D3

2025-06-03

```r
#setwd("/dades/eric.diez/6Q/ADEI")
setwd("C:/Users/Ericd/Pictures/ADEI")
dd <- read.csv("adult_def.csv", stringsAsFactors = TRUE);
names(dd)
```

```
##  [1] "age"            "workclass"      "fnlwgt"         "edu_num"
##  [5] "marital"        "occupation"     "relationship"   "race"
##  [9] "sex"            "cap_gain"       "cap_loss"       "hours_week"
## [13] "native_country" "income"         "income_integer"
```

```r
dim(dd)
```

```
## [1] 48842    15
```

```r
summary(dd)
```

```
##       age        workclass         fnlwgt           edu_num
##  Min.   :17.00   Fed  : 1432   Min.   :  12285   Min.   : 1.00
##  1st Qu.:28.00   Loc  : 3136   1st Qu.: 117551   1st Qu.: 9.00
##  Median :37.00   NoPay:   31   Median : 178145   Median :10.00
##  Mean   :38.64   Priv :36705   Mean   : 189664   Mean   :10.08
##  3rd Qu.:48.00   SelfI: 1695   3rd Qu.: 237642   3rd Qu.:12.00
##  Max.   :90.00   SelfN: 3862   Max.   :1490400   Max.   :16.00
##                  State: 1981
##     marital          occupation            relationship
##  Div    : 6633   Prof     : 8981   Husband       :19716
##  Married:22416   CraftRep : 6112   Not-in-family :12583
##  NevMarr:16117   ExecMan  : 6086   Other-relative: 1506
##  Sep    : 2158   AdminCler: 5611   Own-child     : 7581
##  Widow  : 1518   Sales    : 5504   Unmarried     : 5125
##                  Other    : 4923   Wife          : 2331
##                  (Other)  :11625
##                  race           sex           cap_gain        cap_loss
##  Amer-Indian-Eskimo:  470   Female:16192   Min.   :    0   Min.   :   0.0
##  Asian-Pac-Islander: 1519   Male  :32650   1st Qu.:    0   1st Qu.:   0.0
##  Black             : 4685                  Median :    0   Median :   0.0
##  Other             :  406                  Mean   : 1079   Mean   :  87.5
##  White             :41762                  3rd Qu.:    0   3rd Qu.:   0.0
##                                            Max.   :99999   Max.   :4356.0
##
##    hours_week    native_country   income      income_integer
##  Min.   : 1.00   Other: 5010    <=50K:37155   Min.   :27850
##  1st Qu.:40.00   USA  :43832    >50K :11687   1st Qu.:40820
##  Median :40.00                                Median :44870
##  Mean   :40.42                                Mean   :45684
##  3rd Qu.:45.00                                3rd Qu.:49835
##  Max.   :99.00                                Max.   :80040
```

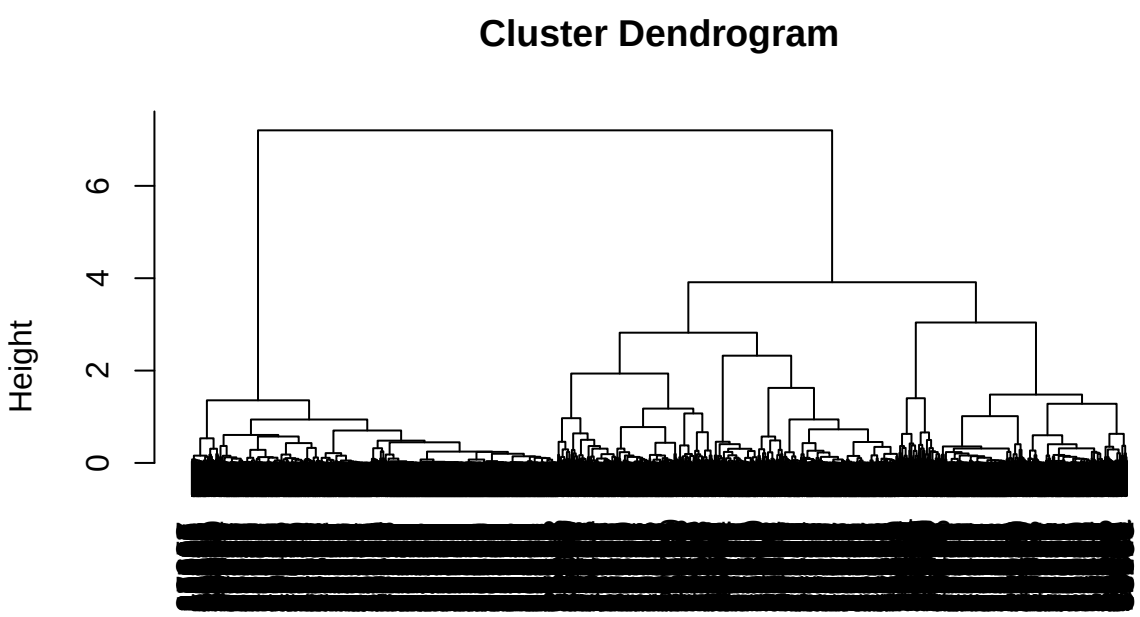
##

```
set.seed(123)
samp<-sample(48842,5000)
par(mar = c(5, 4, 4, 2))  # aumenta espacio inferior


dd<-dd[samp,]
#set a list of numerical variables
names(dd)
```

```
##  [1] "age"            "workclass"      "fnlwgt"         "edu_num"
##  [5] "marital"        "occupation"     "relationship"   "race"
##  [9] "sex"            "cap_gain"       "cap_loss"       "hours_week"
## [13] "native_country" "income"         "income_integer"
```

```
attach(dd)
```

```
#euclidean distance si totes son numeriques
dcon<-data.frame (age,edu_num,cap_gain,cap_loss,hours_week)

d  <- dist(dcon[1:6,])

#move to Gower mixed distance to deal
#simoultaneously with numerical and qualitative data

library(cluster)

#dissimilarity matrix
#do not include in actives the identifier variables nor the potential response variable

actives <- c("age", "workclass", "edu_num",
             "marital", "occupation", "relationship", "race", "sex",
             "cap_gain", "cap_loss", "hours_week", "native_country")
actives <- c(1:2,4:13)
dissimMatrix <- daisy(dd[,actives], metric = "gower", stand=TRUE)
distMatrix <- as.dist(dissimMatrix^2)

h1 <- hclust(distMatrix,method="ward.D2")  # NOTICE THE COST
#versions noves "ward.D" i abans de plot: par(mar=rep(2,4)) si se quejara de los margenes del plot

plot(h1)
```



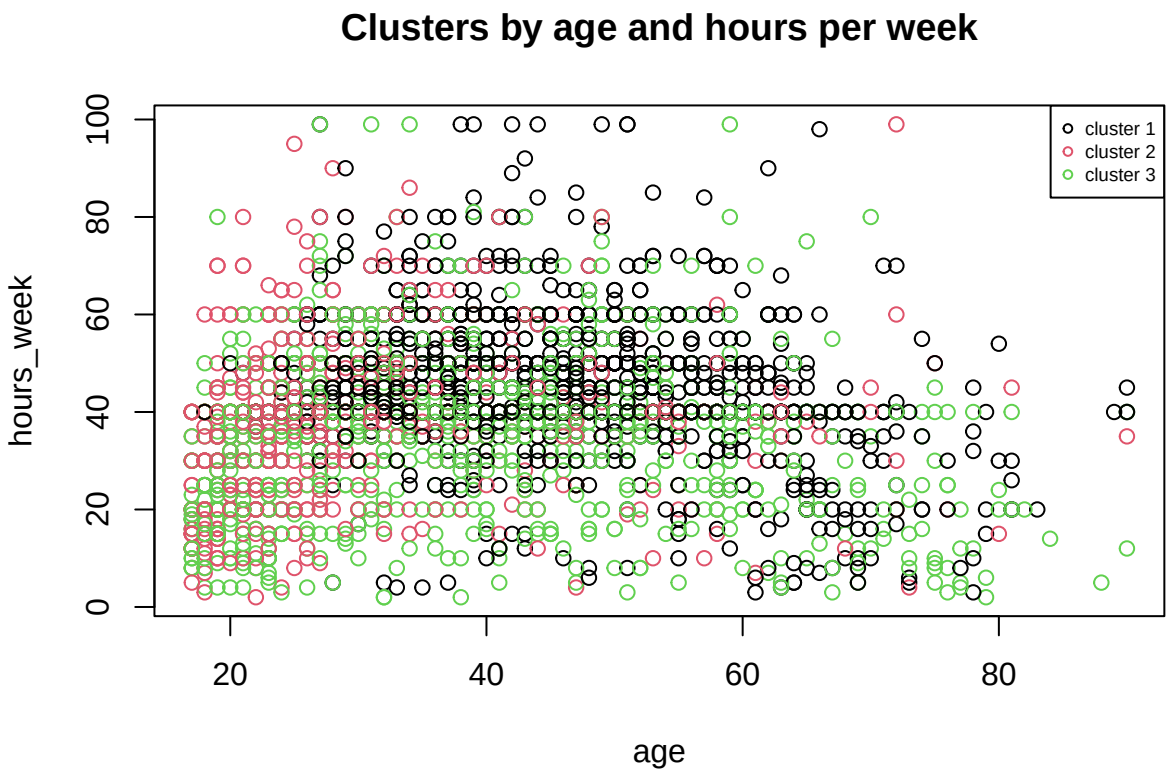

```
k<-3

c2 <- cutree(h1, k=k)
```

Añadir cluster al dataset

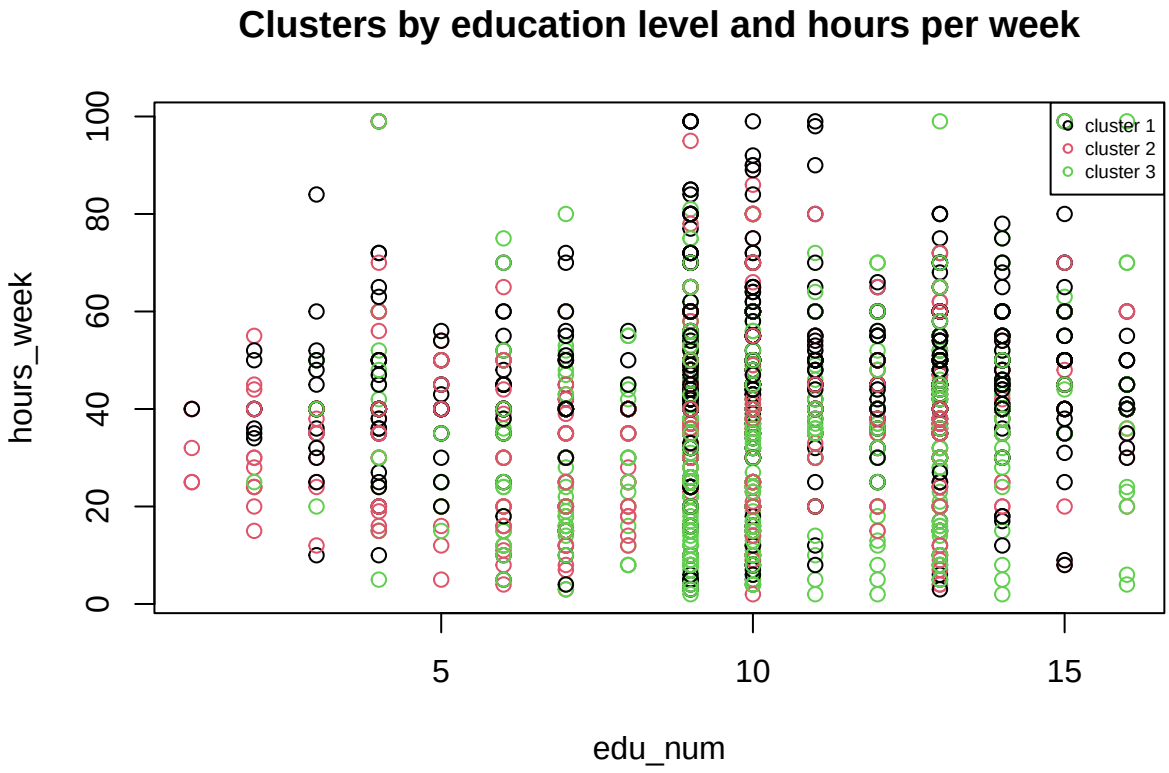
```
dd$cluster <- as.factor(c2)

# Análisis descriptivo de los clusters
table(dd$cluster)
```

```
##
##    1    2    3
## 1957 1221 1822
```

```
# LETS SEE THE PARTITION VISUALLY

c1<-c2
# Basic scatter plots for three key numeric variables (modified version)
plot(age, hours_week, col=c1, main="Clusters by age and hours per week")
legend("topright", paste("cluster", 1:k), pch=1, col=1:k, cex=0.6)
```

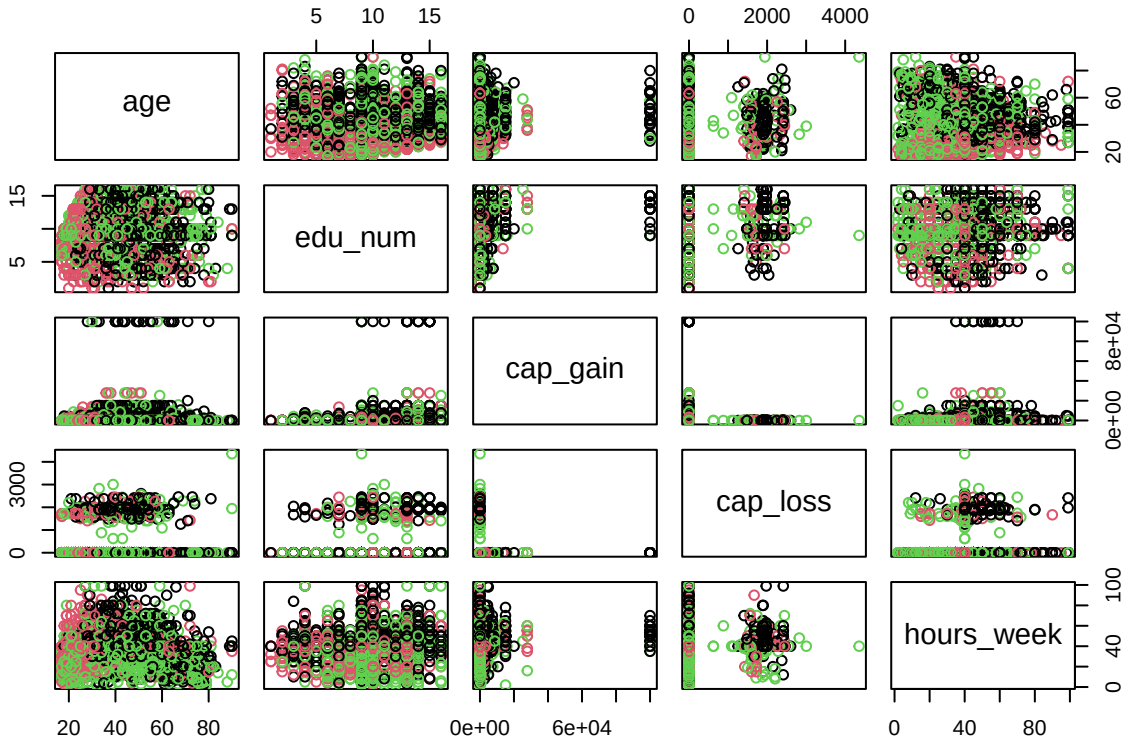



```
plot(edu_num, hours_week, col=c1, main="Clusters by education level and hours per week")
legend("topright", paste("cluster", 1:k), pch=1, col=1:k, cex=0.6)
```




```
plot(age, edu_num, col=c1, main="Clusters by age and education level")
legend("topright", paste("cluster", 1:k), pch=1, col=1:k, cex=0.6)
```


```
pairs(dcon[,1:5], col=c1)
```

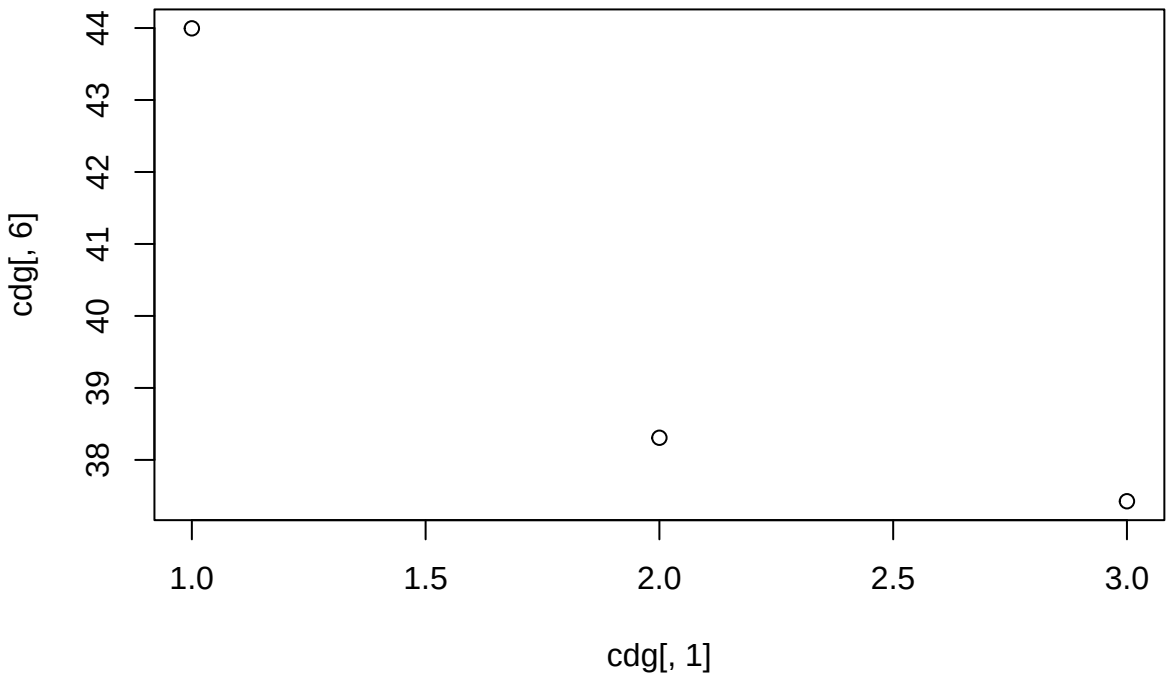


LETS SEE THE QUALITY OF THE HIERARCHICAL PARTITION

```
cdg <- aggregate(as.data.frame(dcon), list(c1), mean)
cdg
```

```
##   Group.1      age   edu_num  cap_gain  cap_loss hours_week
## 1       1 44.17527 10.273889 1922.9918 138.15330   43.99540
## 2       2 30.63718  9.594595  297.0614  54.32514   38.30794
## 3       3 37.61690 10.135565  544.7629  65.65642   37.42591
```

```
plot(cdg[,1], cdg[,6])
```




```r
#Profiling plots

#Calcula els valor test de la variable Xnum per totes les modalitats del factor P
ValorTestXnum <- function(Xnum,P){
  #freq dis of fac
  nk <- as.vector(table(P));
  n <- sum(nk);
  #mitjanes x grups
  xk <- tapply(Xnum,P,mean);
  #valors test
  txk <- (xk-mean(Xnum))/(sd(Xnum)*sqrt((n-nk)/(n*nk)));
  #p-values
  pxk <- pt(txk,n-1,lower.tail=F);
  for(c in 1:length(levels(as.factor(P)))){if (pxk[c]>0.5){pxk[c]<-1-pxk[c]}}
  return (pxk)
}



ValorTestXquali <- function(P,Xquali){
  taula <- table(P,Xquali);
  n <- sum(taula);
  pk <- apply(taula,1,sum)/n;
  pj <- apply(taula,2,sum)/n;
  pf <- taula/(n*pk);
```

```
  pjm <- matrix(data=pj,nrow=dim(pf)[1],ncol=dim(pf)[2], byrow=TRUE);
  dpf <- pf - pjm;
  dvt <- sqrt(((1-pk)/(n*pk))%*%t(pj*(1-pj)));
  #i hi ha divisions iguals a 0 dona NA i no funciona
  zkj <- dpf
  zkj[dpf!=0]<-dpf[dpf!=0]/dvt[dpf!=0];
  pzkj <- pnorm(zkj,lower.tail=F);
  for(c in 1:length(levels(as.factor(P)))){for (s in 1:length(levels(Xquali))){if (pzkj[c,s]> 0.5){pzkj
  return (list(rowpf=pf,vtest=zkj,pval=pzkj))
}
```

```
#source("file")
#dades contain the dataset
dades <- dd[, setdiff(names(dd),
                      c("fnlwgt", "income", "cluster", "income_integer"))]
#dades<-dd[filtro,]
#dades<-df
K<-dim(dades)[2]
par(ask=TRUE)


#P must contain the class variable
#P<-dd[,3]
P<-c2
#P<-dd[,18]
nameP<-"classe"
#P<-df[,33]

nc<-length(levels(factor(P)))
nc
```

```
## [1] 3
```

