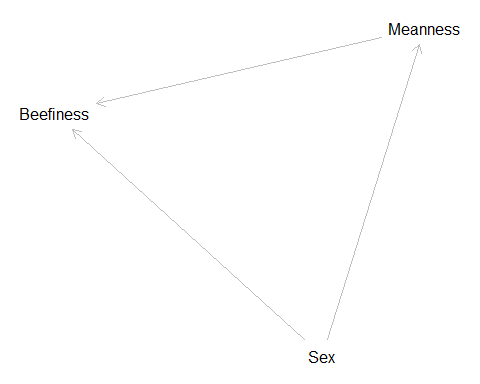
#########################  
  
mod.bf=lm(beefiness~ meanness, data = TD)  
summary(mod.bf)

##   
## Call:  
## lm(formula = beefiness ~ meanness, data = TD)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -50.549 -15.665 0.176 15.685 53.197   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.41512 2.93749 1.503 0.133   
## meanness 0.80861 0.05706 14.171 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 19.77 on 998 degrees of freedom  
## Multiple R-squared: 0.1675, Adjusted R-squared: 0.1667   
## F-statistic: 200.8 on 1 and 998 DF, p-value: < 2.2e-16

mod.s=lm(beefiness~sex + meanness, data = TD)  
summary(mod.s)

##   
## Call:  
## lm(formula = beefiness ~ sex + meanness, data = TD)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -58.088 -11.584 0.204 11.978 50.701   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 6.15361 2.60985 2.358 0.0186 \*   
## sexMales 18.82490 1.14694 16.413 <2e-16 \*\*\*  
## meanness 0.59854 0.05225 11.456 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 17.55 on 997 degrees of freedom  
## Multiple R-squared: 0.3446, Adjusted R-squared: 0.3433   
## F-statistic: 262.1 on 2 and 997 DF, p-value: < 2.2e-16

#causal model   
library(dagitty)  
dag1 <- dagitty("dag {  
Sex -> Beefiness  
Sex->Meanness  
Meanness->Beefiness  
}")  
  
plot(graphLayout(dag1))



adjustmentSets(dag1, exposure = "Meanness", outcome = "Beefiness") #must control for sex

## { Sex }

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

#figuring out which variables to include in the dangerousness model  
#here some possible interactions are included   
  
mod.exp = lm(dangerousness~sex \* height + weapon \* beefiness + bs \* sf + meanness + agility, data = TD)  
  
library(MASS)

##   
## Attaching package: 'MASS'

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

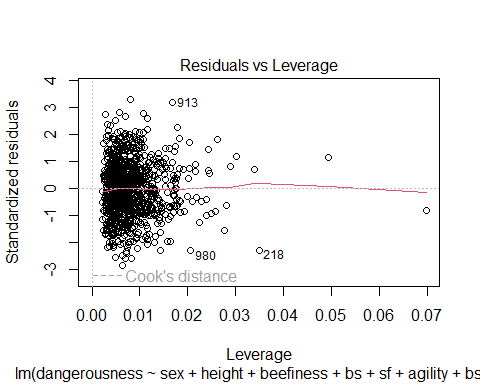
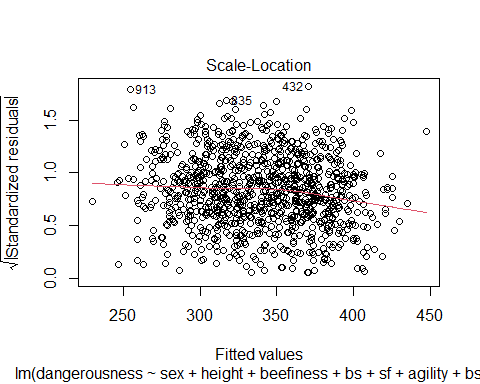
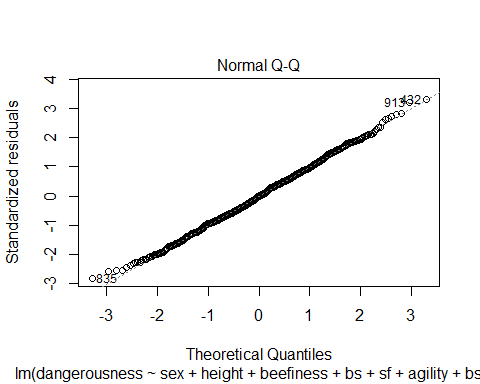
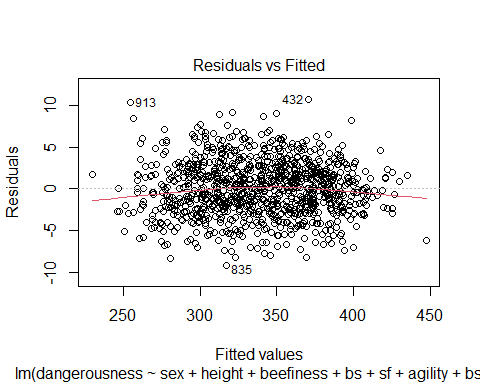
step=stepAIC(mod.exp, direction = c("both"),  
 trace = 0, steps = 1000, k = 4)  
step$anova

## Stepwise Model Path   
## Analysis of Deviance Table  
##   
## Initial Model:  
## dangerousness ~ sex \* height + weapon \* beefiness + bs \* sf +   
## meanness + agility  
##   
## Final Model:  
## dangerousness ~ sex + height + beefiness + bs + sf + agility +   
## bs:sf  
##   
##   
## Step Df Deviance Resid. Df Resid. Dev AIC  
## 1 978 10352.21 2425.200  
## 2 - weapon:beefiness 6 26.2748900 984 10378.48 2403.735  
## 3 - weapon 6 71.6240291 990 10450.11 2386.612  
## 4 - meanness 1 0.6224504 991 10450.73 2382.672  
## 5 - sex:height 1 1.2477498 992 10451.98 2378.791

step$coefficients

## (Intercept) sexMales height beefiness bs sf   
## 6.31555797 5.14886681 2.02312957 1.99089014 0.59875150 -0.46610983   
## agility bs:sf   
## 1.99887368 0.07766062

plot(step)



mod1=lm(dangerousness~sex + height + beefiness + bs + agility, data=TD)  
library(jtools)  
summ(mod1,vifs = TRUE)

## MODEL INFO:  
## Observations: 1000  
## Dependent Variable: dangerousness  
## Type: OLS linear regression   
##   
## MODEL FIT:  
## F(5,994) = 28737.81, p = 0.00  
## R² = 0.99  
## Adj. R² = 0.99   
##   
## Standard errors: OLS  
## ------------------------------------------------------  
## Est. S.E. t val. p VIF  
## ----------------- ------ ------ -------- ------ ------  
## (Intercept) 3.83 2.19 1.75 0.08   
## sexMales 5.12 0.24 21.16 0.00 1.37  
## height 2.03 0.03 63.62 0.00 2.13  
## beefiness 1.99 0.01 244.64 0.00 2.92  
## bs 0.98 0.07 14.65 0.00 1.12  
## agility 2.00 0.01 205.09 0.00 1.85  
## ------------------------------------------------------

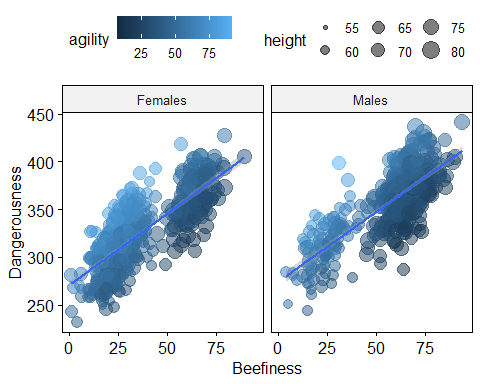
library(ggpubr)

## Registered S3 methods overwritten by 'broom':  
## method from   
## tidy.glht jtools  
## tidy.summary.glht jtools

ggscatter(data=TD, x = "beefiness", y = "dangerousness", add = "reg.line", conf.int = TRUE,   
 size = "height", color = "agility", facet.by = "sex", alpha = 0.5,   
 xlab = "Beefiness",  
 ylab = "Dangerousness")

## `geom\_smooth()` using formula = 'y ~ x'

## Warning: The following aesthetics were dropped during statistical transformation:  
## colour, fill  
## ℹ This can happen when ggplot fails to infer the correct grouping structure in  
## the data.  
## ℹ Did you forget to specify a `group` aesthetic or to convert a numerical  
## variable into a factor?  
## The following aesthetics were dropped during statistical transformation:  
## colour, fill  
## ℹ This can happen when ggplot fails to infer the correct grouping structure in  
## the data.  
## ℹ Did you forget to specify a `group` aesthetic or to convert a numerical  
## variable into a factor?



