Shooting justification algorithm

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```
#importing dataset into R
setwd("D:/Google Drive/RESEARCH/Older projects/APLS - Short form/Study 2")
library(readxl)
S2 <- read_excel("S2.xlsx")
```

```
## New names:
## • `` -> `...22`
```

```
#Filtering out participants who did not answer the justification question

library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 4.2.3
```

```
##
## 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
```

```
S2_filtered <- S2[complete.cases(S2$justif), ]
S <- S2_filtered

##########
#recoding the variables
S <- S %>% mutate(edc=recode(edc, `1` = "Some High School", `2` = "GED",
                             '3' = "High School Diploma", '4'="Associates Degree",
                             '5' = "Some college", '6' = "Bachelor Degree",
                             '7' = "Masters Degree", '8' = "Doctoral Degree"))

S <- S %>% mutate(income=recode(income, `1` = "Less than $10,000", `2` = "$10,001 to $20,000",
                                '3' = "$20,001 to $30,000", '4'="$30,001 to $40,000",
                                '5' = "$40,001 to $50,000", '6' = "$50,001 to $60,000",
                                '7' = "$60,001 to $70,000", '8' = "$70,001 to $80,000",
                                '9' = "$80,001 to $90,000", '10' = "$90,001 to $100,000",
                                '11' = "More than $100,000"))

S <- S %>% mutate(race.recoded=recode(race.recoded, "0" = "White",
                                      "2" = "Asian",
                                      "3"="Black",
                                      "4" = "Hispanic",
                                      "5" = "Middle_Eastern",
                                      "7" = "Other",
                                      "8" = "Multi"))




S <- S %>% mutate(sex=recode(sex, `1` = "Male", `2` = "Female"))

S <- S %>% mutate(justif=recode(justif, `1` = "Justified", `0` = "Not_justified"))



S<-rename(S, APLS_SF.Rasch = APLS.R)

#factoring variables

S$sex <- factor(S$sex)

S$justif <- factor(S$justif)

S$justif<-relevel(S$justif, ref = "Not_justified")

S$race.recoded<-factor(S$race.recoded)

S$income <- factor(S$income, ordered = TRUE)

library(forcats)
S$income <- fct_relevel(S$income, "Less than $10,000", "$10,001 to $20,000", "$20,001 to $30,00
0",
                        "$30,001 to $40,000", "$40,001 to $50,000", "$50,001 to $60,000",
```

```
                        "$60,001 to $70,000", "$70,001 to $80,000", "$80,001 to $90,000",
                        "$90,001 to $100,000", "More than $100,000")

S$edc<-factor(S$edc, ordered = TRUE)

S$edc<-fct_relevel(S$edc, "Some High School", "GED", "High School Diploma", "Some college", "Ass
ociates Degree",
                   "Bachelor Degree", "Masters Degree", "Doctoral Degree")



#creating the training and test sets
set.seed(1234)

S <- S %>% select(age, edc, income, sex, race.recoded, SDO.avg, RWA.avg, APLS_SF.Rasch,
                  apls1, apls2, apls3, apls4, apls5, apls6, apls7, apls8, apls9,
                  apls10, apls11,
                  SDO1, SDO2, SDO3, SDO4, SDO5, SDO6, SDO7, SDO8, SDO9, SDO10,
                  SDO11, SDO12, SDO13, SDO14, SDO15, SDO16,
                  RWA1, RWA3,  RWA3,  RWA4,  RWA5,  RWA6,  RWA7,  RWA8,  RWA9,
                  RWA10, RWA11, RWA12, RWA13,  RWA14, RWA15, justif)

sample_set <- sample(nrow(S), round(nrow(S)*.8), replace = FALSE)

S_train <- S[sample_set, ]

S_test <- S[-sample_set, ]
```

```
#Creating the decision tree model for the training set
library(caret)
```

```
## Warning: package 'caret' was built under R version 4.2.3
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
mod1<- train(justif ~ .,
             data=S_train,
             metric="Kappa",
             method= "rpart",
             trControl= trainControl(method="cv", number=3),
             tuneLength=20
)