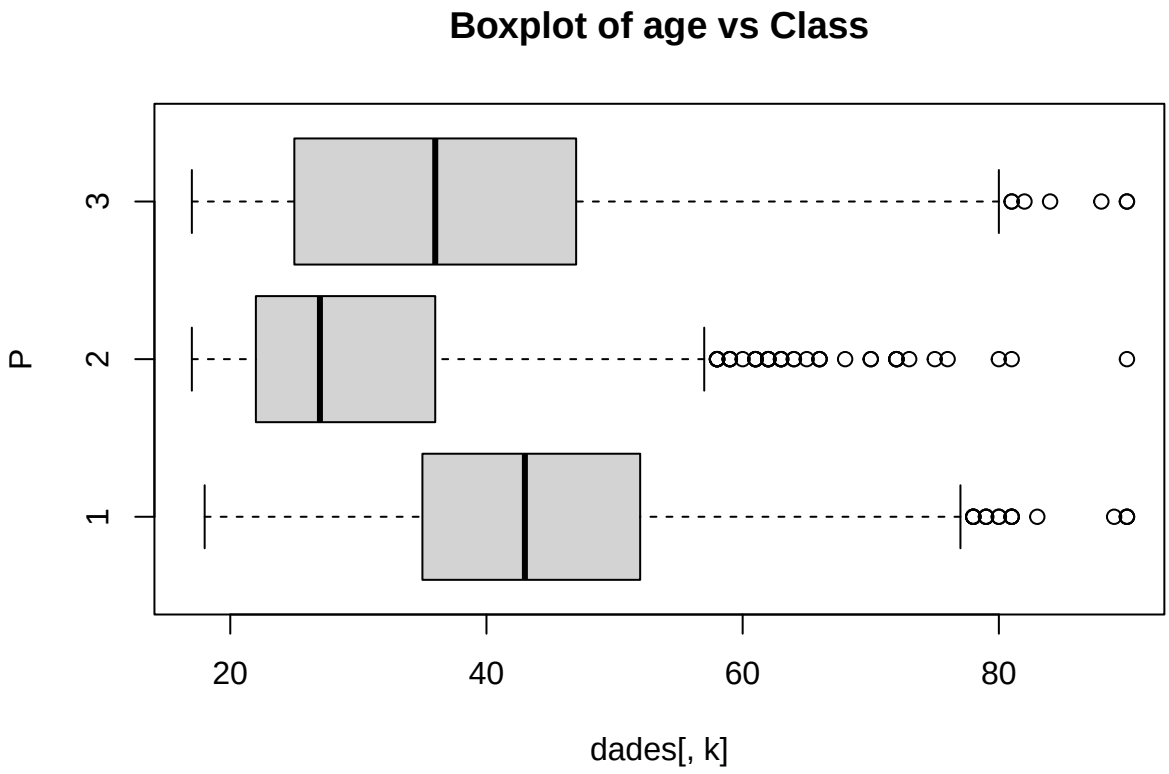
```
pvalk <- matrix(data=0,nrow=nc,ncol=K, dimnames=list(levels(P),names(dades)))
nameP<-"Class"
n<-dim(dades)[1]

for(k in 1:K){
  if (is.numeric(dades[,k])){
    print(paste("Anàlisi per classes de la Variable:", names(dades)[k]))

    boxplot(dades[,k]~P, main=paste("Boxplot of", names(dades)[k], "vs", nameP ), horizontal=TRUE)

    barplot(tapply(dades[[k]], P, mean),main=paste("Means of", names(dades)[k], "by", nameP ))
    abline(h=mean(dades[[k]]))
    legend(0,mean(dades[[k]]),"global mean",bty="n")
    print("Estadístics per groups:")
    for(s in levels(as.factor(P))) {print(summary(dades[P==s,k]))}
    o<-oneway.test(dades[,k]~P)
    print(paste("p-valueANOVA:", o$p.value))
    kw<-kruskal.test(dades[,k]~P)
    print(paste("p-value Kruskal-Wallis:", kw$p.value))
    pvalk[,k]<-ValorTestXnum(dades[,k], P)
    print("p-values ValorsTest: ")
    print(pvalk[,k])
```

```
}else{
  if(class(dd[,k])=="Date"){
    print(summary(dd[,k]))
    print(sd(dd[,k]))
    #decide breaks: weeks, months, quarters...
    hist(dd[,k],breaks="weeks")
  }else{
    #qualitatives
    print(paste("Variable", names(dades)[k]))
    table<-table(P,dades[,k])
    #   print("Cross-table")
    #   print(table)
    rowperc<-prop.table(table,1)

    colperc<-prop.table(table,2)
    #  print("Distribucions condicionades a files")
    # print(rowperc)

    #ojo porque si la variable es true o false la identifica amb el tipus Logical i
    #aquest no te levels, por tanto, coertion preventiva

    dades[,k]<-as.factor(dades[,k])


    marg <- table(as.factor(P))/n
    print(append("Categories=",levels(as.factor(dades[,k]))))
    par(mar = c(8, 4, 4, 2))  # más espacio abajo


    #from next plots, select one of them according to your practical case
    plot(marg,type="l",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]))
    paleta<-rainbow(length(levels(dades[,k])))
    for(c in 1:length(levels(dades[,k]))){lines(colperc[,c],col=paleta[c]) }

    #with legend
    par(mar = c(5, 4, 4, 6))
    plot(marg,type="l",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]))
    paleta<-rainbow(length(levels(dades[,k])))
    for(c in 1:length(levels(dades[,k]))){lines(colperc[,c],col=paleta[c]) }
    legend("topright",inset = c(-0.19, 0), levels(dades[,k]), col=paleta, lty=2, cex=0.6, bg = "transp
    par(mar = c(8, 4, 4, 2))

    #condicionades a classes
    print(append("Categories=",levels(dades[,k])))
    plot(marg,type="n",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]))
    paleta<-rainbow(length(levels(dades[,k])))
    for(c in 1:length(levels(dades[,k]))){lines(rowperc[,c],col=paleta[c]) }

    #with legend
    plot(marg,type="n",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]))
    paleta<-rainbow(length(levels(dades[,k])))
    for(c in 1:length(levels(dades[,k]))){lines(rowperc[,c],col=paleta[c]) }
    legend("topright", levels(dades[,k]), col=paleta, lty=2, cex=0.6)
```

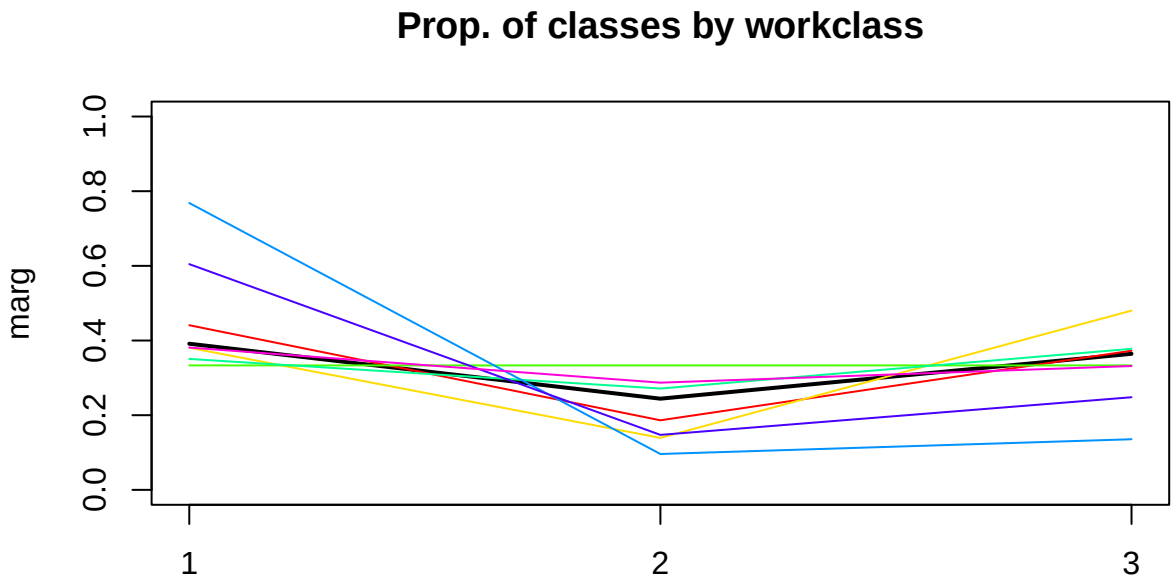
```r
#amb variable en eix d'abcisses
marg <-table(dades[,k])/n
print(append("Categories=",levels(dades[,k])))
plot(marg,type="l",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]), las=3)
#x<-plot(marg,type="l",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]), xaxt="n")
#text(x=x+.25, y=-1, adj=1, levels(CountryName), xpd=TRUE, srt=25, cex=0.7)
paleta<-rainbow(length(levels(as.factor(P))))
for(c in 1:length(levels(as.factor(P)))){lines(rowperc[c,],col=paleta[c]) }

#with legend
plot(marg,type="l",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]), las=3)
for(c in 1:length(levels(as.factor(P)))){lines(rowperc[c,],col=paleta[c])}
legend("topright", levels(as.factor(P)), col=paleta, lty=2, cex=0.6)

#condicionades a columna
plot(marg,type="n",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]), las=3)
paleta<-rainbow(length(levels(as.factor(P))))
for(c in 1:length(levels(as.factor(P)))){lines(colperc[c,],col=paleta[c]) }

#with legend
par(mar = c(8, 4, 4, 6))
plot(marg,type="n",ylim=c(0,1),main=paste("Prop. of classes by",names(dades)[k]), las=3)
for(c in 1:length(levels(as.factor(P)))){lines(colperc[c,],col=paleta[c])}
legend("topright", inset = c(-0.10, 0),levels(as.factor(P)), col=paleta, lty=2, cex=0.6, bg = "tra
par(mar = c(8, 4, 4, 2))

table<-table(dades[,k],P)
print("Cross Table:")
print(table)
print("Distribucions condicionades a columnes:")
print(colperc)

#diagrames de barres apilades

paleta<-rainbow(length(levels(dades[,k])))
barplot(table(dades[,k], as.factor(P)), beside=FALSE,col=paleta )

barplot(table(dades[,k], as.factor(P)), beside=FALSE,col=paleta )
legend("topright",levels(as.factor(dades[,k])),pch=1,cex=0.5, col=paleta)

#diagrames de barres adosades
barplot(table(dades[,k], as.factor(P)), beside=TRUE,col=paleta )

par(mar = c(5, 4, 4, 6))
barplot(table(dades[,k], as.factor(P)), beside=TRUE,col=paleta)
legend("topright", inset = c(-0.17, 0),levels(as.factor(dades[,k])),pch=1,cex=0.5, col=paleta, bg
par(mar = c(8, 4, 4, 2))

print("Test Chi quadrat: ")
print(chisq.test(dades[,k], as.factor(P)))

print("valorsTest:")
print( ValorTestXquali(P,dades[,k]))
```

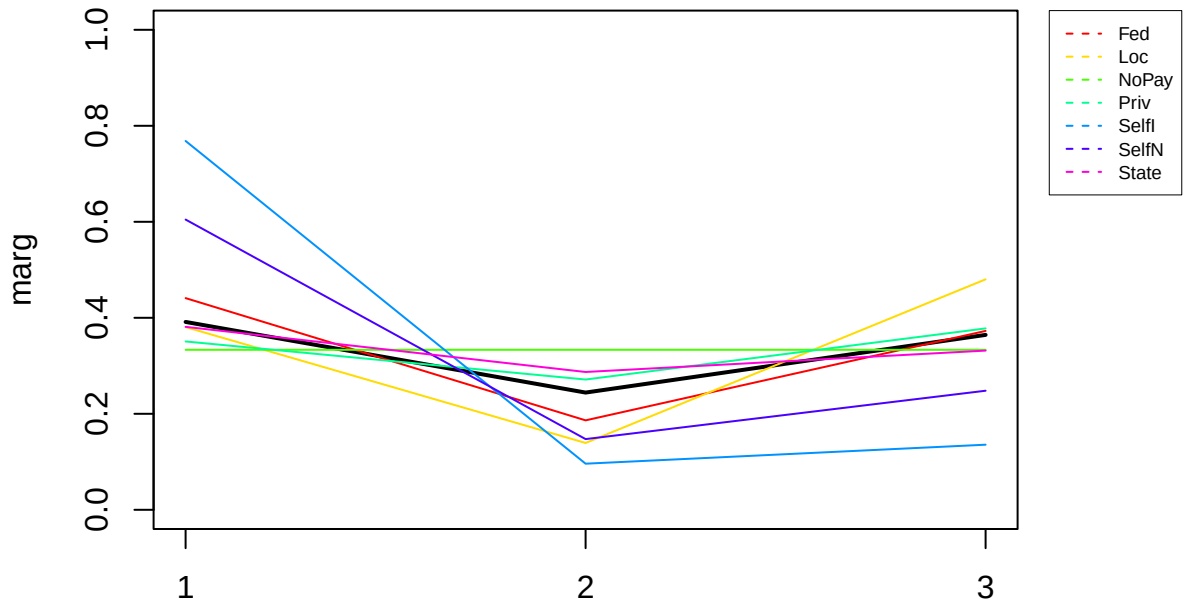
```
      #calcular els pvalues de les quali
    }
  }
}#endfor
```

```
## [1] "Anàlisi per classes de la Variable: age"
```



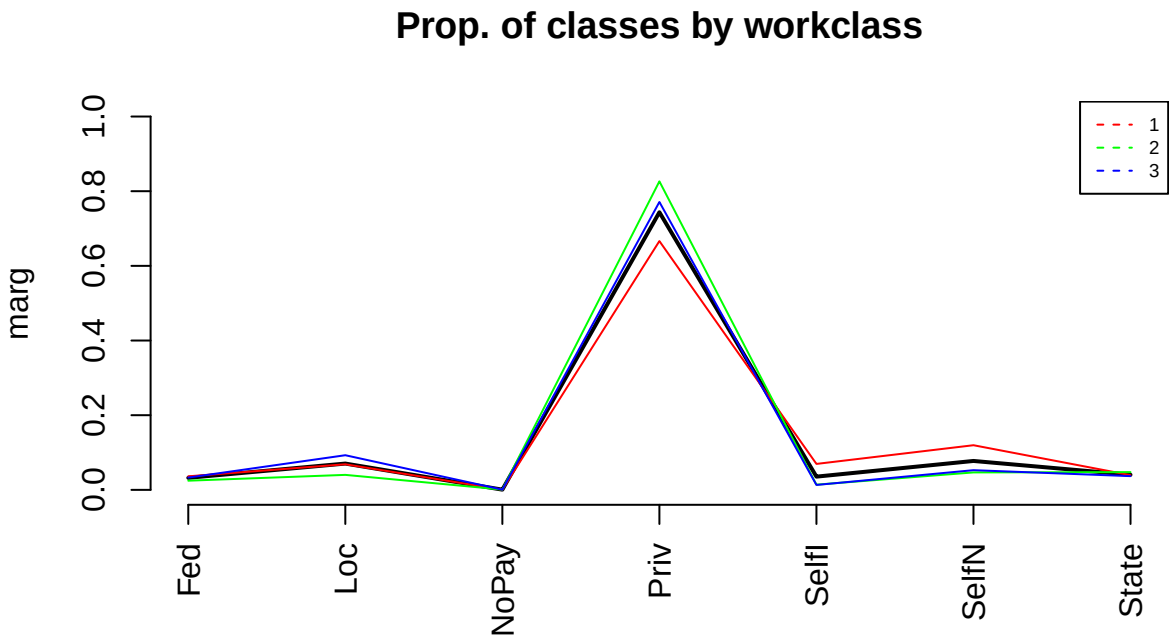

```
## [1] "Estadístics per groups:"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   18.00   35.00   43.00   44.18   52.00   90.00
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   17.00   22.00   27.00   30.64   36.00   90.00
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   17.00   25.00   36.00   37.62   47.00   90.00
## [1] "p-valueANOVA: 3.37964367791504e-190"
## [1] "p-value Kruskal-Wallis: 9.67398091244748e-189"
## [1] "p-values ValorsTest: "
## [1] 9.361532e-115  0.000000e+00  4.265215e-04
## [1] "Variable workclass"
## [1] "Categories=" "Fed"         "Loc"         "NoPay"       "Priv"
## [6] "SelfI"       "SelfN"       "State"
```