#########################################  
#machine learning stuff   
#first using some decision trees via rpart  
library(caret)

## Loading required package: lattice

set.seed(12345)  
treeexp= train(dangerousness~sex + height + weapon + beefiness + bs + sf + meanness + agility,  
 data=TD,   
 method= "rpart",  
 metric="RMSE",  
 trControl= trainControl(method="cv", number=5,  
 returnResamp = "all",  
 savePredictions = "all"),   
 tuneLength=20)

## Warning in nominalTrainWorkflow(x = x, y = y, wts = weights, info = trainInfo, :  
## There were missing values in resampled performance measures.

summary(treeexp)

## Call:  
## (function (formula, data, weights, subset, na.action = na.rpart,   
## method, model = FALSE, x = FALSE, y = TRUE, parms, control,   
## cost, ...)   
## {  
## Call <- match.call()  
## if (is.data.frame(model)) {  
## m <- model  
## model <- FALSE  
## }  
## else {  
## indx <- match(c("formula", "data", "weights", "subset"),   
## names(Call), nomatch = 0)  
## if (indx[1] == 0)   
## stop("a 'formula' argument is required")  
## temp <- Call[c(1, indx)]  
## temp$na.action <- na.action  
## temp[[1]] <- quote(stats::model.frame)  
## m <- eval.parent(temp)  
## }  
## Terms <- attr(m, "terms")  
## if (any(attr(Terms, "order") > 1))   
## stop("Trees cannot handle interaction terms")  
## Y <- model.response(m)  
## wt <- model.weights(m)  
## if (any(wt < 0))   
## stop("negative weights not allowed")  
## if (!length(wt))   
## wt <- rep(1, nrow(m))  
## offset <- model.offset(m)  
## X <- rpart.matrix(m)  
## nobs <- nrow(X)  
## nvar <- ncol(X)  
## if (missing(method)) {  
## method <- if (is.factor(Y) || is.character(Y))   
## "class"  
## else if (inherits(Y, "Surv"))   
## "exp"  
## else if (is.matrix(Y))   
## "poisson"  
## else "anova"  
## }  
## if (is.list(method)) {  
## mlist <- method  
## method <- "user"  
## init <- if (missing(parms))   
## mlist$init(Y, offset, wt = wt)  
## else mlist$init(Y, offset, parms, wt)  
## keep <- rpartcallback(mlist, nobs, init)  
## method.int <- 4  
## parms <- init$parms  
## }  
## else {  
## method.int <- pmatch(method, c("anova", "poisson", "class",   
## "exp"))  
## if (is.na(method.int))   
## stop("Invalid method")  
## method <- c("anova", "poisson", "class", "exp")[method.int]  
## if (method.int == 4)   
## method.int <- 2  
## init <- if (missing(parms))   
## get(paste("rpart", method, sep = "."), envir = environment())(Y,   
## offset, , wt)  
## else get(paste("rpart", method, sep = "."), envir = environment())(Y,   
## offset, parms, wt)  
## ns <- asNamespace("rpart")  
## if (!is.null(init$print))   
## environment(init$print) <- ns  
## if (!is.null(init$summary))   
## environment(init$summary) <- ns  
## if (!is.null(init$text))   
## environment(init$text) <- ns  
## }  
## Y <- init$y  
## xlevels <- .getXlevels(Terms, m)  
## cats <- rep(0, ncol(X))  
## if (!is.null(xlevels)) {  
## xlevels <- xlevels[names(xlevels) %in% colnames(X)]  
## cats[match(names(xlevels), colnames(X))] <- unlist(lapply(xlevels,   
## length))  
## }  
## extraArgs <- list(...)  
## if (length(extraArgs)) {  
## controlargs <- names(formals(rpart.control))  
## indx <- match(names(extraArgs), controlargs, nomatch = 0)  
## if (any(indx == 0))   
## stop(gettextf("Argument %s not matched", names(extraArgs)[indx ==   
## 0]), domain = NA)  
## }  
## controls <- rpart.control(...)  
## if (!missing(control))   
## controls[names(control)] <- control  
## xval <- controls$xval  
## if (is.null(xval) || (length(xval) == 1 && xval == 0) ||   
## method == "user") {  
## xgroups <- 0  
## xval <- 0  
## }  
## else if (length(xval) == 1) {  
## xgroups <- sample(rep(1:xval, length.out = nobs), nobs,   
## replace = FALSE)  
## }  
## else if (length(xval) == nobs) {  
## xgroups <- xval  
## xval <- length(unique(xgroups))  
## }  
## else {  
## if (!is.null(attr(m, "na.action"))) {  
## temp <- as.integer(attr(m, "na.action"))  
## xval <- xval[-temp]  
## if (length(xval) == nobs) {  
## xgroups <- xval  
## xval <- length(unique(xgroups))  
## }  
## else stop("Wrong length for 'xval'")  
## }  
## else stop("Wrong length for 'xval'")  
## }  
## if (missing(cost))   
## cost <- rep(1, nvar)  
## else {  
## if (length(cost) != nvar)   
## stop("Cost vector is the wrong length")  
## if (any(cost <= 0))   
## stop("Cost vector must be positive")  
## }  
## tfun <- function(x) if (is.matrix(x))   
## rep(is.ordered(x), ncol(x))  
## else is.ordered(x)  
## labs <- sub("^`(.\*)`$", "\\1", attr(Terms, "term.labels"))  
## isord <- unlist(lapply(m[labs], tfun))  
## storage.mode(X) <- "double"  
## storage.mode(wt) <- "double"  
## temp <- as.double(unlist(init$parms))  
## if (!length(temp))   
## temp <- 0  
## rpfit <- .Call(C\_rpart, ncat = as.integer(cats \* !isord),   
## method = as.integer(method.int), as.double(unlist(controls)),   
## temp, as.integer(xval), as.integer(xgroups), as.double(t(init$y)),   
## X, wt, as.integer(init$numy), as.double(cost))  
## nsplit <- nrow(rpfit$isplit)  
## ncat <- if (!is.null(rpfit$csplit))   
## nrow(rpfit$csplit)  
## else 0  
## if (nsplit == 0)   
## xval <- 0  
## numcp <- ncol(rpfit$cptable)  
## temp <- if (nrow(rpfit$cptable) == 3)   
## c("CP", "nsplit", "rel error")  
## else c("CP", "nsplit", "rel error", "xerror", "xstd")  
## dimnames(rpfit$cptable) <- list(temp, 1:numcp)  
## tname <- c("<leaf>", colnames(X))  
## splits <- matrix(c(rpfit$isplit[, 2:3], rpfit$dsplit), ncol = 5,   
## dimnames = list(tname[rpfit$isplit[, 1] + 1], c("count",   
## "ncat", "improve", "index", "adj")))  
## index <- rpfit$inode[, 2]  
## nadd <- sum(isord[rpfit$isplit[, 1]])  
## if (nadd > 0) {  
## newc <- matrix(0, nadd, max(cats))  
## cvar <- rpfit$isplit[, 1]  
## indx <- isord[cvar]  
## cdir <- splits[indx, 2]  
## ccut <- floor(splits[indx, 4])  
## splits[indx, 2] <- cats[cvar[indx]]  
## splits[indx, 4] <- ncat + 1:nadd  
## for (i in 1:nadd) {  
## newc[i, 1:(cats[(cvar[indx])[i]])] <- -as.integer(cdir[i])  
## newc[i, 1:ccut[i]] <- as.integer(cdir[i])  
## }  
## catmat <- if (ncat == 0)   
## newc  
## else {  
## cs <- rpfit$csplit  
## ncs <- ncol(cs)  
## ncc <- ncol(newc)  
## if (ncs < ncc)   
## cs <- cbind(cs, matrix(0, nrow(cs), ncc - ncs))  
## rbind(cs, newc)  
## }  
## ncat <- ncat + nadd  
## }  
## else catmat <- rpfit$csplit  
## if (nsplit == 0) {  
## frame <- data.frame(row.names = 1, var = "<leaf>", n = rpfit$inode[,   
## 5], wt = rpfit$dnode[, 3], dev = rpfit$dnode[, 1],   
## yval = rpfit$dnode[, 4], complexity = rpfit$dnode[,   
## 2], ncompete = 0, nsurrogate = 0)  
## }  
## else {  
## temp <- ifelse(index == 0, 1, index)  
## svar <- ifelse(index == 0, 0, rpfit$isplit[temp, 1])  
## frame <- data.frame(row.names = rpfit$inode[, 1], var = tname[svar +   
## 1], n = rpfit$inode[, 5], wt = rpfit$dnode[, 3],   
## dev = rpfit$dnode[, 1], yval = rpfit$dnode[, 4],   
## complexity = rpfit$dnode[, 2], ncompete = pmax(0,   
## rpfit$inode[, 3] - 1), nsurrogate = rpfit$inode[,   
## 4])  
## }  
## if (method.int == 3) {  
## numclass <- init$numresp - 2  
## nodeprob <- rpfit$dnode[, numclass + 5]/sum(wt)  
## temp <- pmax(1, init$counts)  
## temp <- rpfit$dnode[, 4 + (1:numclass)] %\*% diag(init$parms$prior/temp)  
## yprob <- temp/rowSums(temp)  
## yval2 <- matrix(rpfit$dnode[, 4 + (0:numclass)], ncol = numclass +   
## 1)  
## frame$yval2 <- cbind(yval2, yprob, nodeprob)  
## }  
## else if (init$numresp > 1)   
## frame$yval2 <- rpfit$dnode[, -(1:3), drop = FALSE]  
## if (is.null(init$summary))   
## stop("Initialization routine is missing the 'summary' function")  
## functions <- if (is.null(init$print))   
## list(summary = init$summary)  
## else list(summary = init$summary, print = init$print)  
## if (!is.null(init$text))   
## functions <- c(functions, list(text = init$text))  
## if (method == "user")   
## functions <- c(functions, mlist)  
## where <- rpfit$which  
## names(where) <- row.names(m)  
## ans <- list(frame = frame, where = where, call = Call, terms = Terms,   
## cptable = t(rpfit$cptable), method = method, parms = init$parms,   
## control = controls, functions = functions, numresp = init$numresp)  
## if (nsplit)   
## ans$splits = splits  
## if (ncat > 0)   
## ans$csplit <- catmat + 2  
## if (nsplit)   
## ans$variable.importance <- importance(ans)  
## if (model) {  
## ans$model <- m  
## if (missing(y))   
## y <- FALSE  
## }  
## if (y)   
## ans$y <- Y  
## if (x) {  
## ans$x <- X  
## ans$wt <- wt  
## }  
## ans$ordered <- isord  
## if (!is.null(attr(m, "na.action")))   
## ans$na.action <- attr(m, "na.action")  
## if (!is.null(xlevels))   
## attr(ans, "xlevels") <- xlevels  
## if (method == "class")   
## attr(ans, "ylevels") <- init$ylevels  
## class(ans) <- "rpart"  
## ans  
## })(formula = .outcome ~ ., data = list(c(0, 1, 0, 1, 0, 1, 0,   
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## 405.509703948492, 317.121333161042, 360.208960975258, 294.198140993147,   