mod1
```

```
## CART
##
## 255 samples
##  49 predictor
##   2 classes: 'Not_justified', 'Justified'
##
## No pre-processing
## Resampling: Cross-Validated (3 fold)
## Summary of sample sizes: 171, 170, 169
## Resampling results across tuning parameters:
##
##   cp          Accuracy   Kappa
##   0.00000000  0.7214058  0.3416466
##   0.01199201  0.7214058  0.3416466
##   0.02398401  0.7214058  0.3416466
##   0.03597602  0.7214058  0.3416466
##   0.04796802  0.7488568  0.3729921
##   0.05996003  0.7567933  0.4067084
##   0.07195203  0.7567933  0.4067084
##   0.08394404  0.7448885  0.3949031
##   0.09593604  0.7448885  0.3949031
##   0.10792805  0.7369998  0.3860990
##   0.11992005  0.7331238  0.4272221
##   0.13191206  0.7331238  0.4272221
##   0.14390406  0.7331238  0.4272221
##   0.15589607  0.7331238  0.4272221
##   0.16788807  0.7331238  0.4272221
##   0.17988008  0.7098680  0.2671760
##   0.19187209  0.7098680  0.2671760
##   0.20386409  0.7098680  0.2671760
##   0.21585610  0.7098680  0.2671760
##   0.22784810  0.7098680  0.2671760
##
## Kappa was used to select the optimal model using the largest value.
## The final value used for the model was cp = 0.1678881.
```

```
summary(mod1)
```

```
## 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(44, 52, 26, 27, 36,
## 33, 37, 36, 59, 26, 36, 38, 33, 62, 34, 26, 57, 28, 53, 40, 23,
## 26, 19, 59, 50, 21, 22, 39, 20, 23, 52, 20, 44, 68, 26, 31, 26,
## 46, 36, 35, 36, 52, 43, 43, 40, 63, 35, 19, 20, 31, 27, 30, 44,
## 22, 51, 26, 39, 30, 34, 41, 36, 40, 48, 44, 57, 30, 54, 58, 20,
## 35, 54, 46, 41, 25, 48, 35, 23, 27, 36, 28, 33, 26, 36, 32, 30,
## 58, 25, 23, 41, 31, 21, 37, 25, 25, 21, 24, 49, 39, 25, 23, 73,
## 26, 39, 19, 44, 30, 33, 57, 38, 53, 27, 31, 34, 32, 40, 49, 49,
## 27, 26, 40, 53, 29, 71, 66, 64, 35, 26, 73, 55, 39, 48, 20, 36,
## 19, 27, 34, 58, 50, 36, 24, 56, 29, 28, 41, 52, 19, 26, 55, 30,
```