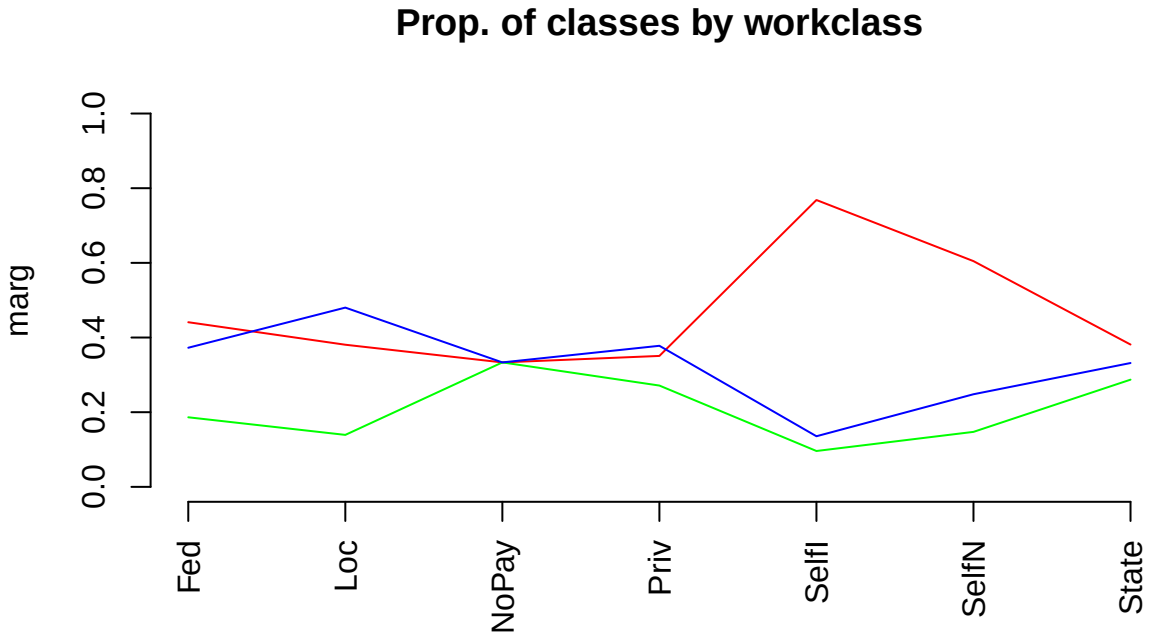

Prop. of classes by workclass
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3

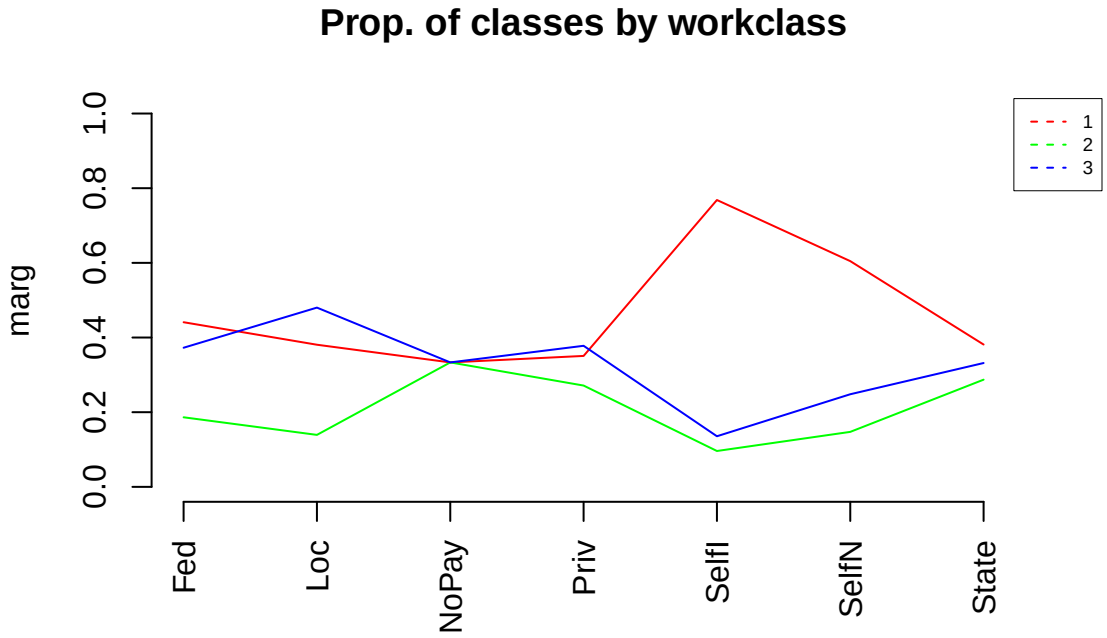



```
## [1] "Categories=" "Fed"         "Loc"         "NoPay"       "Priv"
## [6] "SelfI"       "SelfN"       "State"
```

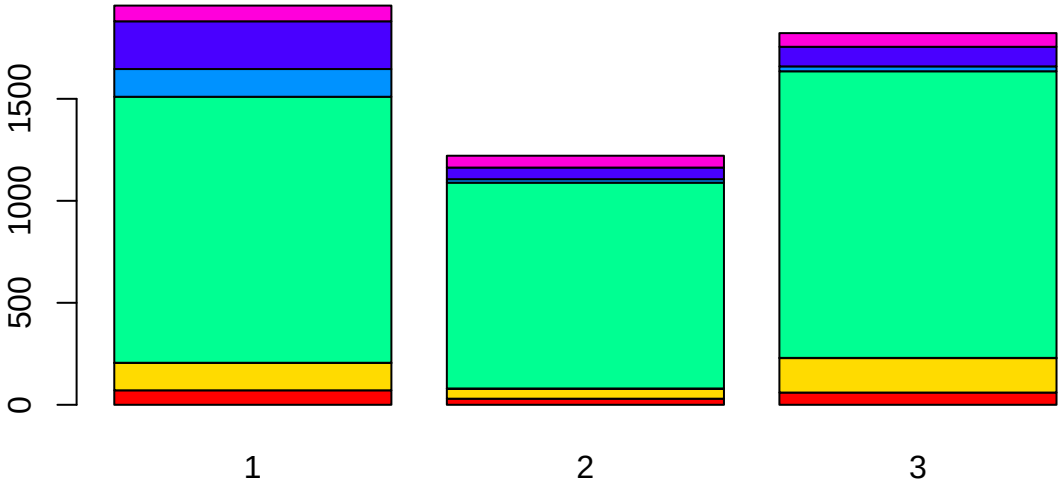

```
## [1] "Categories=" "Fed"         "Loc"         "NoPay"       "Priv"
## [6] "SelfI"       "SelfN"       "State"
```

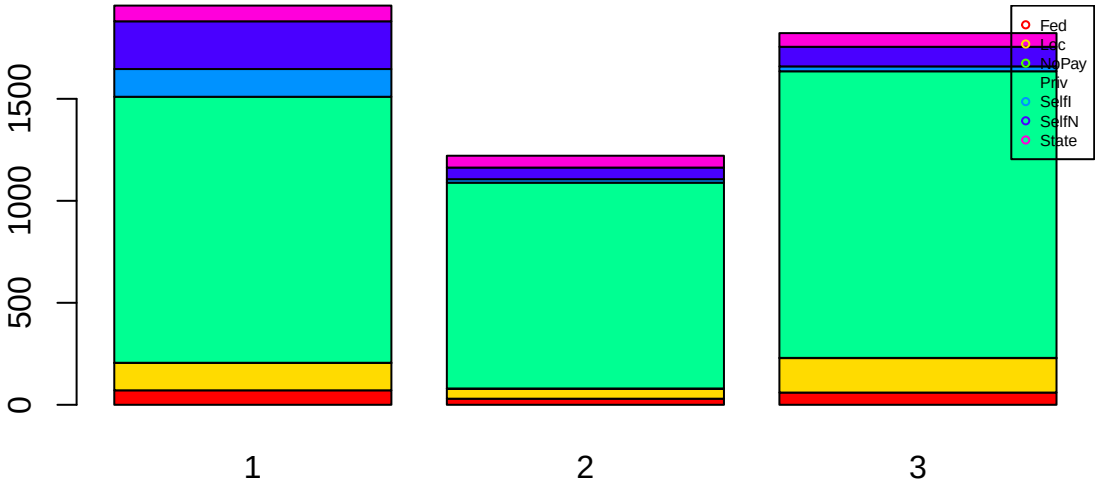

Prop. of classes by workclass
marg
0.0
0.2
0.4
0.6
0.8
1.0
Fed
Loc
NoPay
Priv
SelfI
SelfN
State
1
2
3

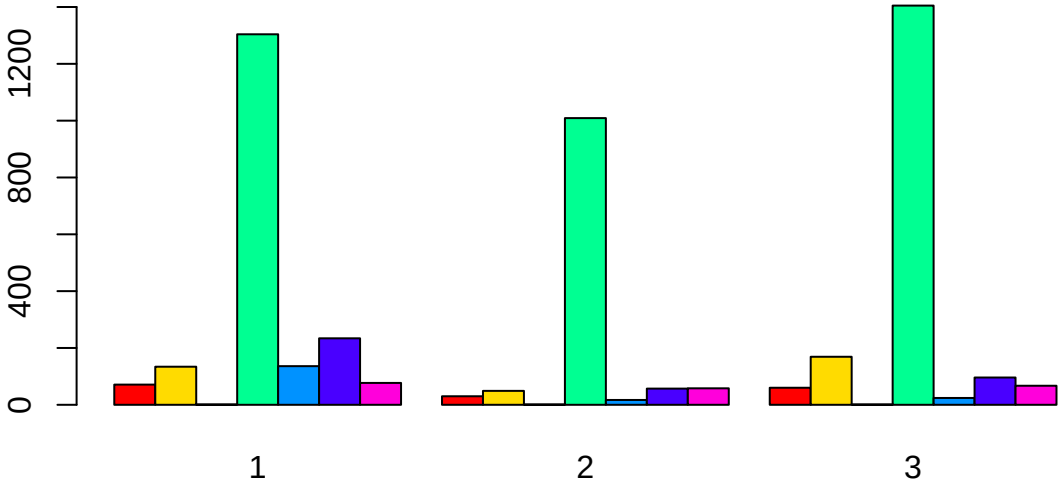

Prop. of classes by workclass
marg
0.0
0.2
0.4
0.6
0.8
1.0
Fed
Loc
NoPay
Priv
SelfI
SelfN
State

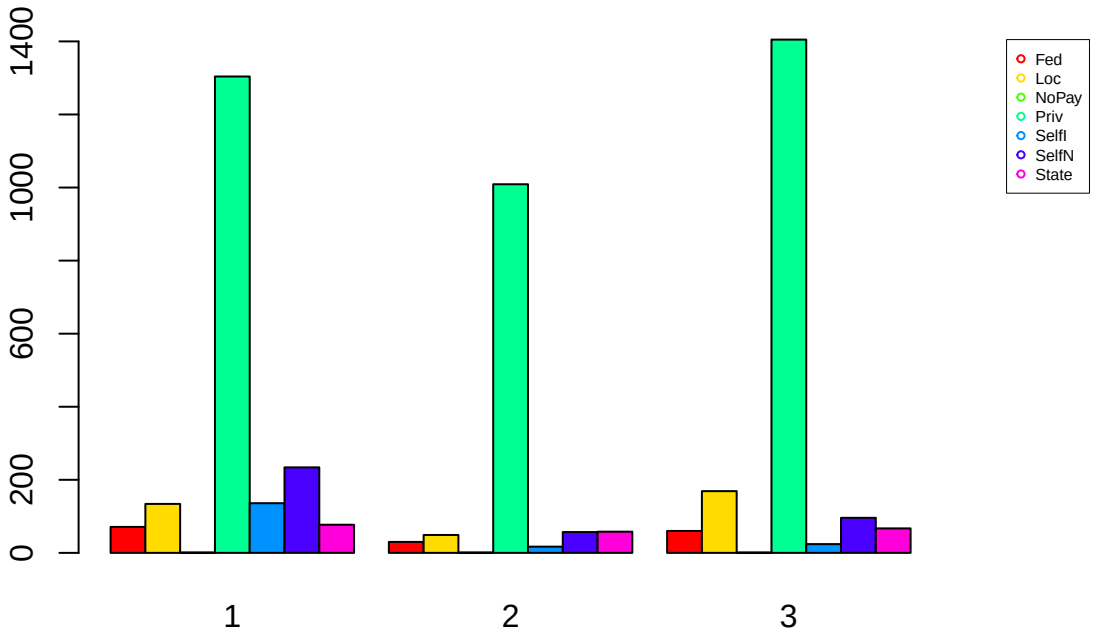



```
## [1] "Cross Table:"
##        P
##            1    2    3
##   Fed     71   30   60
##   Loc    134   49  169
##   NoPay    1    1    1
##   Priv  1304 1009 1405
##   SelfI  136   17   24
##   SelfN  234   57   96
##   State   77   58   67
## [1] "Distribucions condicionades a columnes:"
##
## P         Fed       Loc     NoPay      Priv     SelfI     SelfN     State
##   1 0.4409938 0.3806818 0.3333333 0.3507262 0.7683616 0.6046512 0.3811881
##   2 0.1863354 0.1392045 0.3333333 0.2713825 0.0960452 0.1472868 0.2871287
##   3 0.3726708 0.4801136 0.3333333 0.3778913 0.1355932 0.2480620 0.3316832
```


0
500
1000
1500
1
2
3

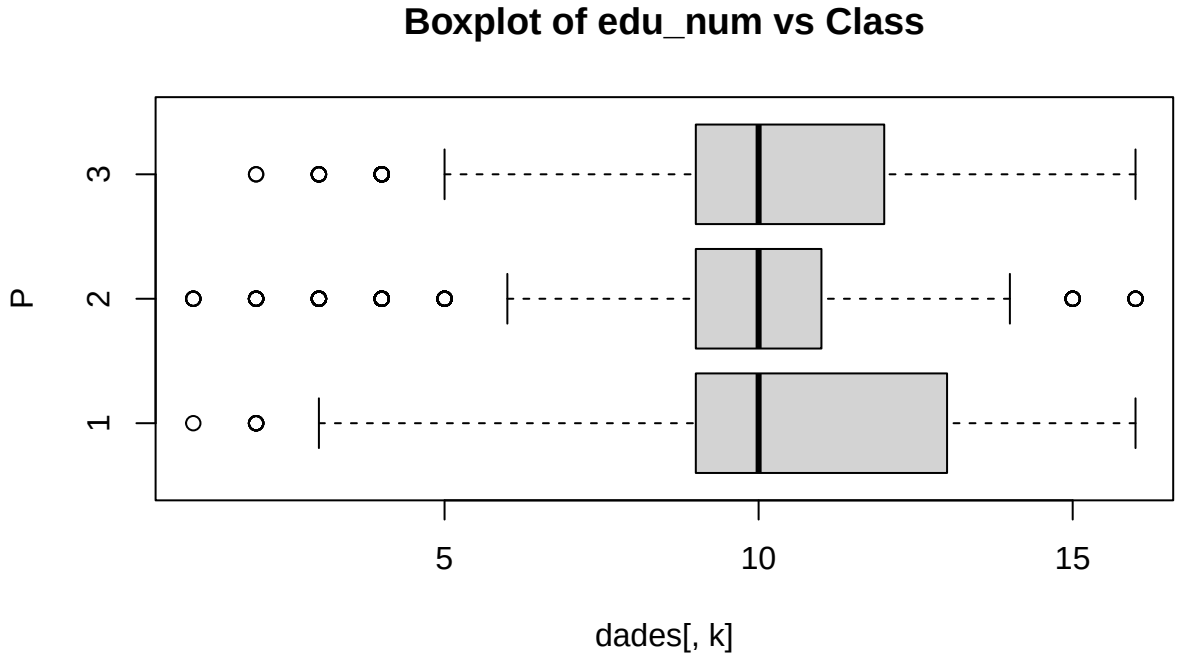

0
500
1000
1500
1
2
3
Fed
Loc
NoPay
Priv
SelfI
SelfN
State

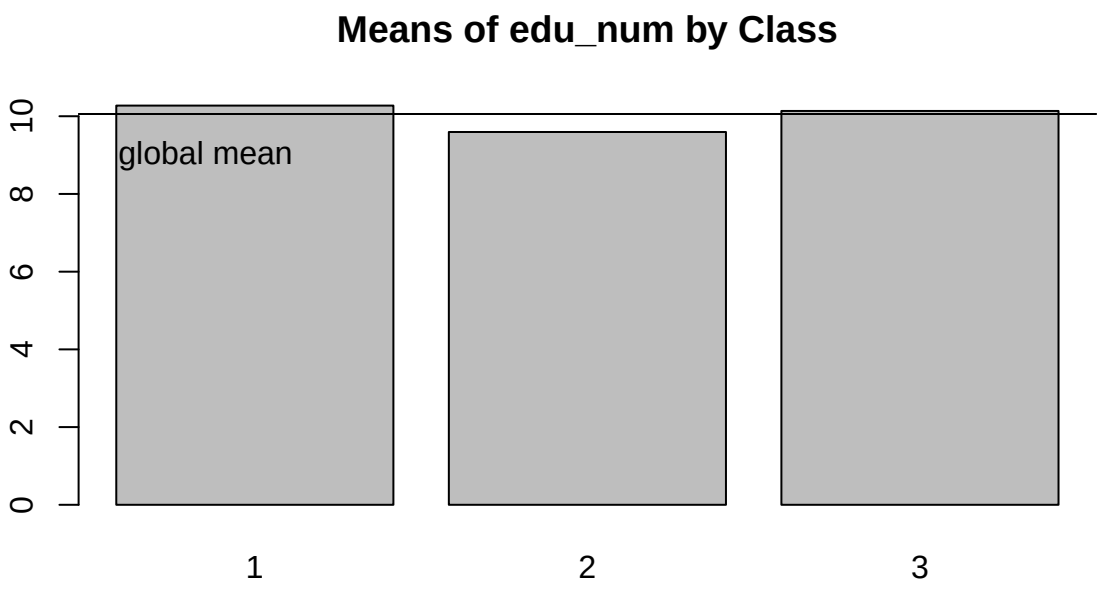

0
400
800
1200
1
2
3



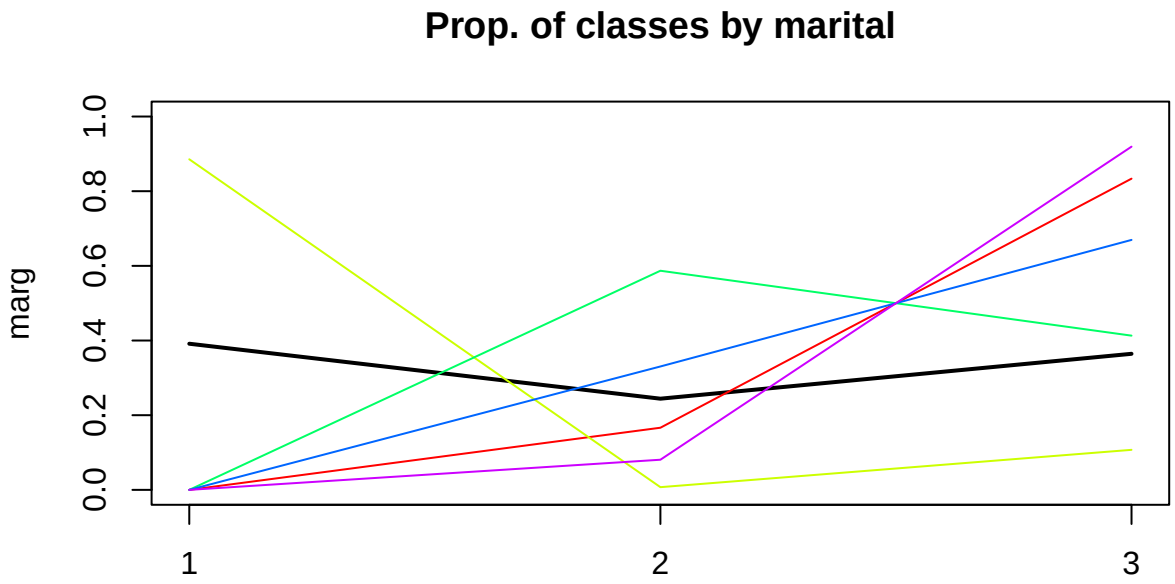

```
## [1] "Test Chi quadrat: "
## Warning in chisq.test(dades[, k], as.factor(P)): Chi-squared approximation may
## be incorrect
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 243.13, df = 12, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P            Fed          Loc        NoPay         Priv        SelfI
##   1 0.0362800204 0.0684721513 0.0005109862 0.6663260092 0.0694941237
##   2 0.0245700246 0.0401310401 0.0008190008 0.8263718264 0.0139230139
##   3 0.0329308452 0.0927552141 0.0005488474 0.7711306257 0.0131723381
##    Xquali
## P          SelfN        State
##   1 0.1195707716 0.0393459377
##   2 0.0466830467 0.0475020475
##   3 0.0526893524 0.0367727772
##
## $vtest
##    Xquali
## P           Fed         Loc       NoPay        Priv       SelfI       SelfN
```