## 332.865644933095, 309.50045710409, 371.577737157786, 294.95408523311,   
## 368.253383322483, 274.871911928254, 376.939160482266, 295.892759594942,   
## 387.346153611265, 317.515230284158, 364.873879008129, 294.914784724447,   
## 377.370570822138, 305.438155702371, 423.017261261044, 320.306231478141,   
## 343.454539763467, 349.722984336434, 357.583086477464, 310.139387726143,   
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## 343.818676962858, 292.704858243733, 362.309726485947, 344.904516848592,   
## 380.291499960805, 276.120238486989, 287.460827928629, 327.379067063407,   
## 354.482993882449, 260.454600797771, 372.084846529922, 322.403167691198,   
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## 385.891459432706, 359.153700034363, 343.760661260249, 289.109485949904,   
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## 408.202956132165, 332.460411064241, 332.203241915029, 320.637314850646,   
## 309.444604522809, 284.361683264913, 382.520119149649, 306.075822449418,   
## 357.113432992631, 324.319434142022, 399.341295465038, 315.267930745965,   
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## 365.65972023347, 329.328968427933, 358.520621479383, 313.850339300902,   
## 406.209952594089, 301.305898169874, 365.052593441641, 334.683356369692,   
## 389.810425381938, 314.600755139285, 363.467951078356, 271.063588619996,   
## 383.172174927619, 337.996393061362, 341.689443423011, 317.351611368555,   
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## 301.257354561025, 301.865670971403, 402.520870646838, 274.740727702398,   
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## 346.17580620797, 393.02577621046, 355.844614426238, 294.709479584892,   
## 354.633339999487, 283.876840603777, 369.910335392707, 325.635133261383,   
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## 375.9323145498, 261.114300289385, 393.462896917185, 302.045527678253,   
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## 386.918393900295, 272.916239637457, 352.007662784664, 267.417610178932,   
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## 386.539592803161, 309.653173758375, 380.53935175793, 315.537103070442,   
## 346.320025104402, 353.03722526624, 341.914223540526, 294.400832925914,   
## 325.737895309685)), control = list(20, 7, 0, 4, 5, 2, 0,   
## 30, 0))  
## n= 1000   
##   
## CP nsplit rel error  
## 1 0.570141366 0 1.00000000  
## 2 0.074759045 1 0.42985863  
## 3 0.065812698 2 0.35509959  
## 4 0.041384669 3 0.28928689  
## 5 0.031704598 4 0.24790222  
## 6 0.019341661 5 0.21619762  
## 7 0.015162838 6 0.19685596  
## 8 0.012696902 7 0.18169313  
## 9 0.012257707 8 0.16899622  
## 10 0.009623840 9 0.15673852  
## 11 0.007235981 10 0.14711468  
## 12 0.007135546 11 0.13987869  
## 13 0.006024534 12 0.13274315  
## 14 0.005859969 13 0.12671861  
## 15 0.005502363 14 0.12085865  
## 16 0.004449289 15 0.11535628  
## 17 0.004058350 16 0.11090699  
## 18 0.003856963 17 0.10684864  
## 19 0.003732429 18 0.10299168  
## 20 0.003705843 19 0.09925925  
##   
## Variable importance  
## beefiness agility height sexMales meanness bs   
## 29 25 19 12 9 6   
##   
## Node number 1: 1000 observations, complexity param=0.5701414  
## mean=339.0632, MSE=1534.819   
## left son=2 (522 obs) right son=3 (478 obs)  
## Primary splits:  
## beefiness < 52.5 to the left, improve=0.57014140, (0 missing)  
## height < 69.20857 to the left, improve=0.40837800, (0 missing)  
## sexMales < 0.5 to the left, improve=0.19545760, (0 missing)  
## meanness < 49.5 to the left, improve=0.08332828, (0 missing)  
## agility < 48.5 to the right, improve=0.07543923, (0 missing)  
## Surrogate splits:  
## height < 68.21148 to the left, agree=0.874, adj=0.736, (0 split)  
## agility < 49.5 to the right, agree=0.825, adj=0.634, (0 split)  
## sexMales < 0.5 to the left, agree=0.759, adj=0.496, (0 split)  
## meanness < 49.5 to the left, agree=0.697, adj=0.366, (0 split)  
## bs < 5.5 to the left, agree=0.633, adj=0.232, (0 split)  
##   
## Node number 2: 522 observations, complexity param=0.07475905  
## mean=310.7558, MSE=748.7839   
## left son=4 (268 obs) right son=5 (254 obs)  
## Primary splits:  
## agility < 59.5 to the left, improve=0.293558100, (0 missing)  
## beefiness < 27.5 to the left, improve=0.288827400, (0 missing)  
## height < 66.87118 to the left, improve=0.061712930, (0 missing)  
## weapon7 < 0.5 to the left, improve=0.012863900, (0 missing)  
## meanness < 29.5 to the right, improve=0.009399561, (0 missing)  
## Surrogate splits:  
## height < 62.47712 to the right, agree=0.557, adj=0.091, (0 split)  
## beefiness < 15.5 to the right, agree=0.534, adj=0.043, (0 split)  
## meanness < 34.5 to the right, agree=0.534, adj=0.043, (0 split)  
## bs < 5.5 to the right, agree=0.533, adj=0.039, (0 split)  
## weapon7 < 0.5 to the left, agree=0.529, adj=0.031, (0 split)  
##   
## Node number 3: 478 observations, complexity param=0.0658127  
## mean=369.9762, MSE=562.5317   
## left son=6 (266 obs) right son=7 (212 obs)  
## Primary splits:  
## agility < 41.5 to the left, improve=0.37565750, (0 missing)  
## beefiness < 65.5 to the left, improve=0.14259100, (0 missing)  
## height < 69.13403 to the left, improve=0.03505555, (0 missing)  
## meanness < 45.5 to the right, improve=0.01504556, (0 missing)  
## sexMales < 0.5 to the left, improve=0.01435128, (0 missing)  
## Surrogate splits:  
## sf < 8.5 to the left, agree=0.569, adj=0.028, (0 split)  
## height < 64.89065 to the right, agree=0.565, adj=0.019, (0 split)  
## beefiness < 55.5 to the right, agree=0.563, adj=0.014, (0 split)  
## bs < 4.5 to the right, agree=0.563, adj=0.014, (0 split)  
## weapon3 < 0.5 to the left, agree=0.561, adj=0.009, (0 split)  
##   
## Node number 4: 268 observations, complexity param=0.04138467  
## mean=296.3222, MSE=564.3884   
## left son=8 (148 obs) right son=9 (120 obs)  
## Primary splits:  
## beefiness < 26.5 to the left, improve=0.41993680, (0 missing)  
## height < 68.81371 to the left, improve=0.16662110, (0 missing)  
## agility < 52.5 to the left, improve=0.11409870, (0 missing)  
## sexMales < 0.5 to the left, improve=0.04300230, (0 missing)  
## meanness < 60.5 to the left, improve=0.02463975, (0 missing)  
## Surrogate splits:  
## height < 68.81371 to the left, agree=0.612, adj=0.133, (0 split)  
## agility < 38.5 to the right, agree=0.601, adj=0.108, (0 split)  
## weapon4 < 0.5 to the left, agree=0.597, adj=0.100, (0 split)  
## weapon6 < 0.5 to the left, agree=0.571, adj=0.042, (0 split)  
## meanness < 56.5 to the left, agree=0.571, adj=0.042, (0 split)  
##   
## Node number 5: 254 observations, complexity param=0.0317046  
## mean=325.985, MSE=491.6042   
## left son=10 (99 obs) right son=11 (155 obs)  
## Primary splits:  
## beefiness < 22.5 to the left, improve=0.38969980, (0 missing)  
## agility < 74.5 to the left, improve=0.25981710, (0 missing)  
## height < 64.28261 to the left, improve=0.09268484, (0 missing)  
## meanness < 42.5 to the right, improve=0.02405100, (0 missing)  
## sf < 9.5 to the left, improve=0.02077405, (0 missing)  
## Surrogate splits:  
## meanness < 61.5 to the right, agree=0.630, adj=0.051, (0 split)  
## sf < 1.5 to the left, agree=0.618, adj=0.020, (0 split)  
##   
## Node number 6: 266 observations, complexity param=0.01934166  
## mean=356.9985, MSE=381.3323   
## left son=12 (26 obs) right son=13 (240 obs)  
## Primary splits:  
## agility < 22.5 to the left, improve=0.29266170, (0 missing)  
## beefiness < 67.5 to the left, improve=0.28872910, (0 missing)  
## height < 69.13403 to the left, improve=0.05372561, (0 missing)  
## bs < 4.5 to the left, improve=0.04627648, (0 missing)  
## sexMales < 0.5 to the left, improve=0.03938987, (0 missing)  
##   
## Node number 7: 212 observations, complexity param=0.01225771  
## mean=386.2595, MSE=313.4207   
## left son=14 (108 obs) right son=15 (104 obs)  
## Primary splits:  
## beefiness < 65.5 to the left, improve=0.28314120, (0 missing)  
## agility < 54.5 to the left, improve=0.21929970, (0 missing)  
## height < 69.00662 to the left, improve=0.10703950, (0 missing)  
## meanness < 45.5 to the right, improve=0.01740099, (0 missing)  
## sexMales < 0.5 to the left, improve=0.01342430, (0 missing)  
## Surrogate splits:  
## agility < 44.5 to the right, agree=0.585, adj=0.154, (0 split)  
## meanness < 60.5 to the left, agree=0.561, adj=0.106, (0 split)  
## height < 74.30353 to the right, agree=0.552, adj=0.087, (0 split)  
## weapon2 < 0.5 to the left, agree=0.538, adj=0.058, (0 split)  
## weapon5 < 0.5 to the left, agree=0.538, adj=0.058, (0 split)  
##   
## Node number 8: 148 observations, complexity param=0.00962384  
## mean=282.4598, MSE=296.6786   
## left son=16 (68 obs) right son=17 (80 obs)  
## Primary splits:  
## agility < 51.5 to the left, improve=0.33640140, (0 missing)  
## beefiness < 22.5 to the left, improve=0.21898680, (0 missing)  
## height < 68.35152 to the left, improve=0.13259250, (0 missing)  
## bs < 2.5 to the left, improve=0.01957344, (0 missing)  
## weapon7 < 0.5 to the left, improve=0.01778132, (0 missing)  
## Surrogate splits:  
## height < 66.72647 to the right, agree=0.588, adj=0.103, (0 split)  
## meanness < 51.5 to the right, agree=0.581, adj=0.088, (0 split)  
## bs < 7.5 to the right, agree=0.568, adj=0.059, (0 split)  
## beefiness < 4.5 to the left, agree=0.554, adj=0.029, (0 split)  
## sf < 5.5 to the left, agree=0.554, adj=0.029, (0 split)  
##   
## Node number 9: 120 observations, complexity