```
## 40, 53, 26, 44, 54, 39, 70, 44, 38, 40, 22, 50, 36, 27, 50, 32,
## 40, 42, 25, 28, 29, 26, 24, 48, 43, 32, 21, 31, 44, 27, 61, 20,
## 30, 30, 23, 57, 35, 42, 27, 64, 46, 42, 39, 24, 61, 32, 33, 39,
## 31, 36, 47, 29, 26, 21, 25, 29, 32, 30, 41, 24, 41, 31, 59, 22,
## 41, 49, 33, 34, 28, 59, 34, 29, 55, 66, 34, 33, 20, 27, 62, 40,
## 22, 40, 54, 47, 20, 39, 60, 25, 45, 22, 19, 25, 42, 32, 74, 23,
## 20, 37, 36, 41, 51, 39, 30, 36, 55, 35), c(0.231455024943138,
## -0.231455024943138, 0.231455024943138, -0.231455024943138, 0.077151674981046,
## -0.231455024943138, -0.38575837490523, -0.0771516749810459, 0.077151674981046,
## -0.540061724867322, 0.540061724867322, -0.0771516749810459, 0.077151674981046,
## 0.231455024943138, -0.0771516749810459, 0.231455024943138, 0.540061724867322,
## -0.0771516749810459, -0.231455024943138, 0.231455024943138, 0.077151674981046,
## -0.540061724867322, -0.231455024943138, 0.231455024943138, -0.0771516749810459,
## 0.231455024943138, 0.231455024943138, -0.231455024943138, -0.0771516749810459,
## 0.077151674981046, 0.231455024943138, -0.0771516749810459, 0.38575837490523,
## 0.077151674981046, 0.231455024943138, 0.231455024943138, 0.231455024943138,
## 0.231455024943138, 0.38575837490523, -0.0771516749810459, 0.231455024943138,
## 0.231455024943138, 0.231455024943138, 0.231455024943138, 0.231455024943138,
## 0.231455024943138, 0.38575837490523, -0.0771516749810459, 0.077151674981046,
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## -0.0771516749810459, -0.0771516749810459, 0.231455024943138,
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## -0.38575837490523, 0.38575837490523, 0.077151674981046, -0.0771516749810459,
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## 0.077151674981046, 0.231455024943138, 0.38575837490523, 0.231455024943138,
## 0.38575837490523, -0.231455024943138, -0.231455024943138, -0.0771516749810459,
## 0.231455024943138, 0.231455024943138, 0.077151674981046, 0.38575837490523,
## 0.231455024943138, 0.38575837490523, 0.231455024943138, 0.231455024943138,
## 0.231455024943138, -0.0771516749810459, 0.231455024943138, 0.231455024943138,
## 0.231455024943138, -0.0771516749810459, -0.0771516749810459,
## -0.0771516749810459, -0.0771516749810459, 0.231455024943138,
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## -0.231455024943138, 0.077151674981046, 0.077151674981046, -0.540061724867322,