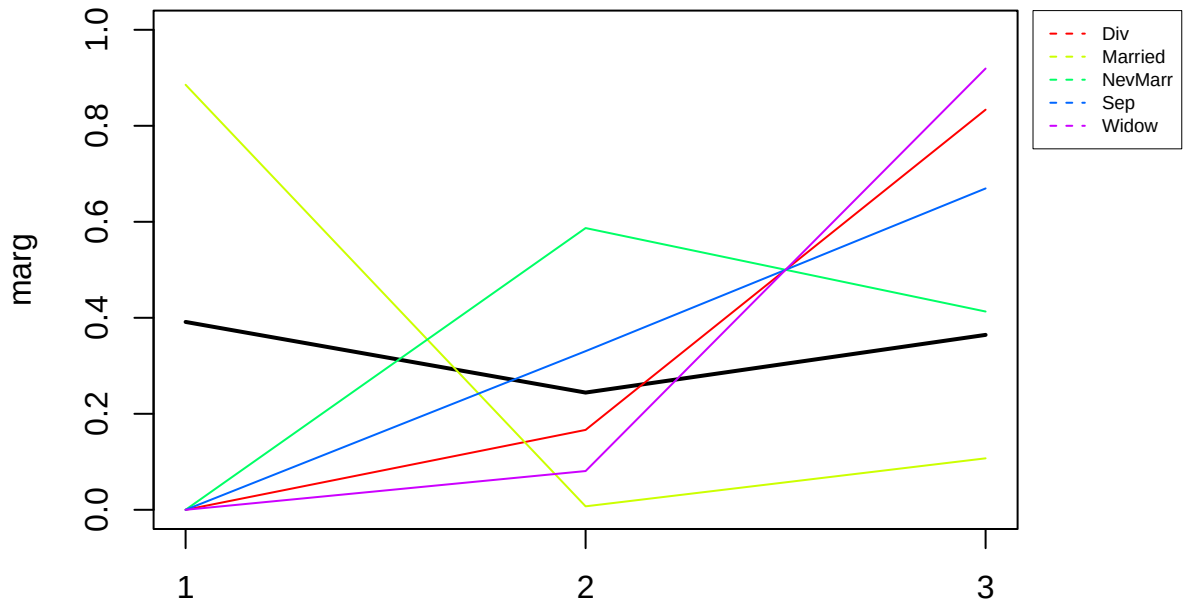
```
##   1   1.3106026  -0.4273346  -0.2061301 -10.0353860  10.4624576   8.9487790
##   2  -1.7372278  -4.7557334   0.3594635   7.6191799  -4.6714582  -4.6201420
##   3   0.2216598   4.6787160  -0.1118419   3.3757449  -6.4402209  -4.9509571
##    Xquali
## P         State
##   1  -0.3035708
##   2   1.4497802
##   3  -0.9863264
##
## $pval
##    Xquali
## P            Fed          Loc        NoPay         Priv        SelfI
##   1 9.499603e-02 3.345678e-01 4.183446e-01 0.000000e+00 6.423963e-26
##   2 4.117348e-02 9.886364e-07 3.596242e-01 1.276463e-14 1.495345e-06
##   3 4.122894e-01 1.443385e-06 4.554744e-01 3.680807e-04 5.964984e-11
##    Xquali
## P          SelfN        State
##   1 1.797181e-19 3.807275e-01
##   2 1.917388e-06 7.355991e-02
##   3 3.692469e-07 1.619865e-01
##
## [1] "Anàlisi per classes de la Variable: edu_num"
```



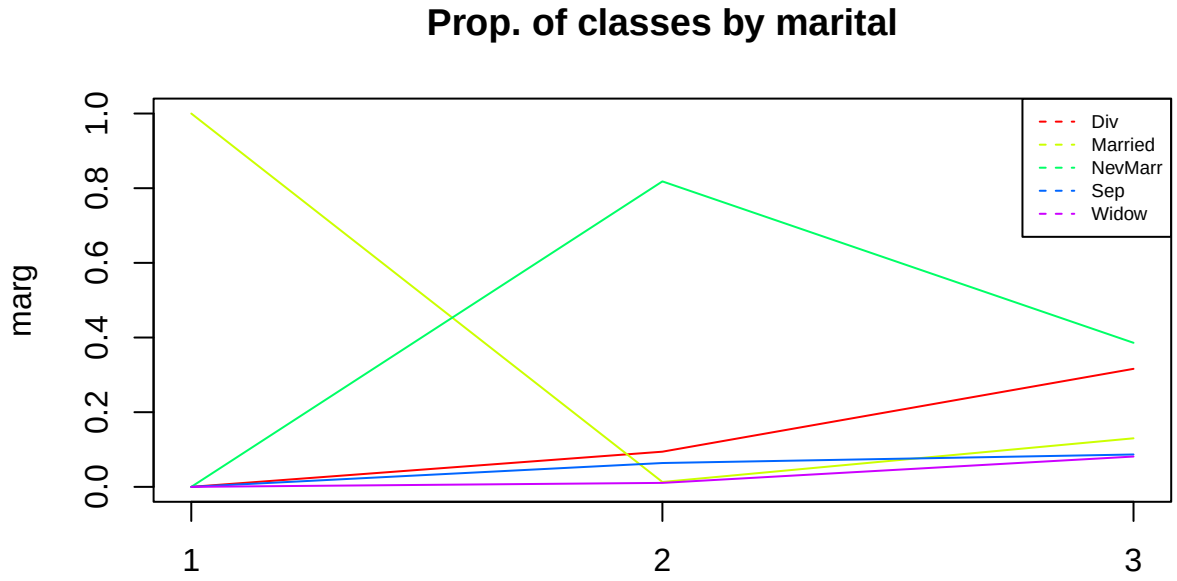



```
## [1] "Estadístics per groups:"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    1.00    9.00   10.00   10.27   13.00   16.00
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   1.000   9.000  10.000   9.595  11.000  16.000
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2.00    9.00   10.00   10.14   12.00   16.00
## [1] "p-valueANOVA: 1.231187841333e-11"
## [1] "p-value Kruskal-Wallis: 1.0090777949887e-08"
## [1] "p-values ValorsTest: "
## [1] 8.904730e-07 2.289280e-13 5.182494e-02
## [1] "Variable marital"
## [1] "Categories=" "Div"         "Married"     "NevMarr"     "Sep"
## [6] "Widow"
```

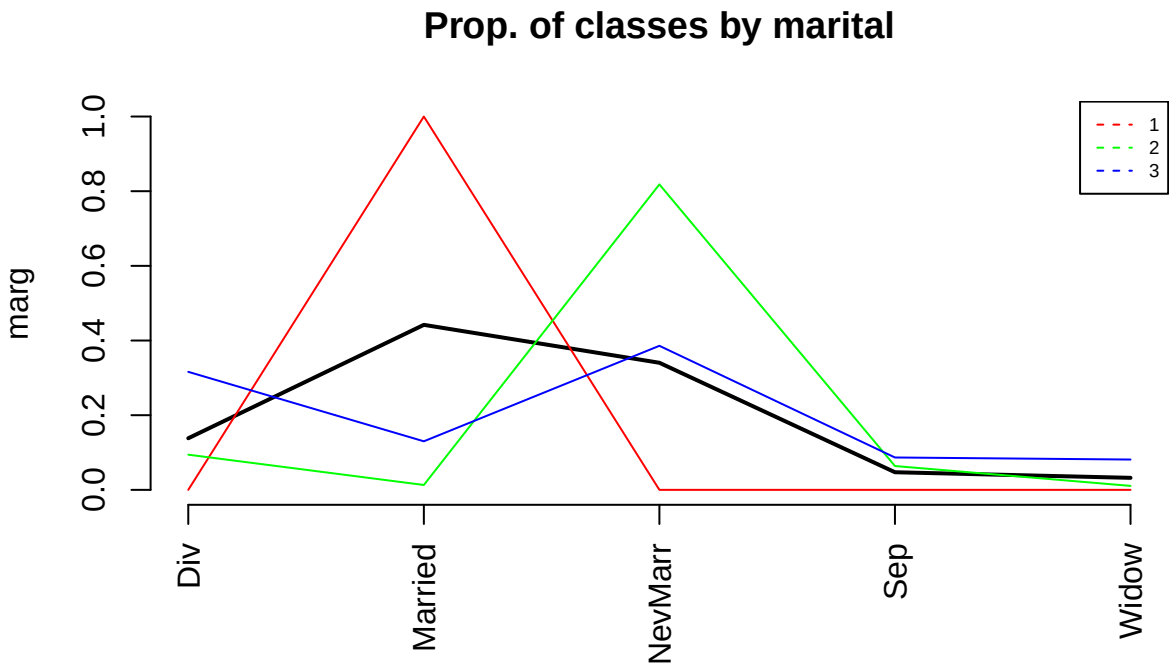

Prop. of classes by marital
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3

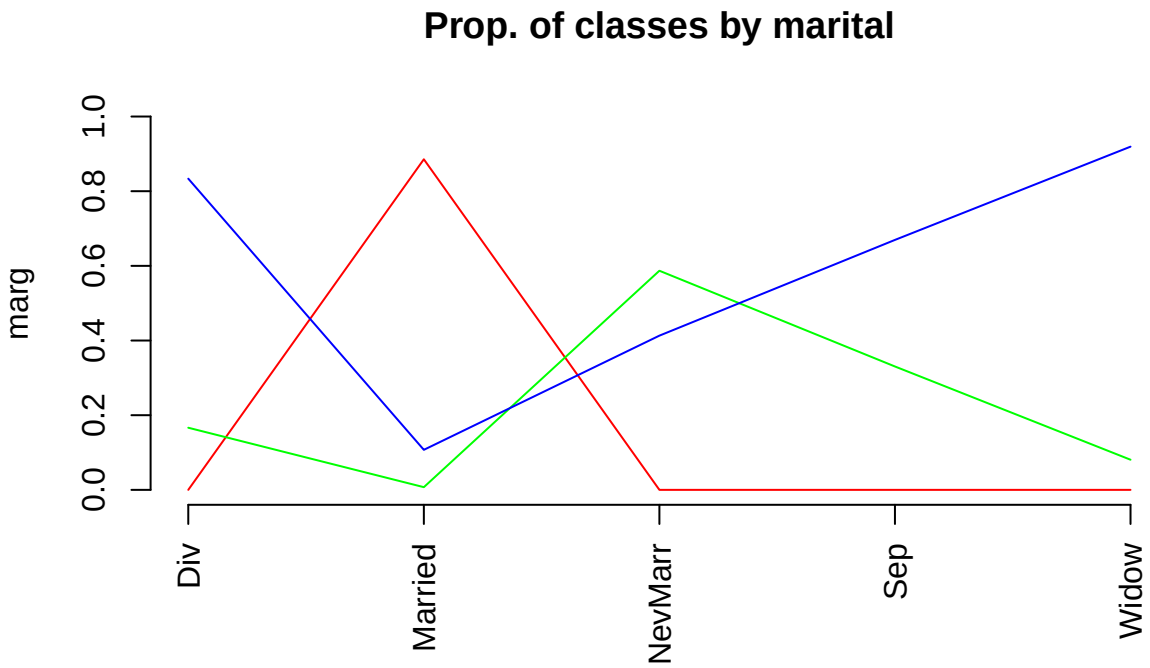


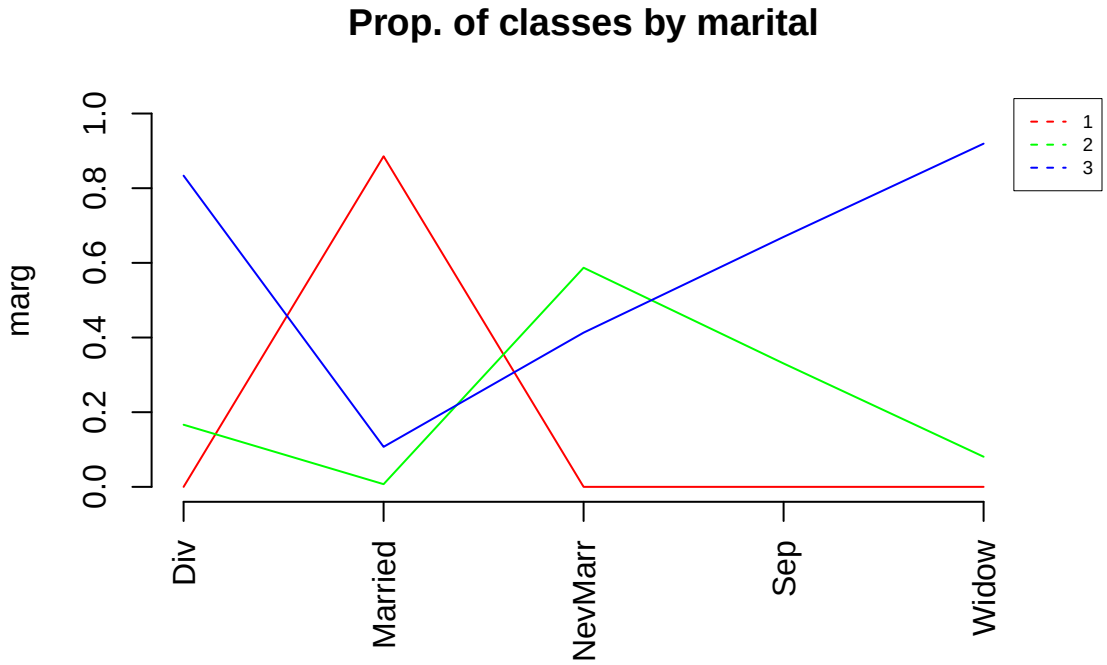

```
## [1] "Categories=" "Div"         "Married"     "NevMarr"     "Sep"
## [6] "Widow"
```



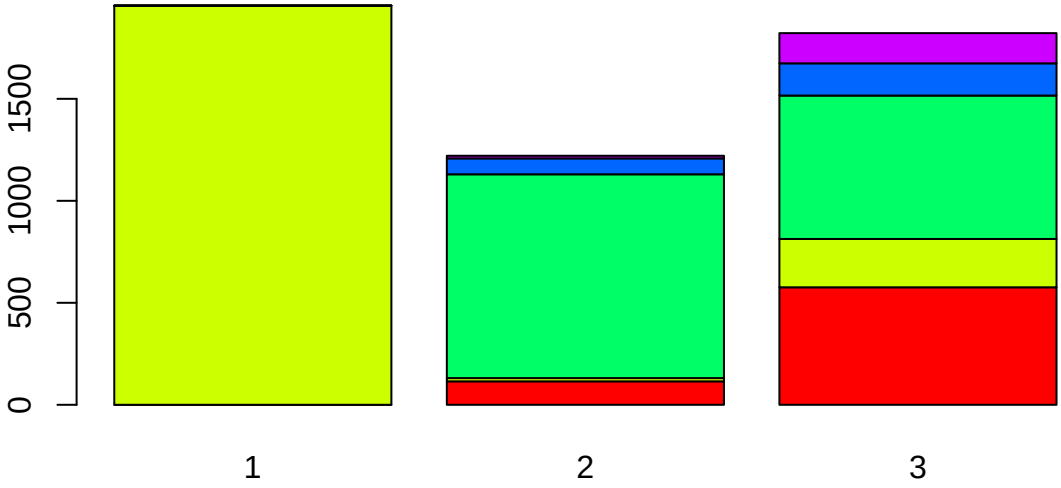

```
## [1] "Categories=" "Div"         "Married"     "NevMarr"     "Sep"
## [6] "Widow"
```

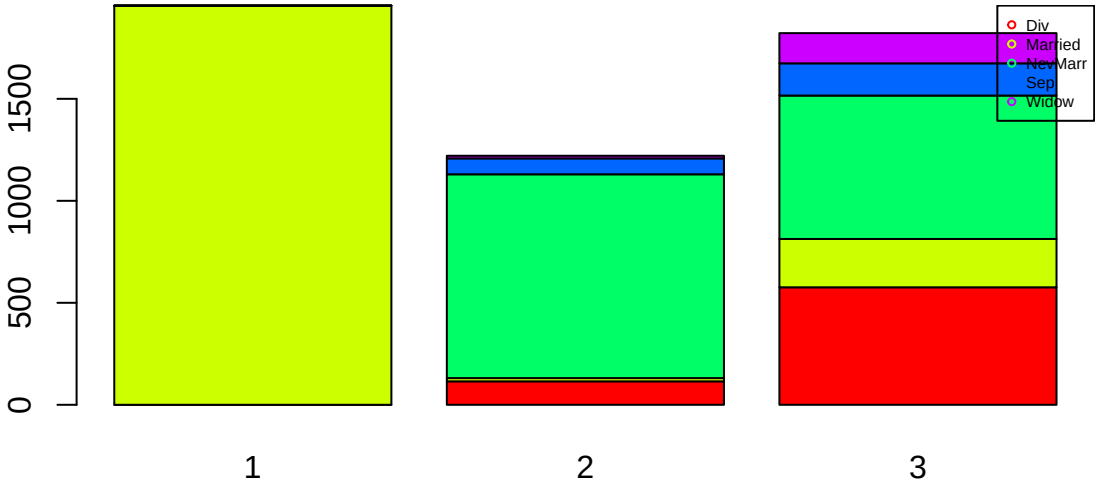

Prop. of classes by marital
marg
0.0
0.2
0.4
0.6
0.8
1.0
Div
Married
NevMarr
Sep
Widow
1
2
3