param=0.007235981  
## mean=313.4193, MSE=365.2472   
## left son=18 (64 obs) right son=19 (56 obs)  
## Primary splits:  
## beefiness < 33.5 to the left, improve=0.25338830, (0 missing)  
## height < 66.85377 to the left, improve=0.24037970, (0 missing)  
## meanness < 53.5 to the left, improve=0.10396520, (0 missing)  
## agility < 45.5 to the left, improve=0.08619279, (0 missing)  
## sexMales < 0.5 to the left, improve=0.07157241, (0 missing)  
## Surrogate splits:  
## agility < 48.5 to the right, agree=0.700, adj=0.357, (0 split)  
## height < 66.92355 to the left, agree=0.683, adj=0.321, (0 split)  
## meanness < 57.5 to the left, agree=0.625, adj=0.196, (0 split)  
## sexMales < 0.5 to the left, agree=0.608, adj=0.161, (0 split)  
## weapon7 < 0.5 to the left, agree=0.575, adj=0.089, (0 split)  
##   
## Node number 10: 99 observations, complexity param=0.007135546  
## mean=308.6661, MSE=252.1102   
## left son=20 (57 obs) right son=21 (42 obs)  
## Primary splits:  
## agility < 67.5 to the left, improve=0.43879220, (0 missing)  
## beefiness < 9.5 to the left, improve=0.35318750, (0 missing)  
## height < 61.96929 to the left, improve=0.16252110, (0 missing)  
## sf < 2.5 to the left, improve=0.04557510, (0 missing)  
## bs < 4.5 to the left, improve=0.02769302, (0 missing)  
## Surrogate splits:  
## bs < 5.5 to the left, agree=0.596, adj=0.048, (0 split)  
## weapon5 < 0.5 to the left, agree=0.586, adj=0.024, (0 split)  
## beefiness < 18.5 to the left, agree=0.586, adj=0.024, (0 split)  
##   
## Node number 11: 155 observations, complexity param=0.0126969  
## mean=337.0468, MSE=330.6305   
## left son=22 (104 obs) right son=23 (51 obs)  
## Primary splits:  
## agility < 69.5 to the left, improve=0.38025980, (0 missing)  
## beefiness < 30.5 to the left, improve=0.22854580, (0 missing)  
## height < 66.53981 to the left, improve=0.13675170, (0 missing)  
## meanness < 28.5 to the right, improve=0.03548843, (0 missing)  
## bs < 5.5 to the left, improve=0.01492765, (0 missing)  
## Surrogate splits:  
## height < 69.87397 to the left, agree=0.690, adj=0.059, (0 split)  
## meanness < 25 to the right, agree=0.690, adj=0.059, (0 split)  
## sf < 9.5 to the left, agree=0.684, adj=0.039, (0 split)  
##   
## Node number 12: 26 observations  
## mean=324.9023, MSE=270.4448   
##   
## Node number 13: 240 observations, complexity param=0.01516284  
## mean=360.4756, MSE=269.6536   
## left son=26 (127 obs) right son=27 (113 obs)  
## Primary splits:  
## beefiness < 67.5 to the left, improve=0.35960050, (0 missing)  
## agility < 31.5 to the left, improve=0.09713194, (0 missing)  
## height < 69.13403 to the left, improve=0.05960727, (0 missing)  
## sexMales < 0.5 to the left, improve=0.03998747, (0 missing)  
## meanness < 71.5 to the right, improve=0.02500460, (0 missing)  
## Surrogate splits:  
## meanness < 49.5 to the right, agree=0.588, adj=0.124, (0 split)  
## agility < 29.5 to the right, agree=0.583, adj=0.115, (0 split)  
## weapon6 < 0.5 to the left, agree=0.562, adj=0.071, (0 split)  
## height < 67.74965 to the right, agree=0.550, adj=0.044, (0 split)  
## bs < 3.5 to the right, agree=0.550, adj=0.044, (0 split)  
##   
## Node number 14: 108 observations, complexity param=0.005859969  
## mean=377.0152, MSE=220.2765   
## left son=28 (71 obs) right son=29 (37 obs)  
## Primary splits:  
## agility < 51.5 to the left, improve=0.37805990, (0 missing)  
## beefiness < 56.5 to the left, improve=0.19194310, (0 missing)  
## height < 69.00662 to the left, improve=0.16649750, (0 missing)  
## weapon6 < 0.5 to the right, improve=0.03961269, (0 missing)  
## sf < 5.5 to the right, improve=0.03476957, (0 missing)  
## Surrogate splits:  
## height < 64.8813 to the right, agree=0.667, adj=0.027, (0 split)  
##   
## Node number 15: 104 observations, complexity param=0.006024534  
## mean=395.8592, MSE=229.2496   
## left son=30 (61 obs) right son=31 (43 obs)  
## Primary splits:  
## agility < 47.5 to the left, improve=0.38782770, (0 missing)  
## beefiness < 73.5 to the left, improve=0.18987040, (0 missing)  
## height < 73.65981 to the left, improve=0.14643160, (0 missing)  
## meanness < 45.5 to the right, improve=0.05620619, (0 missing)  
## bs < 7.5 to the left, improve=0.02350625, (0 missing)  
## Surrogate splits:  
## height < 76.02629 to the left, agree=0.615, adj=0.070, (0 split)  
## weapon7 < 0.5 to the left, agree=0.615, adj=0.070, (0 split)  
## weapon6 < 0.5 to the left, agree=0.606, adj=0.047, (0 split)  
## beefiness < 78.5 to the left, agree=0.606, adj=0.047, (0 split)  
## bs < 7.5 to the left, agree=0.606, adj=0.047, (0 split)  
##   
## Node number 16: 68 observations, complexity param=0.003856963  
## mean=271.6239, MSE=224.0976   
## left son=32 (59 obs) right son=33 (9 obs)  
## Primary splits:  
## height < 68.35152 to the left, improve=0.38846920, (0 missing)  
## beefiness < 19.5 to the left, improve=0.30565590, (0 missing)  
## agility < 44.5 to the left, improve=0.24655420, (0 missing)  
## sexMales < 0.5 to the left, improve=0.05796940, (0 missing)  
## meanness < 34.5 to the right, improve=0.04779093, (0 missing)  
##   
## Node number 17: 80 observations  
## mean=291.6702, MSE=173.7366   
##   
## Node number 18: 64 observations, complexity param=0.005502363  
## mean=304.4204, MSE=217.6183   
## left son=36 (20 obs) right son=37 (44 obs)  
## Primary splits:  
## agility < 50.5 to the left, improve=0.60636080, (0 missing)  
## height < 64.55971 to the left, improve=0.15714170, (0 missing)  
## beefiness < 31.5 to the left, improve=0.07891925, (0 missing)  
## sf < 6.5 to the left, improve=0.05508372, (0 missing)  
## bs < 3.5 to the right, improve=0.03722982, (0 missing)  
## Surrogate splits:  
## height < 58.83705 to the left, agree=0.719, adj=0.10, (0 split)  
## meanness < 32 to the left, agree=0.703, adj=0.05, (0 split)  
##   
## Node number 19: 56 observations  
## mean=323.7038, MSE=335.646   
##   
## Node number 20: 57 observations  
## mean=299.6376, MSE=162.335   
##   
## Node number 21: 42 observations  
## mean=320.9189, MSE=113.1915   
##   
## Node number 22: 104 observations, complexity param=0.00405835  
## mean=329.1948, MSE=167.5436   
## left son=44 (67 obs) right son=45 (37 obs)  
## Primary splits:  
## beefiness < 31.5 to the left, improve=0.35747500, (0 missing)  
## height < 65.35768 to the left, improve=0.19190420, (0 missing)  
## agility < 64.5 to the left, improve=0.13082970, (0 missing)  
## weapon4 < 0.5 to the left, improve=0.03931846, (0 missing)  
## sf < 5.5 to the right, improve=0.03553541, (0 missing)  
## Surrogate splits:  
## weapon4 < 0.5 to the left, agree=0.673, adj=0.081, (0 split)  
## sf < 7.5 to the left, agree=0.654, adj=0.027, (0 split)  
##   
## Node number 23: 51 observations  
## mean=353.0587, MSE=281.0931   
##   
## Node number 26: 127 observations, complexity param=0.004449289  
## mean=351.187, MSE=163.0093   
## left son=52 (56 obs) right son=53 (71 obs)  
## Primary splits:  
## agility < 34.5 to the left, improve=0.32986160, (0 missing)  
## beefiness < 55.5 to the left, improve=0.18775280, (0 missing)  
## height < 74.97564 to the left, improve=0.08192664, (0 missing)  
## meanness < 63.5 to the left, improve=0.05539262, (0 missing)  
## sf < 6.5 to the right, improve=0.02119588, (0 missing)  
## Surrogate splits:  
## beefiness < 64.5 to the right, agree=0.630, adj=0.161, (0 split)  
## weapon5 < 0.5 to the right, agree=0.598, adj=0.089, (0 split)  
## height < 73.61339 to the right, agree=0.583, adj=0.054, (0 split)  
## sf < 5.5 to the right, agree=0.583, adj=0.054, (0 split)  
## meanness < 70.5 to the right, agree=0.575, adj=0.036, (0 split)  
##   
## Node number 27: 113 observations, complexity param=0.003732429  
## mean=370.915, MSE=183.5616   
## left son=54 (99 obs) right son=55 (14 obs)  
## Primary splits:  
## beefiness < 78.5 to the left, improve=0.27617760, (0 missing)  
## agility < 34.5 to the left, improve=0.18815820, (0 missing)  
## height < 68.48662 to the left, improve=0.14352030, (0 missing)  
## bs < 5.5 to the left, improve=0.07317698, (0 missing)  
## sexMales < 0.5 to the left, improve=0.05943628, (0 missing)  
##   
## Node number 28: 71 observations  
## mean=370.4275, MSE=120.5688   
##   
## Node number 29: 37 observations  
## mean=389.6566, MSE=168.5266   
##   
## Node number 30: 61 observations  
## mean=387.9425, MSE=108.6696   
##   
## Node number 31: 43 observations  
## mean=407.0899, MSE=185.2684   
##   
## Node number 32: 59 observations  
## mean=267.9798, MSE=139.934   
##   
## Node number 33: 9 observations  
## mean=295.5131, MSE=118.0881   
##   
## Node number 36: 20 observations  
## mean=287.3821, MSE=90.36992   
##   
## Node number 37: 44 observations  
## mean=312.165, MSE=83.52365   
##   
## Node number 44: 67 observations  
## mean=323.4437, MSE=105.8311   
##   
## Node number 45: 37 observations  
## mean=339.6089, MSE=110.9463   
##   
## Node number 52: 56 observations  
## mean=342.9303, MSE=113.1901   
##   
## Node number 53: 71 observations  
## mean=357.6993, MSE=106.1223   
##   
## Node number 54: 99 observations  
## mean=368.2375, MSE=135.868   
##   
## Node number 55: 14 observations  
## mean=389.8488, MSE=111.6374