## 0.077151674981046, 0.231455024943138, -0.0771516749810459, 0.077151674981046,
## -0.231455024943138, 0.231455024943138, 0.231455024943138, 0.38575837490523,
## 0.38575837490523, 0.231455024943138, 0.231455024943138, 0.540061724867322,
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## 0.38575837490523, 0.231455024943138, -0.231455024943138, -0.0771516749810459,
## 0.231455024943138, -0.0771516749810459, 0.077151674981046, -0.231455024943138,
## -0.0771516749810459, -0.231455024943138, 0.231455024943138, -0.0771516749810459,
## 0.231455024943138, 0.231455024943138, -0.0771516749810459, 0.077151674981046,
## -0.231455024943138, -0.231455024943138, 0.231455024943138, 0.231455024943138,
## 0.231455024943138, 0.231455024943138, 0.077151674981046, 0.077151674981046,
## -0.231455024943138, 0.231455024943138, -0.38575837490523, 0.38575837490523,
## 0.38575837490523, -0.231455024943138, 0.231455024943138, -0.0771516749810459,
## 0.231455024943138, 0.38575837490523, 0.231455024943138, 0.077151674981046,
## 0.077151674981046, 0.231455024943138, -0.0771516749810459, 0.231455024943138,
## -0.231455024943138, 0.231455024943138, -0.231455024943138, 0.38575837490523,
## 0.38575837490523, 0.231455024943138, 0.231455024943138, 0.231455024943138,
## -0.0771516749810459, -0.0771516749810459, 0.231455024943138,
```

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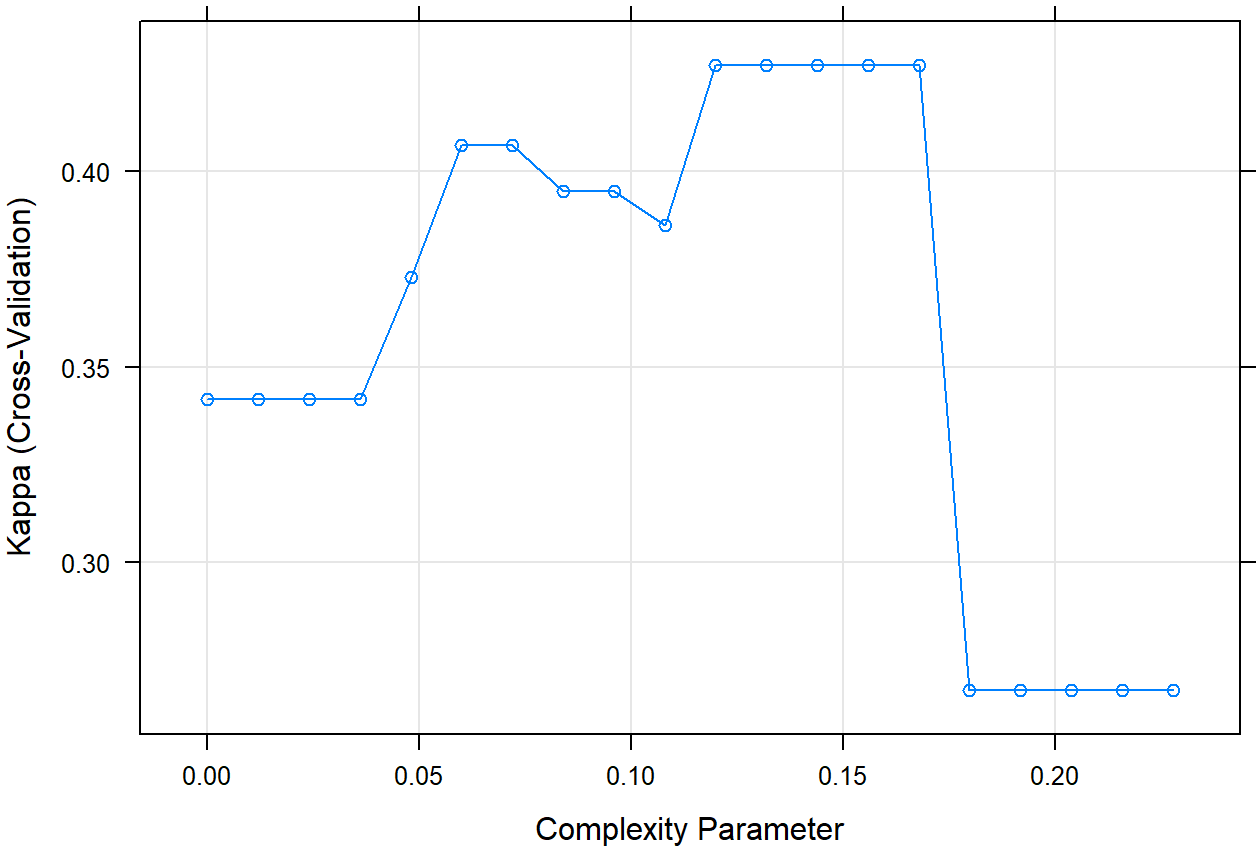
## 6, 1, 4, 6, 2, 1, 7, 2, 1, 4, 4, 7, 2, 3, 7, 2, 3, 1, 5, 2, 5,
## 4, 4, 1, 4, 3, 4, 1, 3, 3, 4, 6, 1, 3, 2, 3, 2, 4, 2, 3, 2, 4,
## 1, 2, 3, 4, 5, 1, 2, 1, 1, 3, 2, 2, 2, 1, 1, 2, 4, 2, 1, 5, 2,
## 4, 1, 7, 3, 4, 5, 7, 1, 2, 2, 4, 4, 1, 4, 2, 1, 3, 2, 3, 1, 4,
## 1, 1, 2, 4, 4, 1, 3, 1, 1, 1, 6, 3, 1, 2, 1, 4, 2, 6, 3, 1, 4,
## 1, 1, 1, 1, 4, 4, 1, 3, 1, 6, 1, 4, 3, 1, 3, 3, 1, 2, 1, 5, 4,
## 1, 1, 2, 2, 3, 2, 3, 4, 1, 2, 1, 1, 1, 1, 4, 1, 1, 1, 2, 4, 1,
## 7, 4, 3, 4, 1, 1, 4, 3, 1, 3, 3, 7, 4, 4, 3, 2, 5, 4, 1, 6, 3,
## 2, 1, 3, 5, 1, 3, 3, 2, 3, 1, 3, 3, 4, 5, 4, 4, 2, 3, 4, 1, 1
## ), c(1, 7, 3, 3, 7, 1, 1, 4, 5, 1, 3, 4, 2, 2, 1, 1, 4, 1, 3,
## 1, 3, 4, 2, 5, 7, 1, 2, 1, 1, 5, 3, 6, 2, 5, 1, 7, 4, 4, 6, 1,
## 2, 2, 2, 2, 4, 2, 1, 1, 5, 3, 6, 6, 7, 3, 7, 3, 1, 4, 1, 1, 4,
## 1, 2, 2, 4, 5, 7, 1, 2, 1, 4, 1, 6, 3, 1, 3, 4, 1, 4, 3, 7, 6,
## 5, 7, 6, 3, 4, 3, 1, 1, 5, 5, 2, 5, 2, 5, 4, 7, 6, 3, 5, 2, 3,
## 5, 1, 