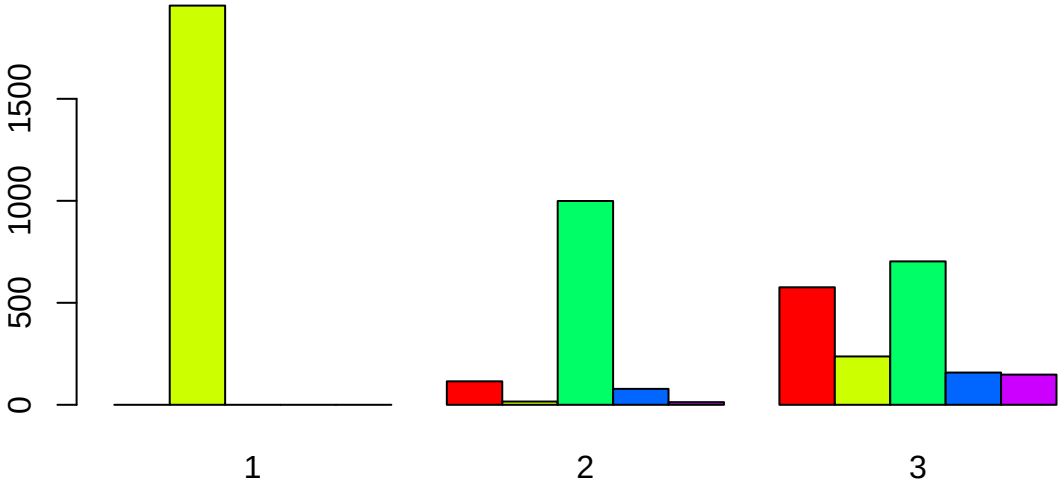

Prop. of classes by marital
marg
0.0
0.2
0.4
0.6
0.8
1.0
Div
Married
NevMarr
Sep
Widow

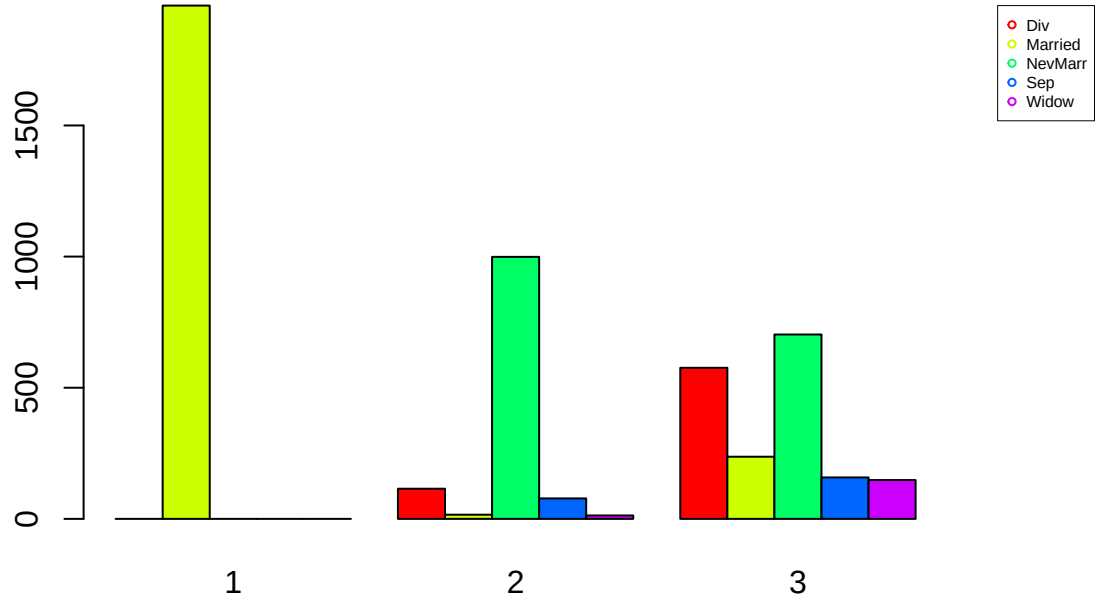



```
## [1] "Cross Table:"
##          P
##              1    2    3
##   Div        0  115  576
##   Married 1957   16  237
##   NevMarr    0  999  703
##   Sep        0   78  158
##   Widow      0   13  148
## [1] "Distribucions condicionades a columnes:"
##
## P           Div     Married     NevMarr         Sep       Widow
##   1 0.000000000 0.885520362 0.000000000 0.000000000 0.000000000
##   2 0.166425470 0.007239819 0.586956522 0.330508475 0.080745342
##   3 0.833574530 0.107239819 0.413043478 0.669491525 0.919254658
```


0
500
1000
1500
1
2
3

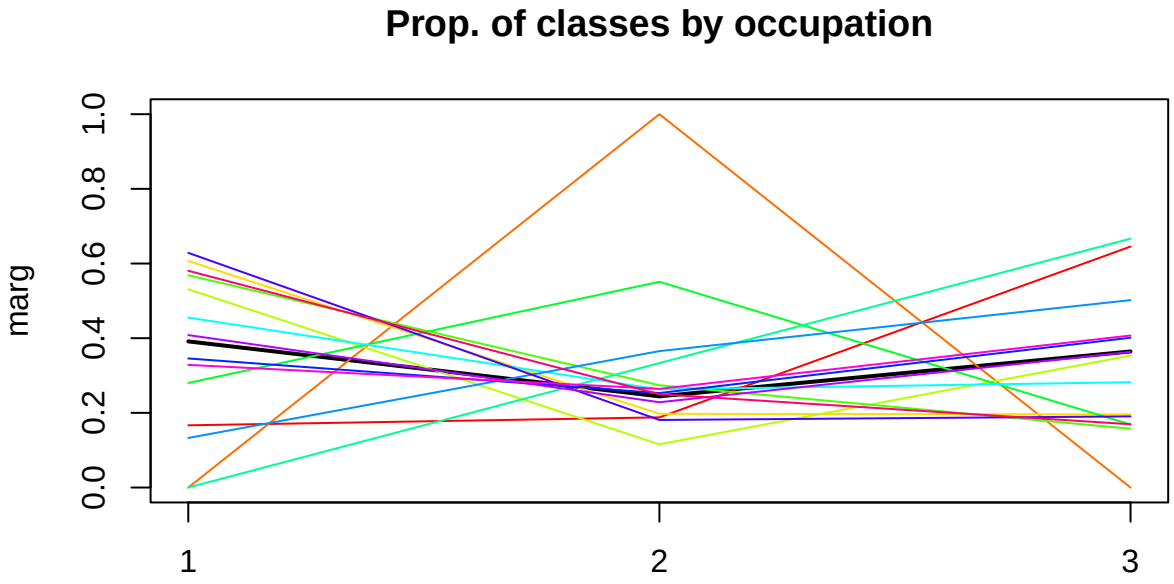

0
500
1000
1500
1
2
3
Div
Married
NewMarr
Sep
Widow

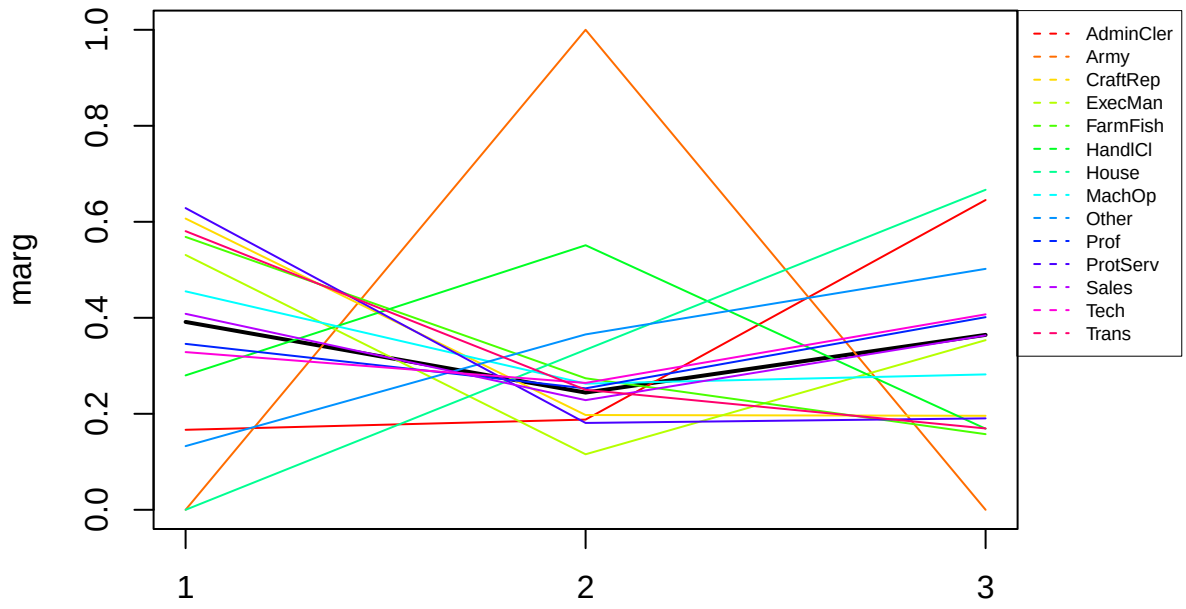

0
500
1000
1500
1
2
3



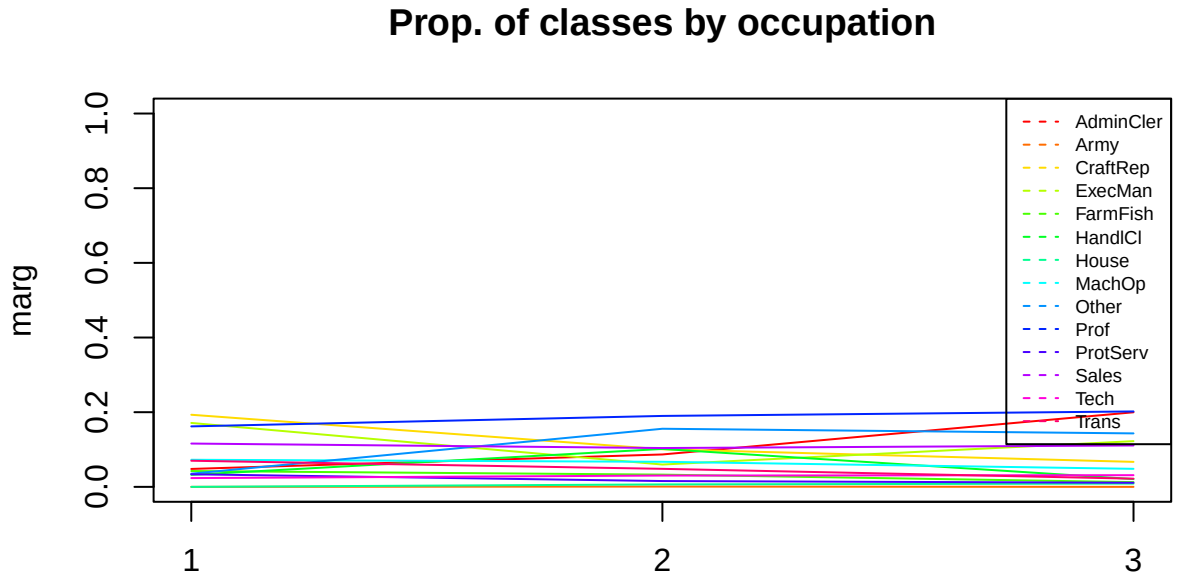

```
## [1] "Test Chi quadrat: "
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 4865.3, df = 8, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P          Div    Married    NevMarr        Sep      Widow
##   1 0.00000000 1.00000000 0.00000000 0.00000000 0.00000000
##   2 0.09418509 0.01310401 0.81818182 0.06388206 0.01064701
##   3 0.31613611 0.13007684 0.38583974 0.08671789 0.08122942
##
## $vtest
##    Xquali
## P          Div    Married    NevMarr        Sep      Widow
##   1 -22.708070  63.714078 -40.736517 -12.621168 -10.343430
##   2  -5.126216 -34.711880  40.527415   3.161785  -4.907284
##   3  27.605084 -33.628046   5.134320   9.977096  14.870249
##
## $pval
##    Xquali
## P             Div       Married       NevMarr           Sep         Widow
##   1  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00  0.000000e+00
```

```
##   2  1.478117e-07  0.000000e+00  0.000000e+00  7.840272e-04  4.617323e-07
##   3 4.834171e-168  0.000000e+00  1.415828e-07  9.600218e-24  2.571091e-50
##
## [1] "Variable occupation"
##  [1] "Categories=" "AdminCler"   "Army"        "CraftRep"    "ExecMan"
##  [6] "FarmFish"    "HandlCl"     "House"       "MachOp"      "Other"
## [11] "Prof"        "ProtServ"    "Sales"       "Tech"        "Trans"
```

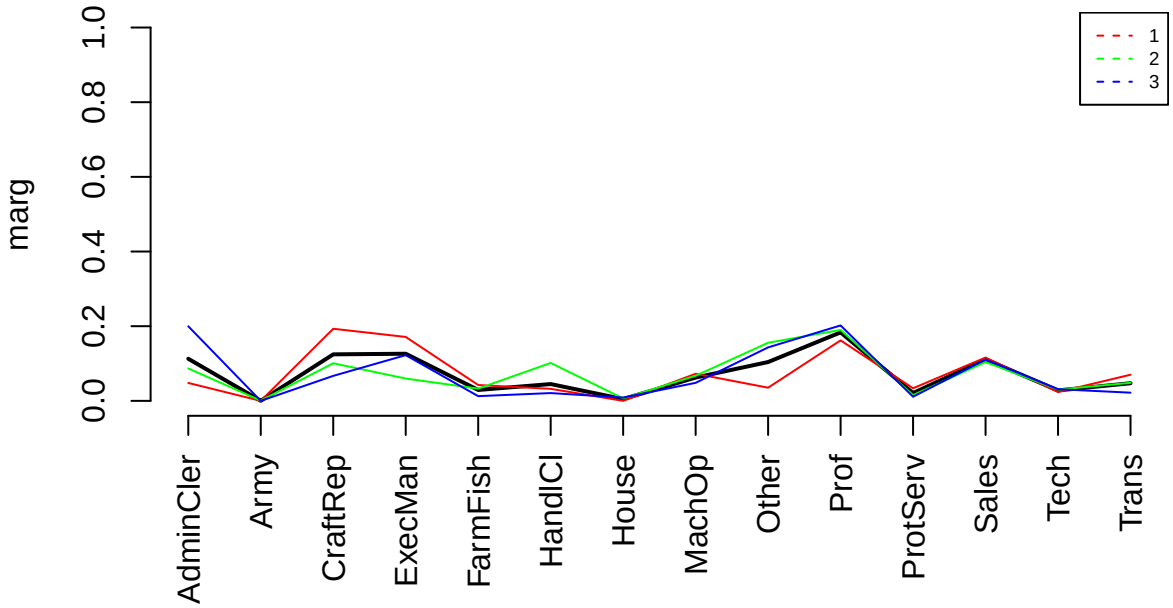


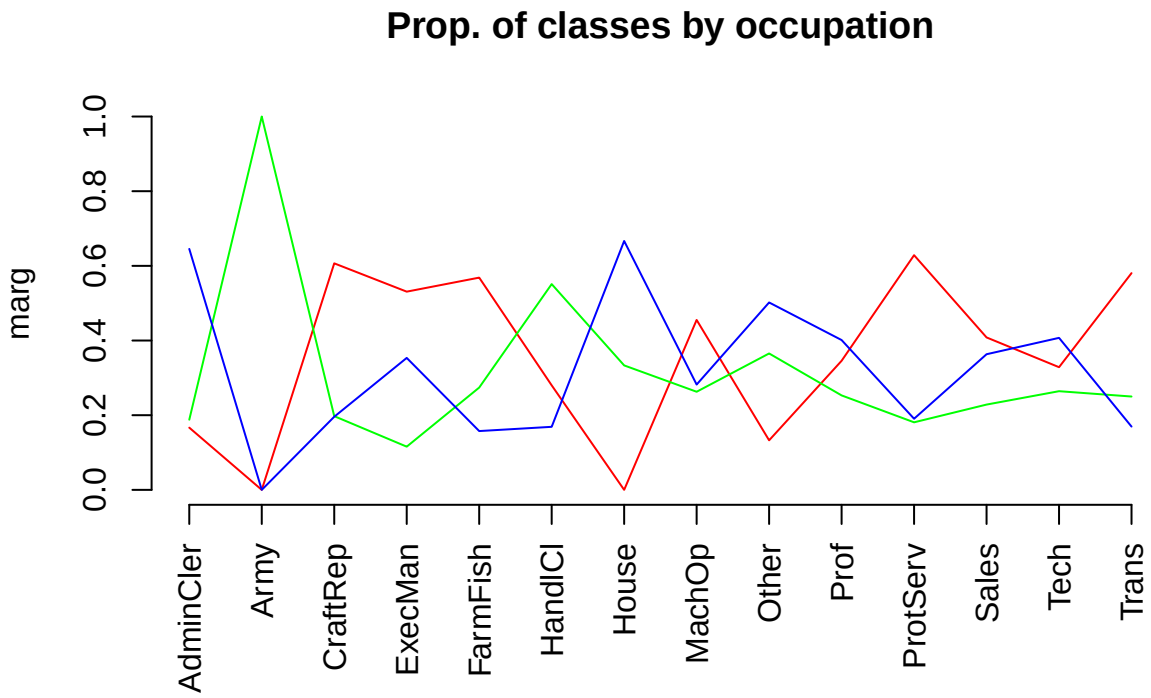


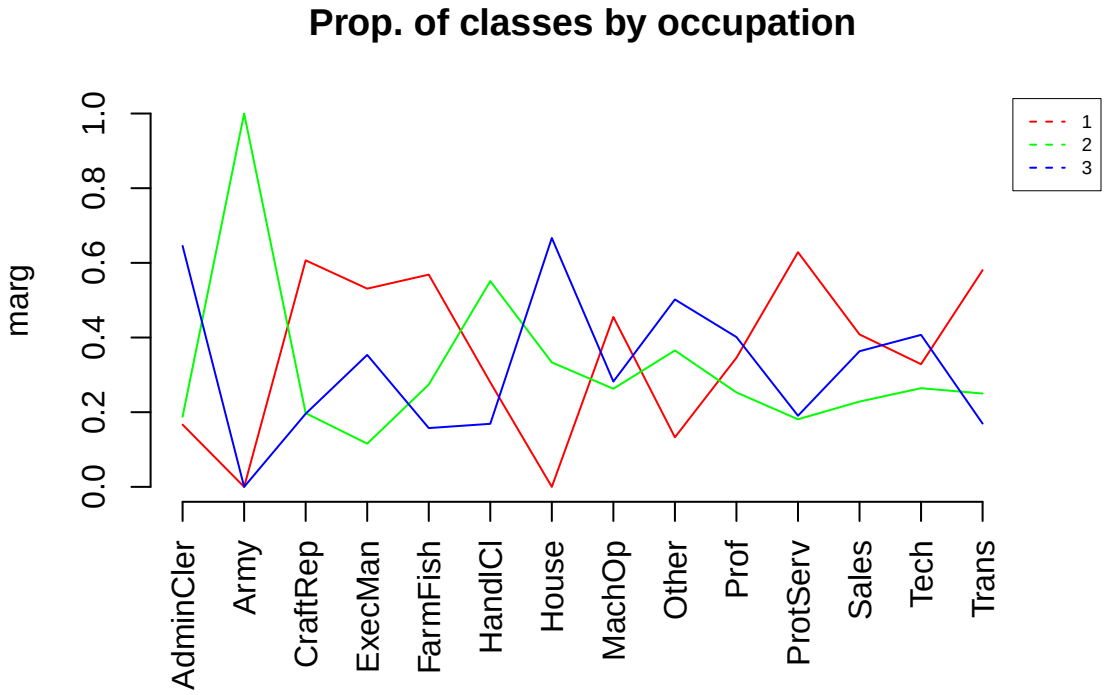

```
##  [1] "Categories=" "AdminCler"   "Army"       "CraftRep"   "ExecMan"
##  [6] "FarmFish"    "HandlCl"     "House"      "MachOp"     "Other"
## [11] "Prof"        "ProtServ"    "Sales"      "Tech"       "Trans"
```




```
##  [1] "Categories=" "AdminCler"   "Army"       "CraftRep"   "ExecMan"
##  [6] "FarmFish"    "HandlCl"     "House"      "MachOp"     "Other"
## [11] "Prof"        "ProtServ"    "Sales"      "Tech"       "Trans"
```