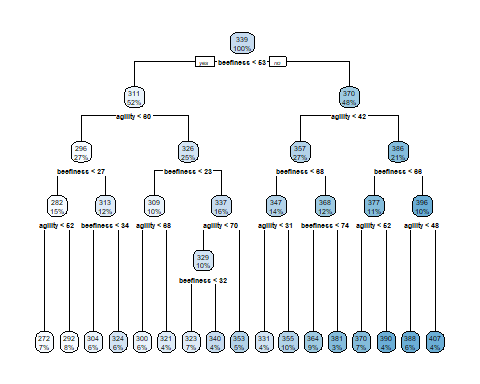
###########################  
library(rpart)  
tree1 <- rpart(  
 dangerousness~sex + height + weapon + beefiness + bs + sf + meanness + agility,  
 data=TD,   
 method = "anova",  
 cp =0.003,  
 maxdepth= 10,  
 minbucket = 30  
)  
  
tree1

## n= 1000   
##   
## node), split, n, deviance, yval  
## \* denotes terminal node  
##   
## 1) root 1000 1534819.000 339.0632   
## 2) beefiness< 52.5 522 390865.200 310.7558   
## 4) agility< 59.5 268 151256.100 296.3222   
## 8) beefiness< 26.5 148 43908.430 282.4598   
## 16) agility< 51.5 68 15238.640 271.6239 \*  
## 17) agility>=51.5 80 13898.930 291.6702 \*  
## 9) beefiness>=26.5 120 43829.670 313.4193   
## 18) beefiness< 33.5 64 13927.570 304.4204 \*  
## 19) beefiness>=33.5 56 18796.170 323.7038 \*  
## 5) agility>=59.5 254 124867.500 325.9850   
## 10) beefiness< 22.5 99 24958.910 308.6661   
## 20) agility< 67.5 57 9253.092 299.6376 \*  
## 21) agility>=67.5 42 4754.042 320.9189 \*  
## 11) beefiness>=22.5 155 51247.730 337.0468   
## 22) agility< 69.5 104 17424.530 329.1948   
## 44) beefiness< 31.5 67 7090.685 323.4437 \*  
## 45) beefiness>=31.5 37 4105.012 339.6089 \*  
## 23) agility>=69.5 51 14335.750 353.0587 \*  
## 3) beefiness>=52.5 478 268890.200 369.9762   
## 6) agility< 41.5 266 101434.400 356.9985   
## 12) beefiness< 67.5 144 39535.170 347.3403   
## 24) agility< 30.5 44 9152.935 330.5548 \*  
## 25) agility>=30.5 100 12530.300 354.7259 \*  
## 13) beefiness>=67.5 122 32612.160 368.3983   
## 26) beefiness< 73.5 88 20475.290 363.6660 \*  
## 27) beefiness>=73.5 34 5065.218 380.6468 \*  
## 7) agility>=41.5 212 66445.190 386.2595   
## 14) beefiness< 65.5 108 23789.860 377.0152   
## 28) agility< 51.5 71 8560.387 370.4275 \*  
## 29) agility>=51.5 37 6235.483 389.6566 \*  
## 15) beefiness>=65.5 104 23841.960 395.8592   
## 30) agility< 47.5 61 6628.843 387.9425 \*  
## 31) agility>=47.5 43 7966.541 407.0899 \*

summary(tree1)