4, 4, 3, 7, 3, 5, 3, 4, 1, 6, 1, 1, 3, 1, 2, 5, 3, 1, 3,
## 4, 1, 5, 4, 7, 4, 1, 4, 4, 4, 3, 1, 2, 4, 1, 1, 4, 2, 2, 3, 3,
## 4, 5, 2, 1, 5, 5, 1, 4, 3, 7, 4, 1, 1, 2, 1, 7, 5, 7, 4, 6, 4,
## 1, 2, 4, 3, 4, 5, 6, 1, 5, 1, 1, 1, 4, 7, 1, 1, 4, 4, 7, 1, 5,
## 1, 5, 1, 5, 4, 1, 2, 1, 1, 2, 2, 4, 4, 3, 2, 1, 4, 1, 7, 4, 3,
## 2, 2, 7, 2, 1, 7, 2, 5, 6, 4, 2, 1, 4, 4, 6, 4, 6, 5, 3, 5, 2,
## 6, 4, 4, 1, 1, 1, 1, 4, 1, 1, 4, 4, 4, 5, 2, 7, 6, 1, 1, 7, 5,
## 4, 4, 3, 4, 1), c(5, 1, 3, 4, 5, 7, 7, 4, 3, 1, 2, 4, 4, 5, 3,
## 4, 5, 1, 3, 3, 4, 1, 2, 4, 6, 1, 1, 2, 2, 2, 4, 6, 2, 4, 1, 5,
## 4, 4, 2, 2, 2, 3, 5, 3, 3, 3, 1, 3, 4, 3, 3, 4, 4, 3, 7, 2, 1,
## 4, 4, 1, 4, 1, 2, 6, 3, 5, 1, 1, 3, 6, 4, 1, 1, 3, 1, 6, 3, 1,
## 4, 4, 5, 4, 4, 2, 6, 1, 4, 3, 4, 2, 1, 4, 6, 3, 4, 4, 5, 5, 3,
## 4, 4, 3, 2, 2, 1, 4, 4, 4, 7, 1, 3, 4, 4, 3, 6, 1, 4, 3, 5, 5,
## 5, 1, 3, 1, 5, 2, 3, 1, 5, 7, 1, 5, 4, 6, 4, 4, 3, 4, 4, 3, 4,
## 3, 2, 3, 2, 4, 1, 5, 1, 4, 3, 1, 4, 3, 3, 2, 2, 1, 2, 4, 6, 2,
## 4, 4, 6, 4, 2, 5, 3, 2, 3, 3, 5, 1, 4, 2, 1, 1, 3, 4, 2, 1, 3,
## 1, 3, 4, 6, 7, 2, 2, 4, 4, 1, 2, 2, 1, 2, 1, 2, 4, 1, 1, 1, 2,
## 1, 6, 2, 2, 4, 1, 1, 6, 1, 7, 6, 2, 5, 2, 5, 1, 3, 4, 5, 1, 1,
## 5, 4, 5, 2, 5, 3, 4, 2, 2, 1, 2, 4, 1, 1, 3, 3, 3, 6, 1, 6, 6,
## 2, 2, 6, 4, 4, 3, 4, 4, 1), c(4, 4, 5, 3, 7, 1, 1, 1, 3, 4, 2,
## 4, 3, 5, 2, 4, 5, 1, 2, 1, 5, 7, 3, 4, 6, 7, 6, 1, 1, 1, 4, 7,
## 2, 4, 1, 7, 4, 3, 5, 4, 3, 2, 6, 1, 5, 1, 1, 4, 5, 1, 4, 6, 1,
## 2, 5, 5, 1, 2, 2, 2, 6, 1, 4, 2, 4, 4, 7, 1, 1, 7, 6, 1, 7, 4,
## 1, 5, 5, 3, 4, 5, 3, 6, 6, 6, 4, 5, 6, 6, 4, 2, 2, 5, 2, 6, 3,
## 5, 4, 6, 5, 5, 4, 5, 5, 4, 7, 7, 2, 4, 7, 1, 5, 2, 6, 1, 4, 1,
## 5, 6, 3, 6, 4, 2, 5, 6, 3, 2, 5, 5, 7, 4, 1, 4, 4, 3, 4, 7, 1,
```

```
## 4, 5, 5, 4, 4, 4, 3, 4, 4, 7, 7, 1, 6, 5, 2, 2, 2, 6, 6, 2, 4,
## 2, 2, 7, 4, 4, 4, 5, 4, 1, 4, 4, 4, 2, 4, 5, 1, 3, 3, 4, 1, 5,
## 6, 3, 1, 4, 3, 5, 2, 6, 1, 3, 3, 5, 3, 1, 7, 4, 1, 4, 2, 5, 4,
## 4, 7, 3, 7, 7, 6, 1, 5, 6, 5, 7, 5, 4, 7, 2, 4, 5, 5, 5, 3, 5,
## 2, 4, 7, 7, 4, 4, 4, 3, 6, 6, 3, 4, 2, 5, 1, 4, 2, 1, 5, 4, 5,
## 3, 4, 7, 3, 4, 1, 7, 4, 4, 5, 1, 4, 1), c(1, 1, 2, 1, 2, 1, 2,
## 1, 2, 1, 1, 1, 2, 1, 1, 1, 2, 2, 1, 2, 1, 1, 1, 2, 2, 1, 1, 1,
## 1, 2, 2, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
## 2, 1, 1, 1, 1, 2, 2, 1, 1, 1, 1, 1, 1, 1, 1, 2, 1, 2, 2, 1, 1,
## 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 1, 2, 1, 1, 