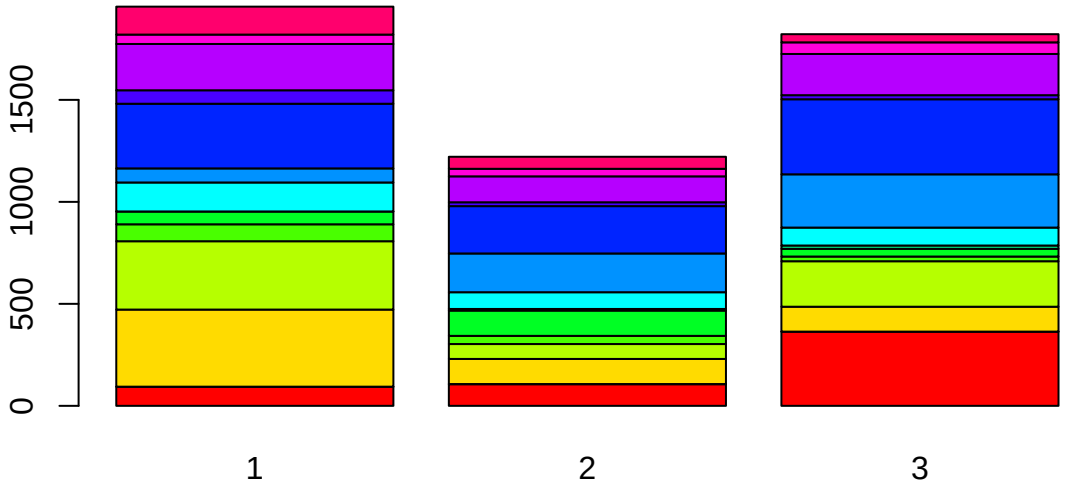

Prop. of classes by occupation
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
AdminCler
Army
CraftRep
ExecMan
FarmFish
HandlCl
House
MachOp
Other
Prof
ProtServ
Sales
Tech
Trans

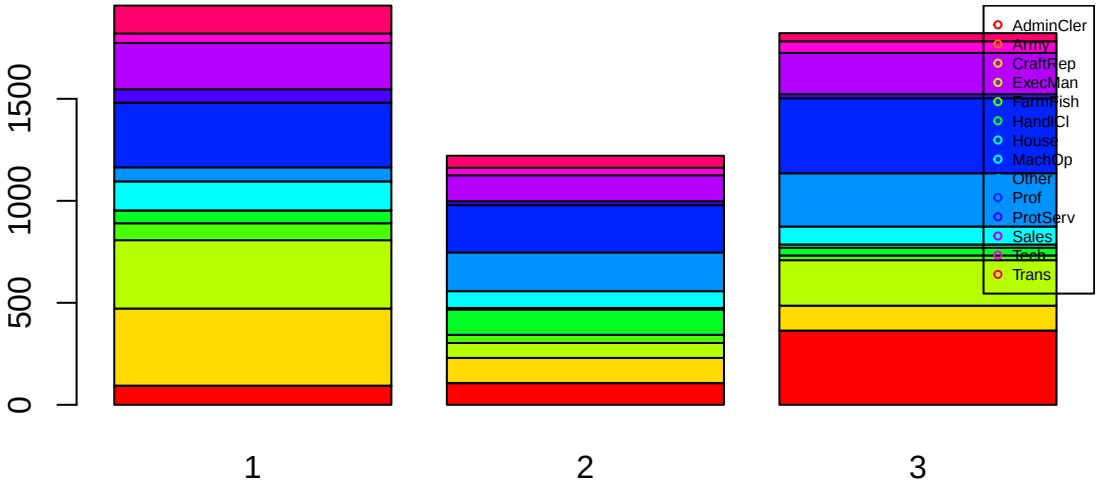

Prop. of classes by occupation
marg
0.0
0.2
0.4
0.6
0.8
1.0
AdminCler
Army
CraftRep
ExecMan
FarmFish
HandlCl
House
MachOp
Other
Prof
ProtServ
Sales
Tech
Trans

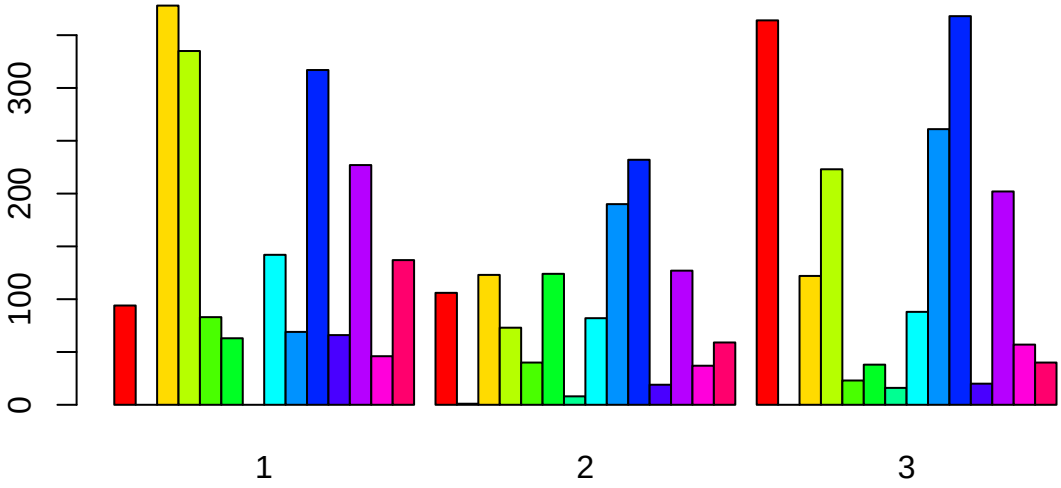


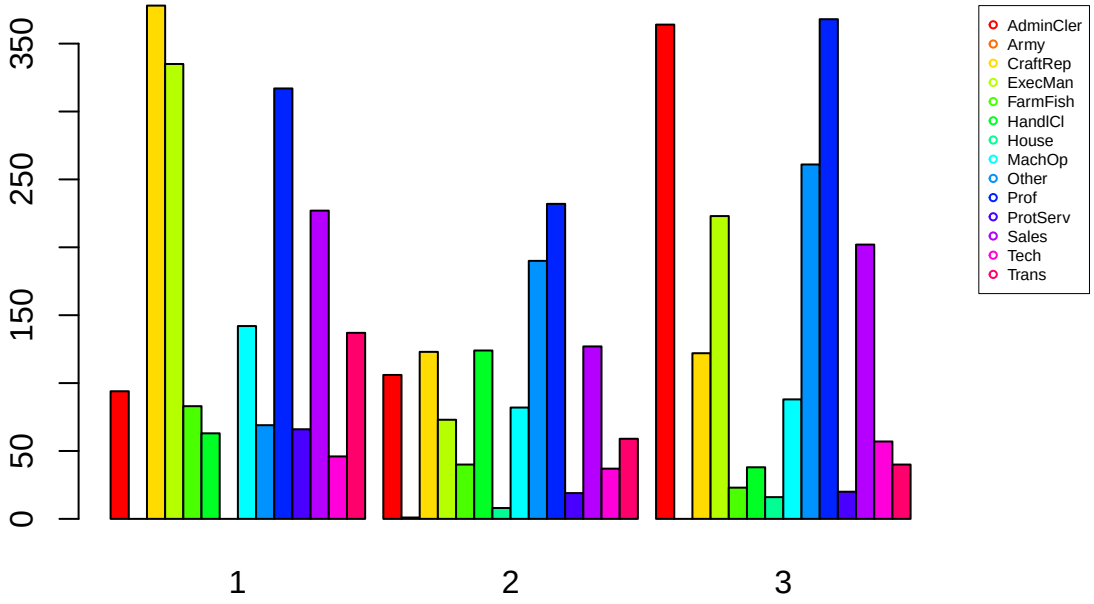

```
## [1] "Cross Table:"
##             P
##                1   2   3
##   AdminCler   94 106 364
##   Army         0   1   0
##   CraftRep   378 123 122
##   ExecMan    335  73 223
##   FarmFish    83  40  23
##   HandlCl     63 124  38
##   House        0   8  16
##   MachOp     142  82  88
##   Other       69 190 261
##   Prof       317 232 368
##   ProtServ    66  19  20
##   Sales      227 127 202
##   Tech        46  37  57
##   Trans      137  59  40
## [1] "Distribucions condicionades a columnes:"
##
## P   AdminCler      Army  CraftRep   ExecMan  FarmFish   HandlCl     House
##   1 0.1666667 0.0000000 0.6067416 0.5309033 0.5684932 0.2800000 0.0000000
##   2 0.1879433 1.0000000 0.1974318 0.1156894 0.2739726 0.5511111 0.3333333
##   3 0.6453901 0.0000000 0.1958266 0.3534073 0.1575342 0.1688889 0.6666667
##
## P      MachOp     Other      Prof  ProtServ     Sales      Tech     Trans
##   1 0.4551282 0.1326923 0.3456925 0.6285714 0.4082734 0.3285714 0.5805085
```

```
##    2 0.2628205 0.3653846 0.2529989 0.1809524 0.2284173 0.2642857 0.2500000
##    3 0.2820513 0.5019231 0.4013086 0.1904762 0.3633094 0.4071429 0.1694915
```



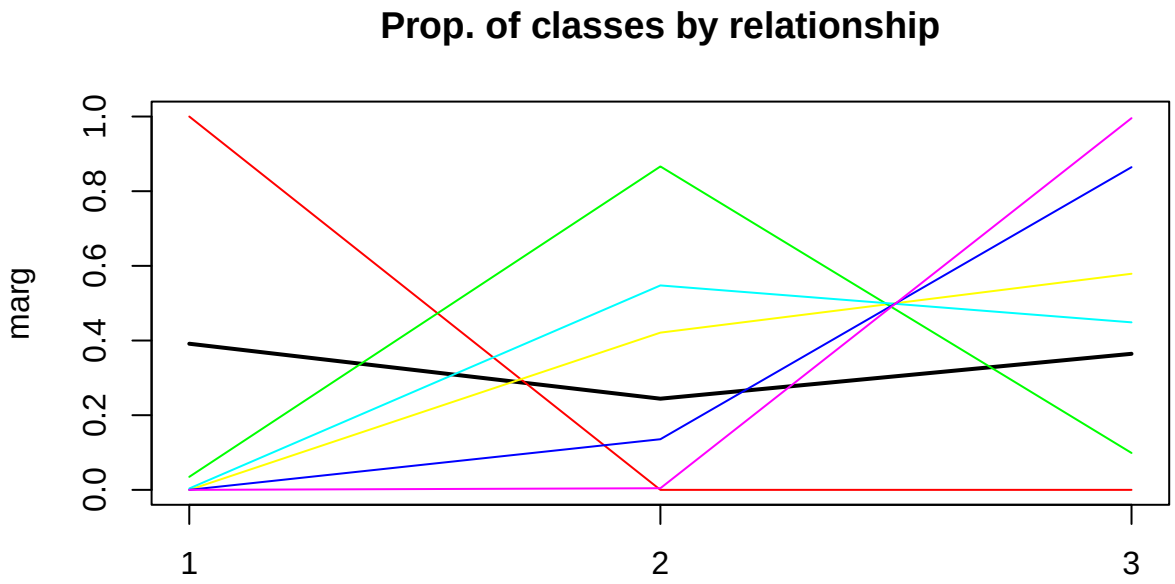

0
500
1000
1500
1
2
3
AdminCler
Army
CraftRep
ExecMan
FarmFish
HandCl
House
MachOp
Other
Prof
ProtServ
Sales
Tech
Trans

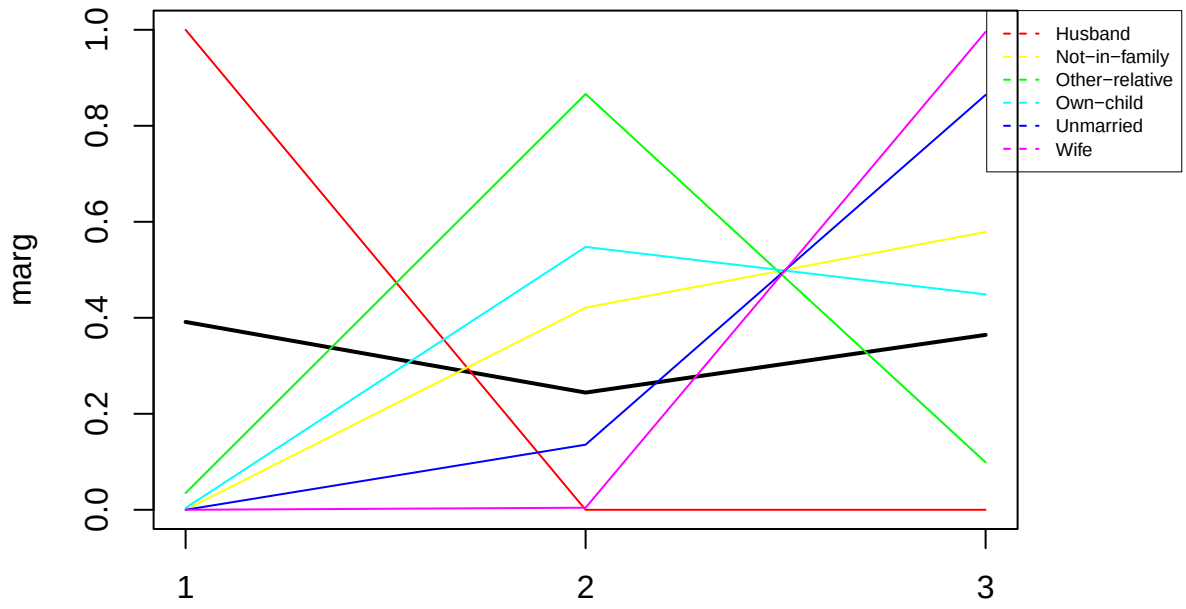

0
100
200
300
1
2
3



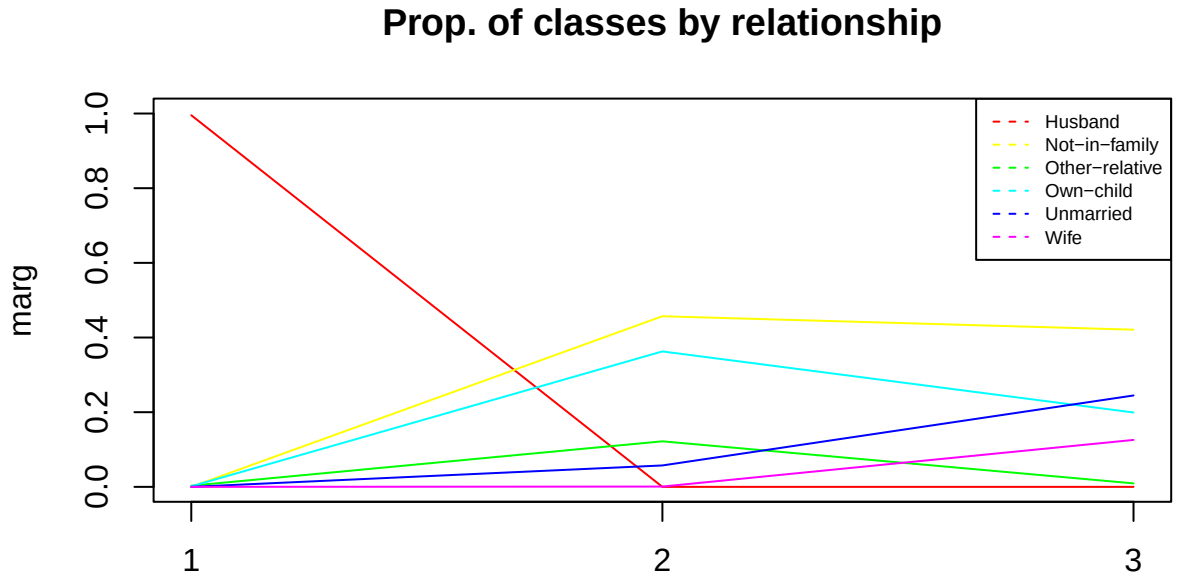

```
## [1] "Test Chi quadrat: "
## Warning in chisq.test(dades[, k], as.factor(P)): Chi-squared approximation may
## be incorrect
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 811.03, df = 26, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P       AdminCler          Army     CraftRep      ExecMan     FarmFish
##   1 0.0480327031 0.0000000000 0.1931527849 0.1711803781 0.0424118549
##   2 0.0868140868 0.0008190008 0.1007371007 0.0597870598 0.0327600328
##   3 0.1997804610 0.0000000000 0.0669593853 0.1223929748 0.0126234907
##    Xquali
## P         HandlCl        House       MachOp        Other         Prof
##   1 0.0321921308 0.0000000000 0.0725600409 0.0352580480 0.1619826265
##   2 0.1015561016 0.0065520066 0.0671580672 0.1556101556 0.1900081900
##   3 0.0208562020 0.0087815587 0.0482985730 0.1432491767 0.2019758507
##    Xquali
## P        ProtServ        Sales         Tech        Trans
##   1 0.0337250894 0.1159938682 0.0235053654 0.0700051099
##   2 0.0155610156 0.1040131040 0.0303030303 0.0483210483
```

```
##   3 0.0109769484 0.1108671789 0.0312843030 0.0219538968
##
## $vtest
##    Xquali
## P      AdminCler         Army     CraftRep      ExecMan     FarmFish
##   1 -11.60967051  -0.80202493  11.77042783   7.68098370   4.44976345
##   2  -3.30161976   1.75943833  -2.90412499  -8.03843303   0.84986917
##   3  14.72104468  -0.75725243  -9.34433831  -0.61380766  -5.27131555
##    Xquali
## P        HandlCl        House       MachOp        Other         Prof
##   1  -3.50346981  -3.93817376   2.38190151 -12.76969794  -3.13827716
##   2  10.96543617   1.01885953   0.79064925   6.79546034   0.68632933
##   3  -6.23562355   3.08432096  -3.12136252   6.88401993   2.56996140
##    Xquali
## P       ProtServ        Sales         Tech        Trans
##   1   5.03256379   0.86469134  -1.54494024   6.09803249
##   2  -1.52465370  -0.91884304   0.56110210   0.21247452
##   3  -3.74266723  -0.05668115   1.06589225  -6.37389231
##
## $pval
##    Xquali
## P      AdminCler         Army     CraftRep      ExecMan     FarmFish
##   1 0.000000e+00 2.112693e-01 2.772131e-32 7.893579e-15 4.298246e-06
##   2 4.806414e-04 3.925154e-02 1.841406e-03 4.440892e-16 1.976989e-01
##   3 2.361536e-49 2.244493e-01 0.000000e+00 2.696712e-01 6.772468e-08
##    Xquali
## P        HandlCl        House       MachOp        Other         Prof
##   1 2.296194e-04 4.105207e-05 8.611752e-03 0.000000e+00 8.497205e-04
##   2 2.801487e-28 1.541348e-01 2.145744e-01 5.398361e-12 2.462527e-01
##   3 2.249910e-10 1.020087e-03 9.000814e-04 2.909336e-12 5.085492e-03
##    Xquali
## P       ProtServ        Sales         Tech        Trans
##   1 2.419817e-07 1.936041e-01 6.118036e-02 5.369096e-10
##   2 6.367275e-02 1.790888e-01 2.873640e-01 4.158684e-01
##   3 9.103864e-05 4.773996e-01 1.432362e-01 9.214496e-11
##
## [1] "Variable relationship"
## [1] "Categories="    "Husband"        "Not-in-family"  "Other-relative"
## [5] "Own-child"      "Unmarried"      "Wife"
```