## Call:  
## rpart(formula = dangerousness ~ sex + height + weapon + beefiness +   
## bs + sf + meanness + agility, data = TD, method = "anova",   
## cp = 0.003, maxdepth = 10, minbucket = 30)  
## n= 1000   
##   
## CP nsplit rel error xerror xstd  
## 1 0.570141366 0 1.0000000 1.0010791 0.035983545  
## 2 0.074759045 1 0.4298586 0.4465726 0.020316879  
## 3 0.065812698 2 0.3550996 0.3921790 0.017853201  
## 4 0.041384669 3 0.2892869 0.3130273 0.015504425  
## 5 0.031704598 4 0.2479022 0.2795601 0.013993685  
## 6 0.019081762 5 0.2161976 0.2420638 0.011067485  
## 7 0.012696902 6 0.1971159 0.2150485 0.010271330  
## 8 0.012257707 7 0.1844190 0.2000141 0.009860478  
## 9 0.011631296 8 0.1721613 0.1868071 0.009353031  
## 10 0.009623840 9 0.1605300 0.1834317 0.009295611  
## 11 0.007235981 10 0.1509061 0.1765091 0.008926905  
## 12 0.007135546 11 0.1436701 0.1765097 0.008888624  
## 13 0.006024534 12 0.1365346 0.1646282 0.008220888  
## 14 0.005859969 13 0.1305101 0.1622763 0.008235415  
## 15 0.004607480 14 0.1246501 0.1551555 0.007965232  
## 16 0.004058350 15 0.1200426 0.1535923 0.007879906  
## 17 0.003000000 16 0.1159843 0.1513030 0.007815932  
##   
## Variable importance  
## beefiness agility height sex meanness bs weapon   
## 29 24 19 12 9 6 1   
##   
## Node number 1: 1000 observations, complexity param=0.5701414  
## mean=339.0632, MSE=1534.819   
## left son=2 (522 obs) right son=3 (478 obs)  
## Primary splits:  
## beefiness < 52.5 to the left, improve=0.57014140, (0 missing)  
## height < 69.20857 to the left, improve=0.40837800, (0 missing)  
## sex splits as LR, improve=0.19545760, (0 missing)  
## meanness < 49.5 to the left, improve=0.08332828, (0 missing)  
## agility < 48.5 to the right, improve=0.07543923, (0 missing)  
## Surrogate splits:  
## height < 68.21148 to the left, agree=0.874, adj=0.736, (0 split)  
## agility < 49.5 to the right, agree=0.825, adj=0.634, (0 split)  
## sex splits as LR, agree=0.759, adj=0.496, (0 split)  
## meanness < 49.5 to the left, agree=0.697, adj=0.366, (0 split)  
## bs < 5.5 to the left, agree=0.633, adj=0.232, (0 split)  
##   
## Node number 2: 522 observations, complexity param=0.07475905  
## mean=310.7558, MSE=748.7839   
## left son=4 (268 obs) right son=5 (254 obs)  
## Primary splits:  
## agility < 59.5 to the left, improve=0.293558100, (0 missing)  
## beefiness < 27.5 to the left, improve=0.288827400, (0 missing)  
## height < 66.87118 to the left, improve=0.061712930, (0 missing)  
## weapon splits as LLLLLLR, improve=0.012863900, (0 missing)  
## meanness < 30.5 to the right, improve=0.008839797, (0 missing)  
## Surrogate splits:  
## height < 62.47712 to the right, agree=0.557, adj=0.091, (0 split)  
## weapon splits as RLLLLRR, agree=0.540, adj=0.055, (0 split)  
## beefiness < 15.5 to the right, agree=0.534, adj=0.043, (0 split)  
## meanness < 34.5 to the right, agree=0.534, adj=0.043, (0 split)  
## bs < 5.5 to the right, agree=0.533, adj=0.039, (0 split)  
##   
## Node number 3: 478 observations, complexity param=0.0658127  
## mean=369.9762, MSE=562.5317   
## left son=6 (266 obs) right son=7 (212 obs)  
## Primary splits:  
## agility < 41.5 to the left, improve=0.37565750, (0 missing)  
## beefiness < 65.5 to the left, improve=0.14259100, (0 missing)  
## height < 69.13403 to the left, improve=0.03505555, (0 missing)  
## meanness < 45.5 to the right, improve=0.01504556, (0 missing)  
## sex splits as LR, improve=0.01435128, (0 missing)  
## Surrogate splits:  
## sf < 8.5 to the left, agree=0.569, adj=0.028, (0 split)  
## height < 64.89065 to the right, agree=0.565, adj=0.019, (0 split)  
## weapon splits as LLRLLLR, agree=0.563, adj=0.014, (0 split)  
## beefiness < 55.5 to the right, agree=0.563, adj=0.014, (0 split)  
## bs < 4.5 to the right, agree=0.563, adj=0.014, (0 split)  
##   
## Node number 4: 268 observations, complexity param=0.04138467  
## mean=296.3222, MSE=564.3884   
## left son=8 (148 obs) right son=9 (120 obs)  
## Primary splits:  
## beefiness < 26.5 to the left, improve=0.41993680, (0 missing)  
## height < 68.81371 to the left, improve=0.16662110, (0 missing)  
## agility < 52.5 to the left, improve=0.11409870, (0 missing)  
## sex splits as LR, improve=0.04300230, (0 missing)  
## weapon splits as LLLRRRR, improve=0.02683148, (0 missing)  
## Surrogate splits:  
## weapon splits as LLLRLRL, agree=0.616, adj=0.142, (0 split)  
## height < 68.81371 to the left, agree=0.612, adj=0.133, (0 split)  
## agility < 38.5 to the right, agree=0.601, adj=0.108, (0 split)  
## meanness < 56.5 to the left, agree=0.571, adj=0.042, (0 split)  
## sf < 2.5 to the right, agree=0.567, adj=0.033, (0 split)  
##   
## Node number 5: 254 observations, complexity param=0.0317046  
## mean=325.985, MSE=491.6042   
## left son=10 (99 obs) right son=11 (155 obs)  
## Primary splits:  
## beefiness < 22.5 to the left, improve=0.38969980, (0 missing)  
## agility < 74.5 to the left, improve=0.25981710, (0 missing)  
## height < 64.28261 to the left, improve=0.09268484, (0 missing)  
## meanness < 42.5 to the right, improve=0.02405100, (0 missing)  
## bs < 5.5 to the left, improve=0.01850370, (0 missing)  
## Surrogate splits:  
## weapon splits as LRRRRRR, agree=0.630, adj=0.051, (0 split)  
## meanness < 61.5 to the right, agree=0.630, adj=0.051, (0 split)  
## sf < 1.5 to the left, agree=0.618, adj=0.020, (0 split)  
##   
## Node number 6: 266 observations, complexity param=0.01908176  
## mean=356.9985, MSE=381.3323   
## left son=12 (144 obs) right son=13 (122 obs)  
## Primary splits:  
## beefiness < 67.5 to the left, improve=0.28872910, (0 missing)  
## agility < 24.5 to the left, improve=0.24308000, (0 missing)  
## height < 69.13403 to the left, improve=0.05372561, (0 missing)  
## bs < 4.5 to the left, improve=0.04627648, (0 missing)  
## sex splits as LR, improve=0.03938987, (0 missing)  
## Surrogate splits:  
## meanness < 47.5 to the right, agree=0.579, adj=0.082, (0 split)  
## weapon splits as RLRLLRL, agree=0.571, adj=0.066, (0 split)  
## height < 67.74965 to the right, agree=0.564, adj=0.049, (0 split)  
## bs < 3.5 to the right, agree=0.560, adj=0.041, (0 split)  
## agility < 29.5 to the right, agree=0.560, adj=0.041, (0 split)  
##   
## Node number 7: 212 observations, complexity param=0.01225771  
## mean=386.2595, MSE=313.4207   
## left son=14 (108 obs) right son=15 (104 obs)  
## Primary splits:  
## beefiness < 65.5 to the left, improve=0.28314120, (0 missing)  
## agility < 54.5 to the left, improve=0.21929970, (0 missing)  
## height < 69.00662 to the left, improve=0.10703950, (0 missing)  
## weapon splits as RRLLRLR, improve=0.02245809, (0 missing)  
## meanness < 45.5 to the right, improve=0.01740099, (0 missing)  
## Surrogate splits:  
## agility < 44.5 to the right, agree=0.585, adj=0.154, (0 split)  
## weapon splits as RRLLRLR, agree=0.575, adj=0.135, (0 split)  
## meanness < 60.5 to the left, agree=0.561, adj=0.106, (0 split)  
## height < 74.30353 to the right, agree=0.552, adj=0.087, (0 split)  
## sf < 5.5 to the left, agree=0.538, adj=0.058, (0 split)  
##   
## Node number 8: 148 observations, complexity param=0.00962384  
## mean=282.4598, MSE=296.6786   
## left son=16 (68 obs) right son=17 (80 obs)  
## Primary splits:  
## agility < 51.5 to the left, improve=0.33640140, (0 missing)  
## beefiness < 22.5 to the left, improve=0.21898680, (0 missing)  
## height < 62.76089 