1, 2, 1, 1,
## 1, 1, 2, 1, 2, 1, 1, 2, 1, 2, 1, 2, 1, 1, 1, 1, 1, 2, 1, 1, 2,
## 2, 1, 2, 2, 1, 1, 1, 1, 1, 1, 2, 2, 2, 1, 1, 2, 2, 2, 1, 1, 1,
## 1, 1, 1, 1, 1, 1, 1, 2, 1, 1, 2, 2, 1, 2, 1, 1, 2, 1, 1, 2, 2,
## 1, 2, 1, 1, 1, 1, 2, 2, 2, 1, 2, 2, 1, 1, 1, 1, 1, 1, 1, 1, 1,
## 1, 2, 2, 1, 2, 1, 1, 1, 1, 1, 1, 2, 1, 2, 1, 2, 2, 1, 1, 1, 1,
## 1, 1, 1, 2, 2, 1, 1, 2, 1, 2, 1, 2, 1, 1, 2, 2, 1, 2, 1, 1, 2,
## 1, 1, 1, 1, 2, 2, 2, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 1, 1,
## 1, 1, 2, 1, 2, 1, 1, 2, 1, 1, 2, 2, 1, 1, 1, 1, 1)), control = list(
##     20, 7, 0, 4, 5, 2, 0, 30, 0))
##   n= 255
##
##          CP nsplit rel error
## 1 0.2278481      0 1.0000000
## 2 0.1678881      1 0.7721519
##
## Variable importance
##         apls2 APLS_SF.Rasch         apls5         apls4         apls3
##            24            19            17            14            14
##         apls1
##            13
##
## Node number 1: 255 observations,    complexity param=0.2278481
##   predicted class=Not_justified  expected loss=0.3098039  P(node) =1
##     class counts:   176    79
##    probabilities: 0.690 0.310
##   left son=2 (151 obs) right son=3 (104 obs)
##   Primary splits:
##       apls2         < 3.5    to the left,  improve=26.90006, (0 missing)
##       APLS_SF.Rasch < 55.395 to the left,  improve=25.25502, (0 missing)
##       apls5         < 3.5    to the left,  improve=22.40698, (0 missing)
##       apls8         < 3.5    to the left,  improve=20.37007, (0 missing)
##       apls10        < 2.5    to the left,  improve=19.90602, (0 missing)
##   Surrogate splits:
##       APLS_SF.Rasch < 55.395 to the left,  agree=0.914, adj=0.788, (0 split)
##       apls5         < 3.5    to the left,  agree=0.878, adj=0.702, (0 split)
##       apls4         < 3.5    to the left,  agree=0.843, adj=0.615, (0 split)
##       apls3         < 3.5    to the left,  agree=0.827, adj=0.577, (0 split)
##       apls1         < 3.5    to the left,  agree=0.824, adj=0.567, (0 split)
##
## Node number 2: 151 observations
##   predicted class=Not_justified  expected loss=0.1192053  P(node) =0.5921569
##     class counts:   133    18
```

```
##    probabilities: 0.881 0.119
##
## Node number 3: 104 observations
##   predicted class=Justified      expected loss=0.4134615  P(node) =0.4078431
##     class counts:    43    61
##    probabilities: 0.413 0.587
```