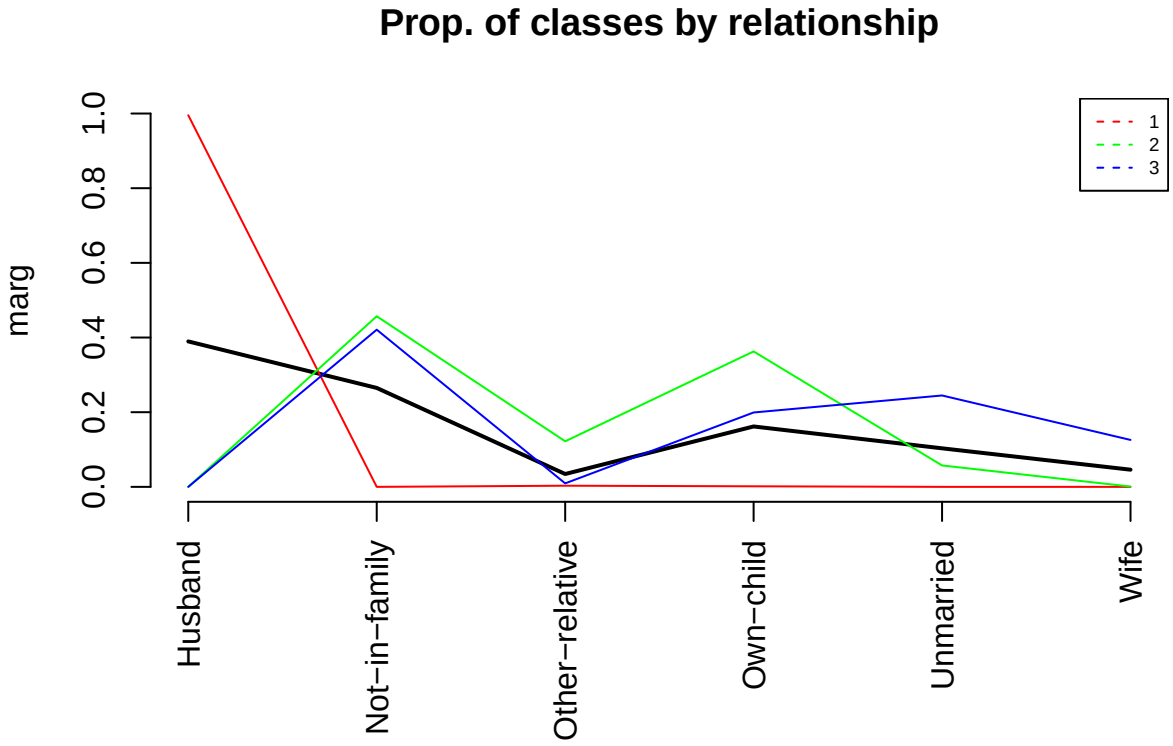

Prop. of classes by relationship
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3

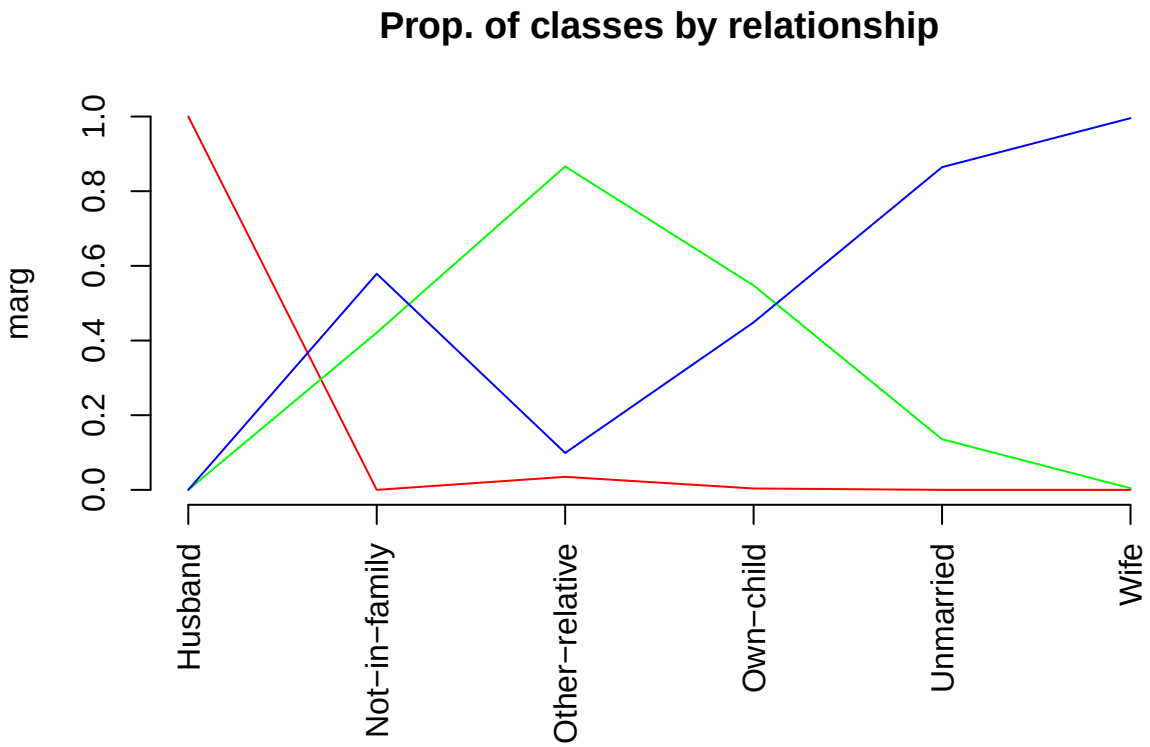


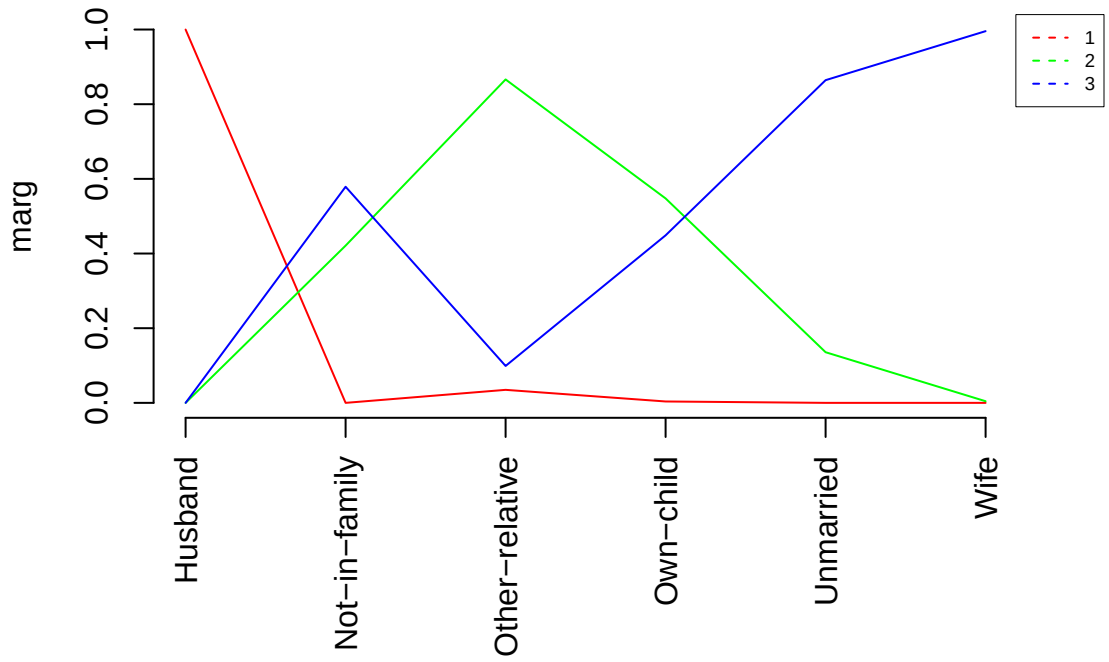

```
## [1] "Categories="    "Husband"        "Not-in-family"  "Other-relative"
## [5] "Own-child"      "Unmarried"      "Wife"
```



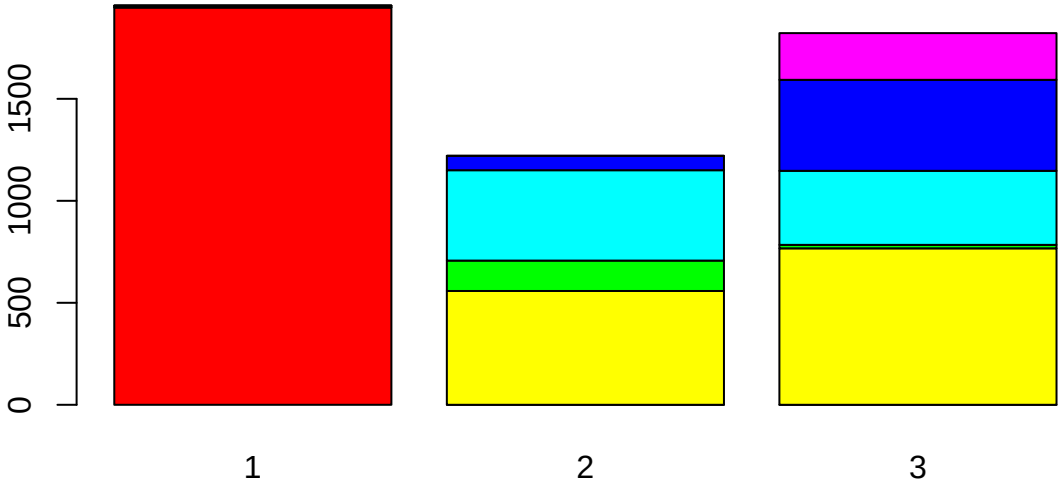

```
## [1] "Categories="    "Husband"        "Not-in-family"  "Other-relative"
## [5] "Own-child"      "Unmarried"      "Wife"
```

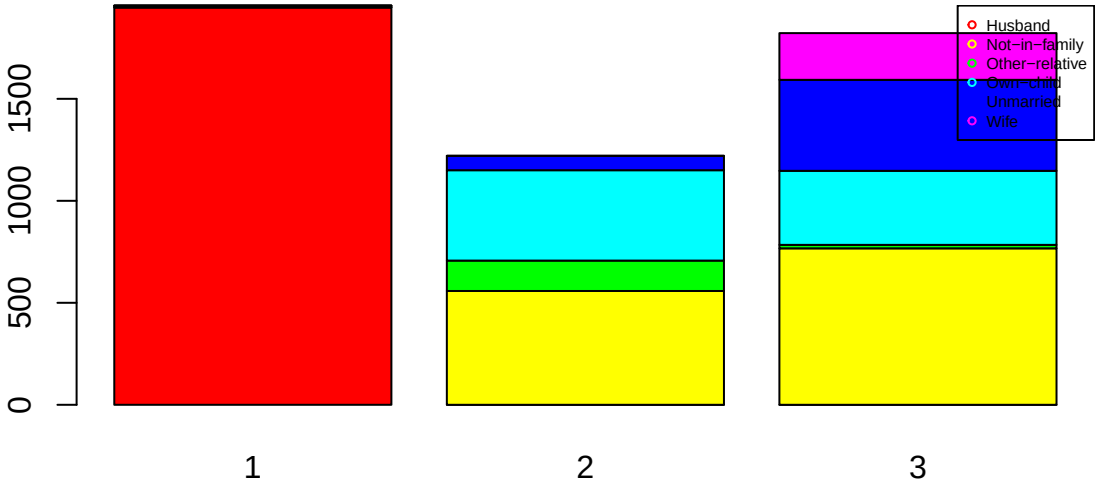

Prop. of classes by relationship
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
Husband
Not−in−family
Other−relative
Own−child
Unmarried
Wife

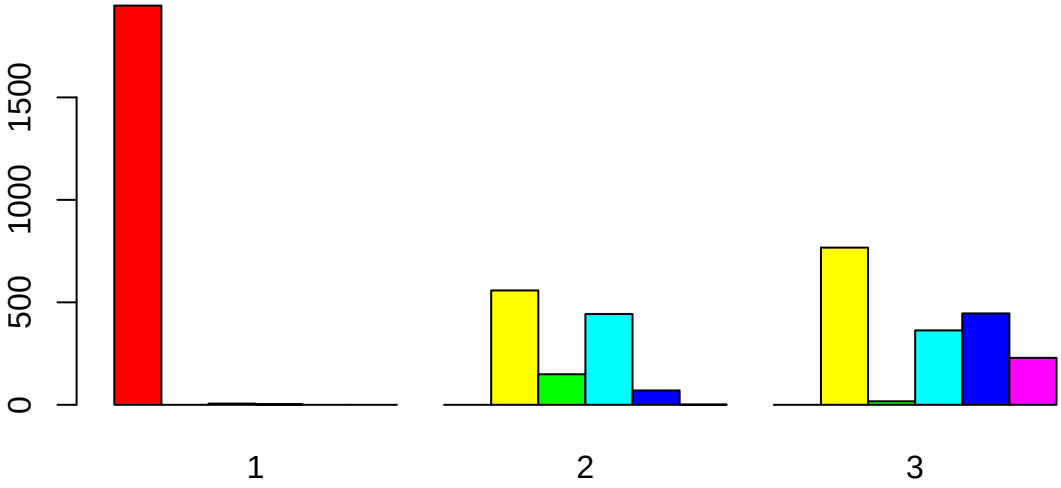

Prop. of classes by relationship
marg
0.0
0.2
0.4
0.6
0.8
1.0
Husband
Not−in−family
Other−relative
Own−child
Unmarried
Wife

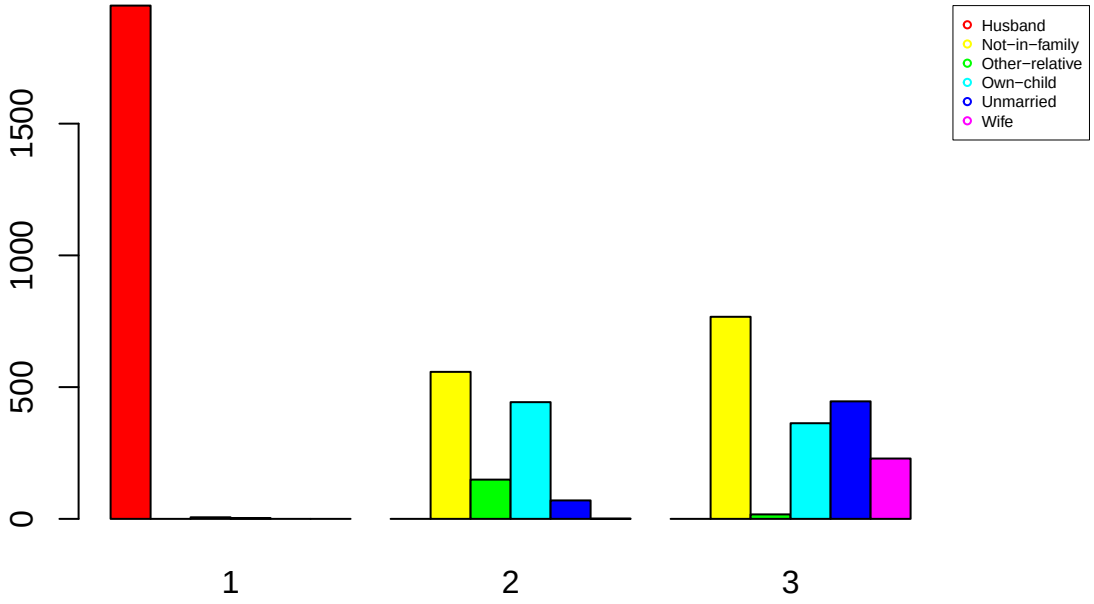



```
## [1] "Cross Table:"
##                  P
##                     1    2    3
##   Husband        1948    0    0
##   Not-in-family     0  558  767
##   Other-relative    6  149   17
##   Own-child         3  443  363
##   Unmarried         0   70  446
##   Wife              0    1  229
## [1] "Distribucions condicionades a columnes:"
##
## P       Husband Not-in-family Other-relative   Own-child   Unmarried
##   1 1.000000000   0.000000000    0.034883721 0.003708282 0.000000000
##   2 0.000000000   0.421132075    0.866279070 0.547589617 0.135658915
##   3 0.000000000   0.578867925    0.098837209 0.448702101 0.864341085
##
## P          Wife
##   1 0.000000000
##   2 0.004347826
##   3 0.995652174
```


0
500
1000
1500
1
2
3

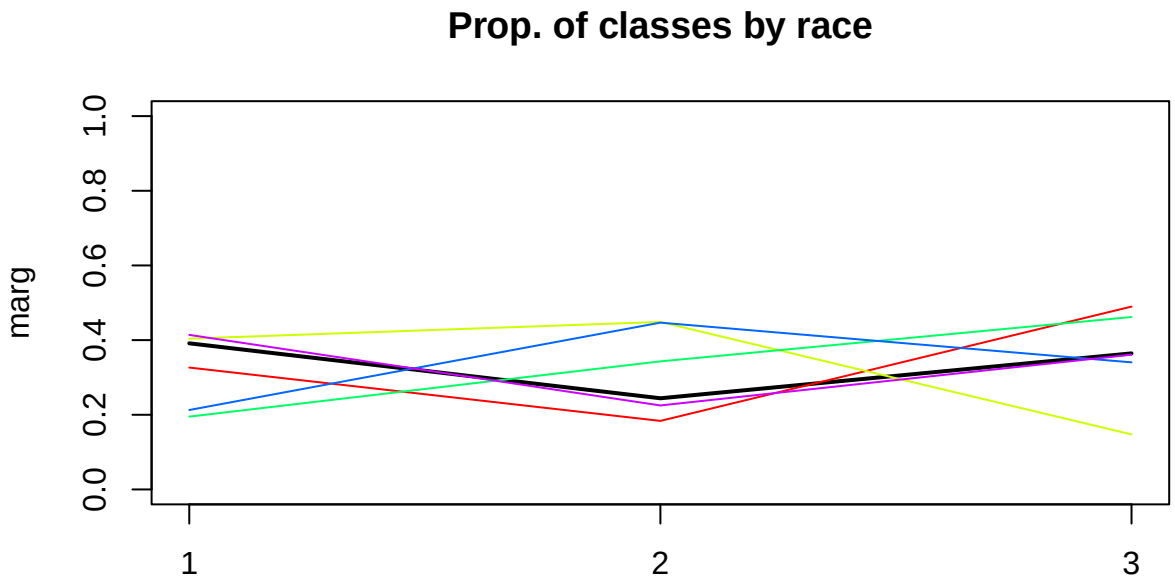

0
500
1000
1500
1
2
3
Husband
Not−in−family
Other−relative
Own−child
Unmarried
Wife