to the left, improve=0.05893440, (0 missing)  
## sex splits as LR, improve=0.01730027, (0 missing)  
## meanness < 40.5 to the right, improve=0.01564390, (0 missing)  
## Surrogate splits:  
## height < 66.72647 to the right, agree=0.588, adj=0.103, (0 split)  
## meanness < 51.5 to the right, agree=0.581, adj=0.088, (0 split)  
## weapon splits as LRRRRRR, agree=0.574, adj=0.074, (0 split)  
## bs < 7.5 to the right, agree=0.568, adj=0.059, (0 split)  
## beefiness < 4.5 to the left, agree=0.554, adj=0.029, (0 split)  
##   
## Node number 9: 120 observations, complexity param=0.007235981  
## mean=313.4193, MSE=365.2472   
## left son=18 (64 obs) right son=19 (56 obs)  
## Primary splits:  
## beefiness < 33.5 to the left, improve=0.25338830, (0 missing)  
## height < 66.85377 to the left, improve=0.24037970, (0 missing)  
## meanness < 53.5 to the left, improve=0.10396520, (0 missing)  
## agility < 51.5 to the left, improve=0.08306477, (0 missing)  
## sex splits as LR, improve=0.07157241, (0 missing)  
## Surrogate splits:  
## agility < 48.5 to the right, agree=0.700, adj=0.357, (0 split)  
## height < 66.92355 to the left, agree=0.683, adj=0.321, (0 split)  
## meanness < 57.5 to the left, agree=0.625, adj=0.196, (0 split)  
## sex splits as LR, agree=0.608, adj=0.161, (0 split)  
## weapon splits as LLLLLLR, agree=0.575, adj=0.089, (0 split)  
##   
## Node number 10: 99 observations, complexity param=0.007135546  
## mean=308.6661, MSE=252.1102   
## left son=20 (57 obs) right son=21 (42 obs)  
## Primary splits:  
## agility < 67.5 to the left, improve=0.43879220, (0 missing)  
## beefiness < 18.5 to the left, improve=0.22829410, (0 missing)  
## height < 63.64828 to the left, improve=0.13430650, (0 missing)  
## weapon splits as LRLRLRR, improve=0.05924231, (0 missing)  
## bs < 4.5 to the left, improve=0.02769302, (0 missing)  
## Surrogate splits:  
## bs < 5.5 to the left, agree=0.596, adj=0.048, (0 split)  
## weapon splits as LLLLRLL, agree=0.586, adj=0.024, (0 split)  
## beefiness < 18.5 to the left, agree=0.586, adj=0.024, (0 split)  
##   
## Node number 11: 155 observations, complexity param=0.0126969  
## mean=337.0468, MSE=330.6305   
## left son=22 (104 obs) right son=23 (51 obs)  
## Primary splits:  
## agility < 69.5 to the left, improve=0.38025980, (0 missing)  
## beefiness < 30.5 to the left, improve=0.22854580, (0 missing)  
## height < 66.53981 to the left, improve=0.13675170, (0 missing)  
## meanness < 38.5 to the right, improve=0.01790089, (0 missing)  
## bs < 5.5 to the left, improve=0.01492765, (0 missing)  
## Surrogate splits:  
## height < 69.87397 to the left, agree=0.690, adj=0.059, (0 split)  
## meanness < 25 to the right, agree=0.690, adj=0.059, (0 split)  
## sf < 9.5 to the left, agree=0.684, adj=0.039, (0 split)  
##   
## Node number 12: 144 observations, complexity param=0.0116313  
## mean=347.3403, MSE=274.5498   
## left son=24 (44 obs) right son=25 (100 obs)  
## Primary splits:  
## agility < 30.5 to the left, improve=0.45154580, (0 missing)  
## beefiness < 60.5 to the left, improve=0.09333379, (0 missing)  
## height < 71.67107 to the left, improve=0.04605728, (0 missing)  
## weapon splits as LRLRLRR, improve=0.03477631, (0 missing)  
## meanness < 51.5 to the left, improve=0.03013695, (0 missing)  
## Surrogate splits:  
## beefiness < 54.5 to the left, agree=0.736, adj=0.136, (0 split)  
## bs < 3.5 to the left, agree=0.715, adj=0.068, (0 split)  
## meanness < 70.5 to the right, agree=0.701, adj=0.023, (0 split)  
##   
## Node number 13: 122 observations, complexity param=0.00460748  
## mean=368.3983, MSE=267.3128   
## left son=26 (88 obs) right son=27 (34 obs)  
## Primary splits:  
## beefiness < 73.5 to the left, improve=0.21684090, (0 missing)  
## agility < 34.5 to the left, improve=0.20745010, (0 missing)  
## height < 70.35828 to the left, improve=0.11480960, (0 missing)  
## bs < 5.5 to the left, improve=0.06085127, (0 missing)  
## weapon splits as LRLLRRL, improve=0.01568398, (0 missing)  
##   
## Node number 14: 108 observations, complexity param=0.005859969  
## mean=377.0152, MSE=220.2765   
## left son=28 (71 obs) right son=29 (37 obs)  
## Primary splits:  
## agility < 51.5 to the left, improve=0.37805990, (0 missing)  
## beefiness < 58.5 to the left, improve=0.16290920, (0 missing)  
## height < 70.71032 to the left, improve=0.06727173, (0 missing)  
## sf < 5.5 to the right, improve=0.03476957, (0 missing)  
## meanness < 56.5 to the right, improve=0.03126181, (0 missing)  
## Surrogate splits:  
## height < 64.8813 to the right, agree=0.667, adj=0.027, (0 split)  
##   
## Node number 15: 104 observations, complexity param=0.006024534  
## mean=395.8592, MSE=229.2496   
## left son=30 (61 obs) right son=31 (43 obs)  
## Primary splits:  
## agility < 47.5 to the left, improve=0.38782770, (0 missing)  
## beefiness < 72.5 to the left, improve=0.18946280, (0 missing)  
## height < 73.65357 to the left, improve=0.13451210, (0 missing)  
## meanness < 53.5 to the right, improve=0.02369911, (0 missing)  
## weapon splits as RRLLLRR, improve=0.01325784, (0 missing)  
## Surrogate splits:  
## weapon splits as RLLLLRR, agree=0.654, adj=0.163, (0 split)  
## height < 76.02629 to the left, agree=0.615, adj=0.070, (0 split)  
## beefiness < 78.5 to the left, agree=0.606, adj=0.047, (0 split)  
## bs < 7.5 to the left, agree=0.606, adj=0.047, (0 split)  
## sf < 9.5 to the left, agree=0.596, adj=0.023, (0 split)  
##   
## Node number 16: 68 observations  
## mean=271.6239, MSE=224.0976   
##   
## Node number 17: 80 observations  
## mean=291.6702, MSE=173.7366   
##   
## Node number 18: 64 observations  
## mean=304.4204, MSE=217.6183   
##   
## Node number 19: 56 observations  
## mean=323.7038, MSE=335.646   
##   
## Node number 20: 57 observations  
## mean=299.6376, MSE=162.335   
##   
## Node number 21: 42 observations  
## mean=320.9189, MSE=113.1915   
##   
## Node number 22: 104 observations, complexity param=0.00405835  
## mean=329.1948, MSE=167.5436   
## left son=44 (67 obs) right son=45 (37 obs)  
## Primary splits:  
## beefiness < 31.5 to the left, improve=0.35747500, (0 missing)  
## height < 65.35768 to the left, improve=0.19190420, (0 missing)  
## agility < 64.5 to the left, improve=0.13082970, (0 missing)  
## weapon splits as LLRRRRL, improve=0.04784078, (0 missing)  
## sf < 5.5 to the right, improve=0.03553541, (0 missing)  
## Surrogate splits:  
## weapon splits as LLLRLLL, agree=0.673, adj=0.081, (0 split)  
## sf < 7.5 to the left, agree=0.654, adj=0.027, (0 split)  
##   
## Node number 23: 51 observations  
## mean=353.0587, MSE=281.0931   
##   
## Node number 24: 44 observations  
## mean=330.5548, MSE=208.0212   
##   
## Node number 25: 100 observations  
## mean=354.7259, MSE=125.303   
##   
## Node number 26: 88 observations  
## mean=363.666, MSE=232.6737   
##   
## Node number 27: 34 observations  
## mean=380.6468, MSE=148.977   
##   
## Node number 28: 71 observations  
## mean=370.4275, MSE=120.5688   
##   
## Node number 29: 37 observations  
## mean=389.6566, MSE=168.5266   
##   
## Node number 30: 61 observations  
## mean=387.9425, MSE=108.6696   
##   
## Node number 31: 43 observations  
## mean=407.0899, MSE=185.2684   
##   
## Node number 44: 67 observations  
## mean=323.4437, MSE=105.8311   
##   
## Node number 45: 37 observations  
## mean=339.6089, MSE=110.9463