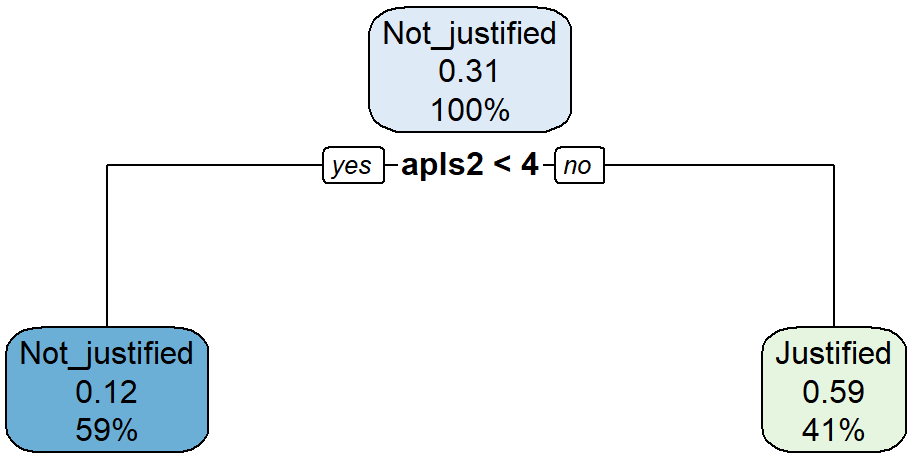
```
plot(mod1)
```




```
library(rpart.plot)
```

```
## Loading required package: rpart
```

```
rpart.plot(mod1$finalModel)
```




```
#building the final model in rpart based on the training results
library(rpart)

mod1.r <- rpart(justif ~ .,
                data=S_train,
                method = "class",
                cp = .167,
                maxdepth= 10,
                minbucket = 10
)

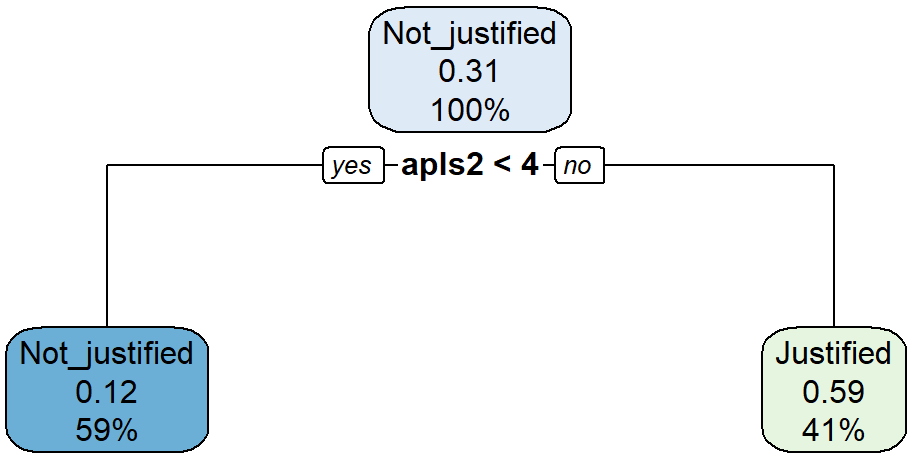

mod1.r
```

```
## n= 255
##
## node), split, n, loss, yval, (yprob)
##       * denotes terminal node
##
## 1) root 255 79 Not_justified (0.6901961 0.3098039)
##   2) apls2< 3.5 151 18 Not_justified (0.8807947 0.1192053) *
##   3) apls2>=3.5 104 43 Justified (0.4134615 0.5865385) *
```

```
summary(mod1.r)
```

```
## Call:
## rpart(formula = justif ~ ., data = S_train, method = "class",
##     cp = 0.167, maxdepth = 10, minbucket = 10)
##   n= 255
##
##          CP nsplit rel error    xerror       xstd
## 1 0.2278481      0 1.0000000 1.0000000 0.09347010
## 2 0.1670000      1 0.7721519 0.8860759 0.09020647
##
## Variable importance
##         apls2 APLS_SF.Rasch         apls5         apls4         apls3
##            24            19            17            14            14
##         apls1
##            13
##
## Node number 1: 255 observations,    complexity param=0.2278481
##   predicted class=Not_justified  expected loss=0.3098039  P(node) =1
##     class counts:   176    79
##    probabilities: 0.690 0.310
##   left son=2 (151 obs) right son=3 (104 obs)
##   Primary splits:
##       apls2         < 3.5    to the left,  improve=26.90006, (0 missing)
##       APLS_SF.Rasch < 55.395 to the left,  improve=25.25502, (0 missing)
##       apls5         < 3.5    to the left,  improve=22.40698, (0 missing)
##       apls8         < 3.5    to the left,  improve=20.37007, (0 missing)
##       apls10        < 2.5    to the left,  improve=19.90602, (0 missing)
##   Surrogate splits:
##       APLS_SF.Rasch < 55.395 to the left,  agree=0.914, adj=0.788, (0 split)
##       apls5         < 3.5    to the left,  agree=0.878, adj=0.702, (0 split)
##       apls4         < 3.5    to the left,  agree=0.843, adj=0.615, (0 split)
##       apls3         < 3.5    to the left,  agree=0.827, adj=0.577, (0 split)
##       apls1         < 3.5    to the left,  agree=0.824, adj=0.567, (0 split)
##
## Node number 2: 151 observations
##   predicted class=Not_justified  expected loss=0.1192053  P(node) =0.5921569
##     class counts:   133    18
##    probabilities: 0.881 0.119
##
## Node number 3: 104 observations
##   predicted class=Justified      expected loss=0.4134615  P(node) =0.4078431
##     class counts:    43    61
##    probabilities: 0.413 0.587
```