library(rpart.plot)  
rpart.plot(tree1)



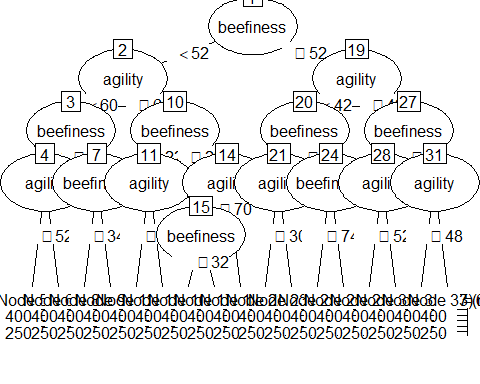
library(partykit)

## Loading required package: grid

## Loading required package: libcoin

## Loading required package: mvtnorm

tree1.pk <- as.party(tree1)  
plot(tree1.pk , ep\_args = list(digits = 0)) #the branching symbols are getting messed up for some reason.



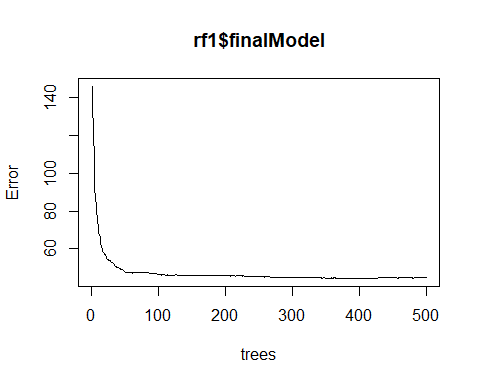
###################  
#random forest model  
library(caret)  
set.seed(12345)  
rf1= train(dangerousness~sex + height + weapon + beefiness + bs + sf + meanness + agility, data=TD, method= "rf", trControl= trainControl(method="cv", number=5))  
  
rf1

## Random Forest   
##   
## 1000 samples  
## 8 predictor  
##   
## No pre-processing  
## Resampling: Cross-Validated (5 fold)   
## Summary of sample sizes: 800, 800, 800, 800, 800   
## Resampling results across tuning parameters:  
##   
## mtry RMSE Rsquared MAE   
## 2 16.871188 0.8594504 13.013865  
## 7 7.795428 0.9662975 5.735455  
## 13 6.953772 0.9702981 5.287937  
##   
## RMSE was used to select the optimal model using the smallest value.  
## The final value used for the model was mtry = 13.

summary(rf1)

## Length Class Mode   
## call 4 -none- call   
## type 1 -none- character  
## predicted 1000 -none- numeric   
## mse 500 -none- numeric   
## rsq 500 -none- numeric   
## oob.times 1000 -none- numeric   
## importance 13 -none- numeric   
## importanceSD 0 -none- NULL   
## localImportance 0 -none- NULL   
## proximity 0 -none- NULL   
## ntree 1 -none- numeric   
## mtry 1 -none- numeric   
## forest 11 -none- list   
## coefs 0 -none- NULL   
## y 1000 -none- numeric   
## test 0 -none- NULL   
## inbag 0 -none- NULL   
## xNames 13 -none- character  
## problemType 1 -none- character  
## tuneValue 1 data.frame list   
## obsLevels 1 -none- logical   
## param 0 -none- list

plot(rf1$finalModel)



###################  
#Code that was used to generate the data  
set.seed(1908)  
id=1:1000  
  
weapon= round(runif(n=1000, min = 1, max = 7))  
sex=rbinom(n=1000, 1, prob= c(.2, .7))  
height =rnorm(n = 1000, mean = c(65, 72), sd = 3)  
beefiness= round(rnorm(n = 1000, mean = c(25, 65), sd = 8))  
meanness=round(rnorm(n = 1000, mean = c(45, 55), sd = 10))  
mohawk=rbinom(n=1000, 1, .1)  
bs=round(rnorm(n = 1000, mean = c(5, 6), sd = 1.5))  
sf=rpois(1000, lambda = 5)  
agility=round(rnorm(n = 1000, mean = c(60, 40), sd = 10))   
e=rnorm(n = 1000, mean = 0, sd = .5)  
  
a=5  
error=rnorm(n = 1000, mean = 0, sd = 2)  
  
  
b1=5  
b2=2  
b3=2  
b4=1  
b5=2  
  
dangerousness = a + (b1 \* sex + e) + (b2\* height + e) + (b3\*beefiness + e) + (b4\*bs + e) + (b5\*agility + e) + error  
  
TD=data.frame(id, weapon, sex, height, beefiness, meanness, mohawk, bs, sf, agility, dangerousness)