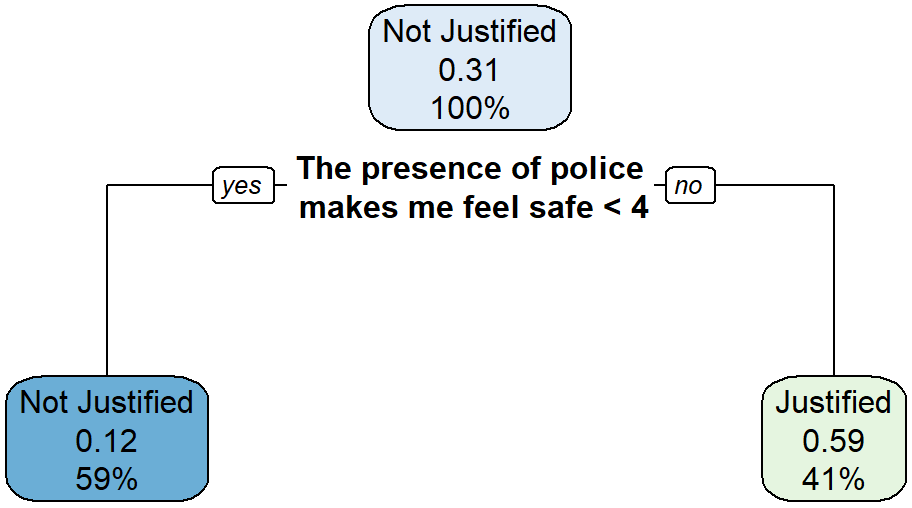
```
library(rpart)
library(rpart.plot)
rpart.plot(mod1.r)
```




```
split.fun <- function(x, labs, digits, varlen, faclen)
{
  labs <- gsub("apls2",      "The presence of police\n makes me feel safe", labs)
labs
}


node.fun <- function(x, labs, digits, varlen)
{
  labs <- gsub("Not_justified", "Not Justified", labs)
  labs
}

rpart.plot(mod1.r, node.fun=node.fun, split.fun=split.fun, type = 2)
```




```
setwd("D:/Google Drive/RESEARCH/LAB STUFF/Officer involved shooting sudy") #setting working dire
ctory to folder in D drive
pdf(file="plot1.pdf")
rpart.plot(mod1.r, node.fun=node.fun, split.fun=split.fun, type = 2)
dev.off()
```

```
## png
##   2
```

```
setwd("D:/Google Drive/RESEARCH/LAB STUFF/Officer involved shooting sudy") #setting working dire
ctory to folder in D drive
png(file="plot1.png")
rpart.plot(mod1.r, node.fun=node.fun, split.fun=split.fun, type = 2)
dev.off()
```

```
## png
##   2
```

```
mod1.r.pred<-predict(mod1.r, newdata = S_test, type = "class")
confusionMatrix(data=mod1.r.pred, reference=S_test$justif, positive = "Justified",  mode = "ever
ything")
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction      Not_justified Justified
##   Not_justified            36         7
##   Justified                 2        19
##
##                Accuracy : 0.8594
##                  95% CI : (0.7498, 0.9336)
##     No Information Rate : 0.5938
##     P-Value [Acc > NIR] : 3.792e-06
##
##                   Kappa : 0.6994
##
##  Mcnemar's Test P-Value : 0.1824
##
##             Sensitivity : 0.7308
##             Specificity : 0.9474
##          Pos Pred Value : 0.9048
##          Neg Pred Value : 0.8372
##               Precision : 0.9048
##                  Recall : 0.7308
##                      F1 : 0.8085
##              Prevalence : 0.4062
##          Detection Rate : 0.2969
##    Detection Prevalence : 0.3281
##       Balanced Accuracy : 0.8391
##
##        'Positive' Class : Justified
##
```

```
# calculate area under curve
library(pROC)
```

```
## Type 'citation("pROC")' for a citation.
```

```
##
## Attaching package: 'pROC'
```

```
## The following objects are masked from 'package:stats':
##
##     cov, smooth, var
```

```
mod1.r.pred2<-predict(mod1.r,  S_test, type = "prob")

mod1.r.rpart_ROC <- multiclass.roc(S_test$justif, mod1.r.pred2)

auc(mod1.r.rpart_ROC)
```

```
## Multi-class area under the curve: 0.8391
```

```
######
#apls item 2 - The presence of police makes me feel safe.
#the algorithm predicts that, on a scale from 1-5, those who answer the question, "The presence of police makes me feel safe" with 1-3 will perceive a shooting as Not justified.
#for those who answer it 4 or 5, the algorithm predicts that they would view it as justified
#Remarkably, using this single item, the algorithm achieves a balanced accuracy of .8391, an AUC of .8391, and a Kappa of .6994
```