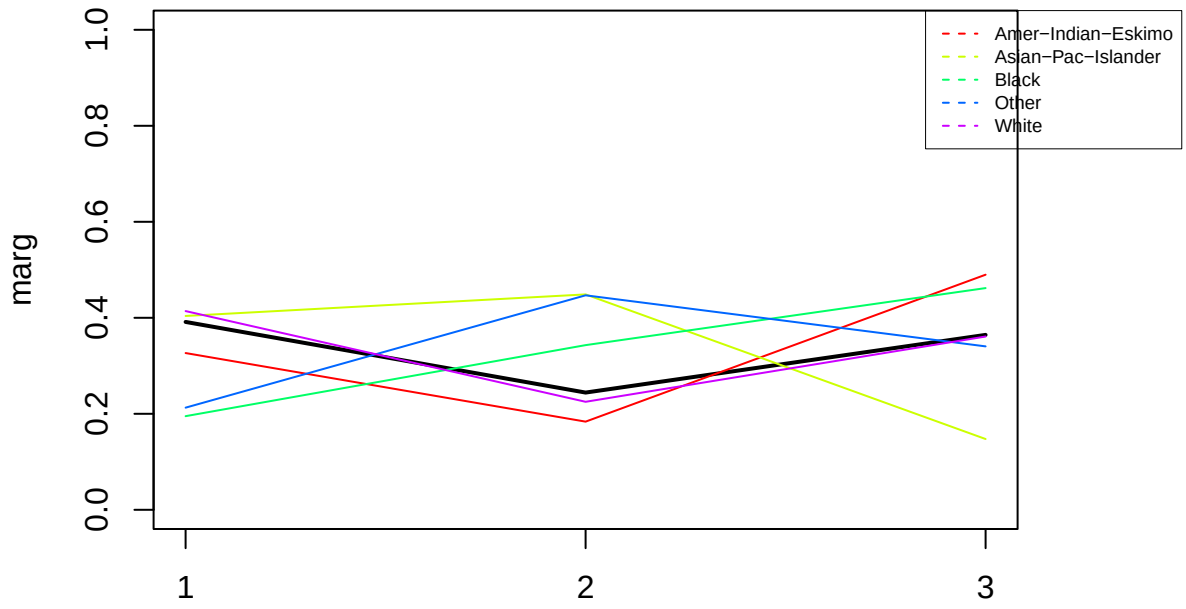

0
500
1000
1500
1
2
3



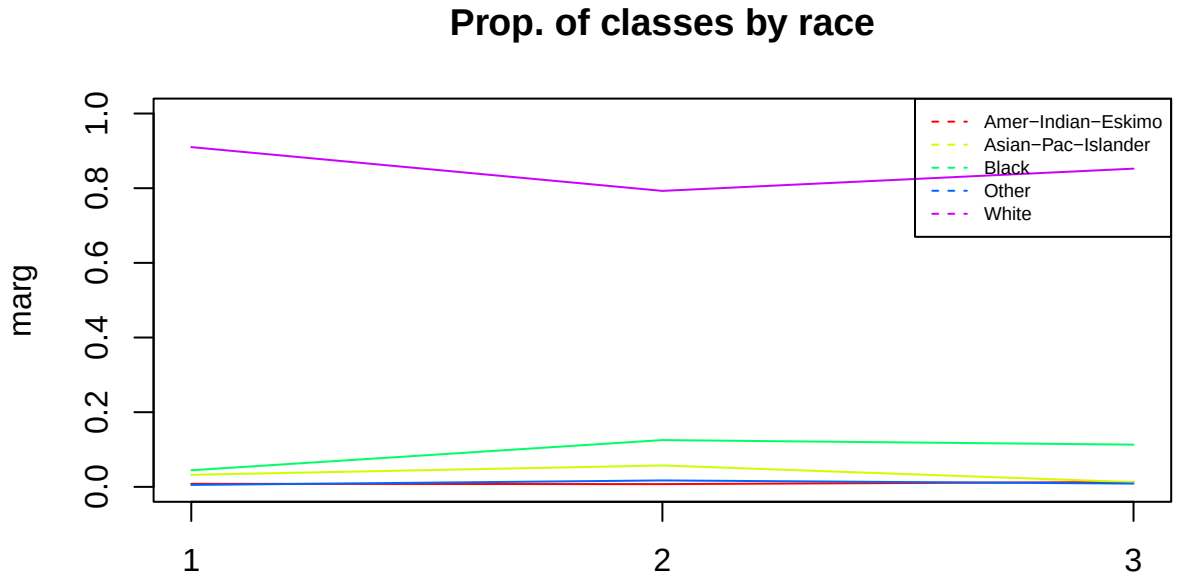

```
## [1] "Test Chi quadrat: "
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 5854.3, df = 10, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P        Husband Not-in-family Other-relative    Own-child    Unmarried
##   1 0.9954011242  0.0000000000   0.0030659172 0.0015329586 0.0000000000
##   2 0.0000000000  0.4570024570   0.1220311220 0.3628173628 0.0573300573
##   3 0.0000000000  0.4209659715   0.0093304061 0.1992316136 0.2447859495
##    Xquali
## P           Wife
##   1 0.0000000000
##   2 0.0008190008
##   3 0.1256860593
##
## $vtest
##    Xquali
## P      Husband Not-in-family Other-relative  Own-child  Unmarried       Wife
##   1  70.443800    -34.049341      -9.749191 -24.678035 -19.236298 -12.451858
##   2 -32.111205     17.486165      19.325686  21.939406  -6.060311  -8.668763
##   3 -42.774452     18.921061      -7.364643   5.441990  24.918090  20.366270
```

```
##
## $pval
##    Xquali
## P         Husband Not-in-family Other-relative     Own-child     Unmarried
##   1  0.000000e+00  0.000000e+00   0.000000e+00  0.000000e+00  0.000000e+00
##   2  0.000000e+00  9.132125e-69   1.633078e-83 5.465957e-107  6.792915e-10
##   3  0.000000e+00  3.824933e-80   8.881784e-14  2.634438e-08 2.368874e-137
##    Xquali
## P            Wife
##   1  0.000000e+00
##   2  0.000000e+00
##   3  1.665531e-92
##
## [1] "Variable race"
## [1] "Categories="        "Amer-Indian-Eskimo" "Asian-Pac-Islander"
## [4] "Black"              "Other"              "White"
```

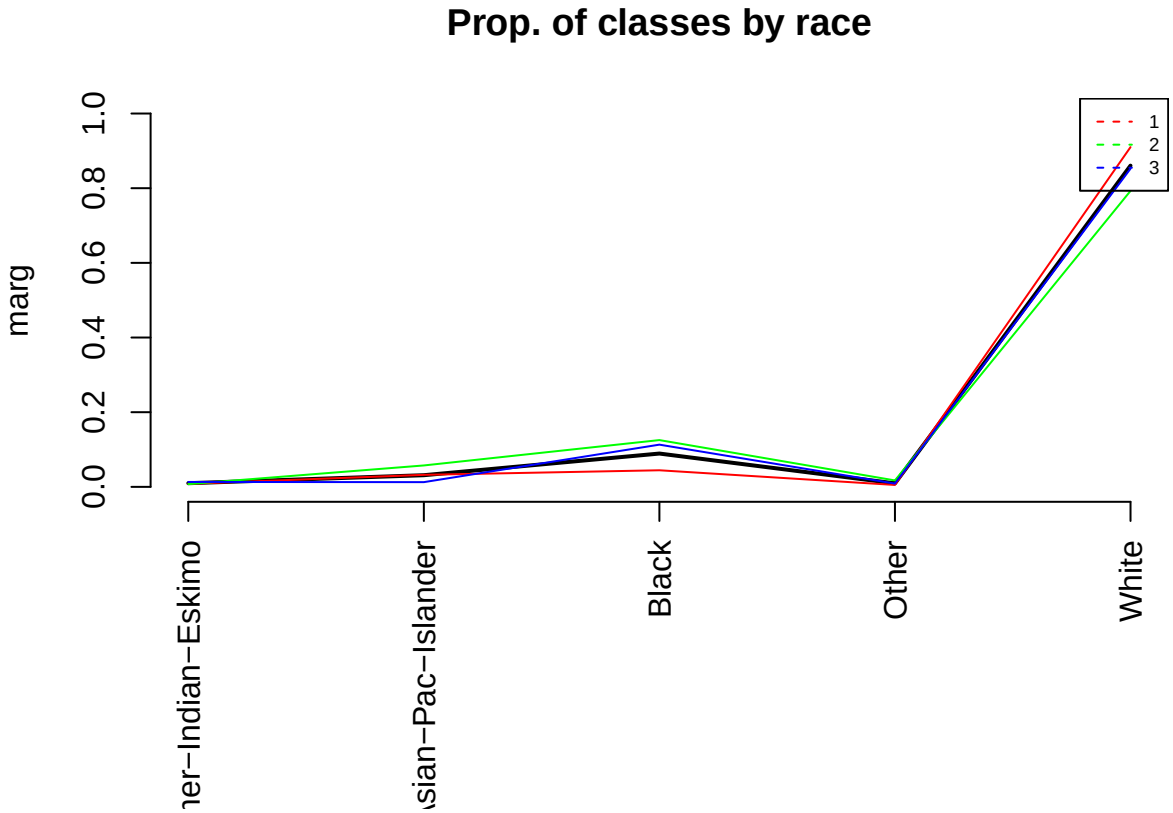


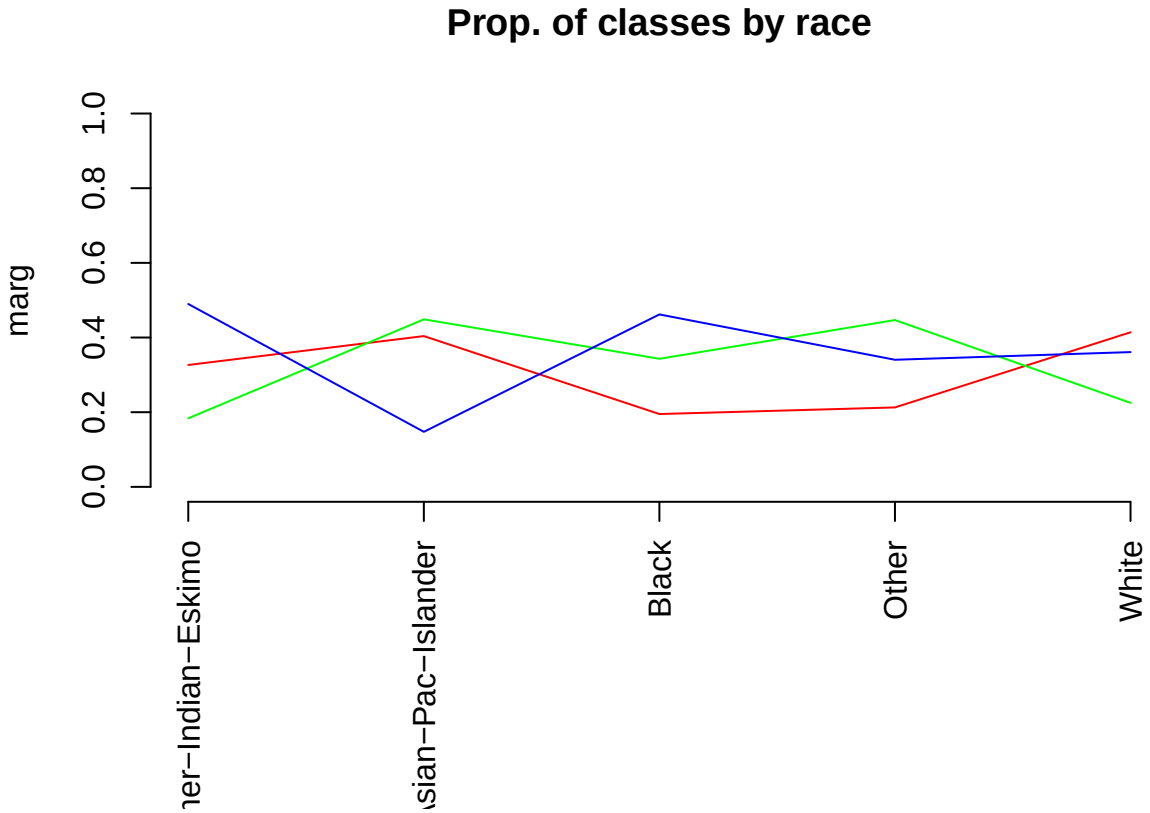


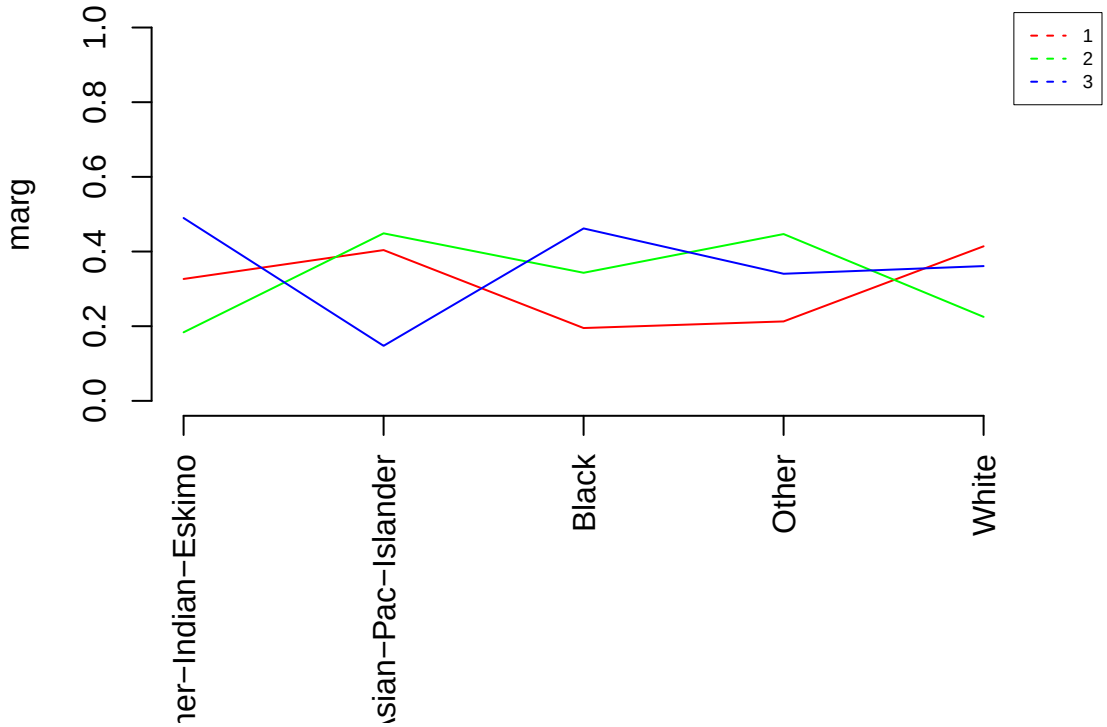

```
## [1] "Categories="        "Amer-Indian-Eskimo" "Asian-Pac-Islander"
## [4] "Black"              "Other"              "White"
```



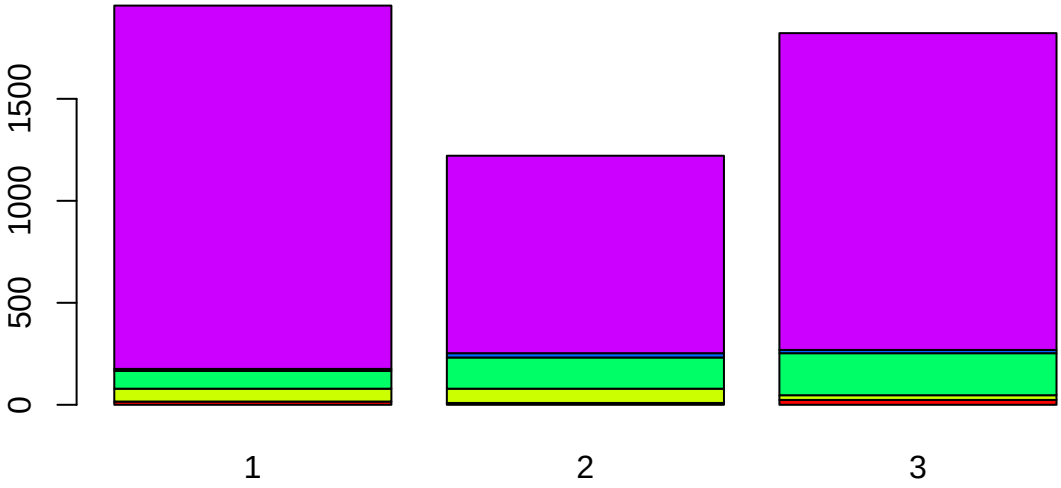

```
## [1] "Categories="        "Amer-Indian-Eskimo" "Asian-Pac-Islander"
## [4] "Black"              "Other"              "White"
```

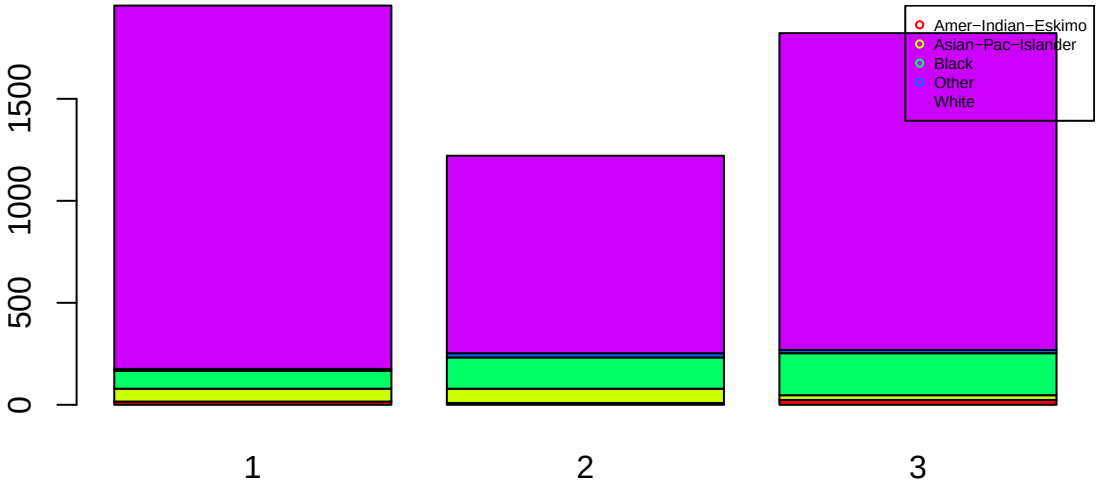

Prop. of classes by race
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3
ner−Indian−Eskimo
sian−Pac−Islander
Black
Other
White

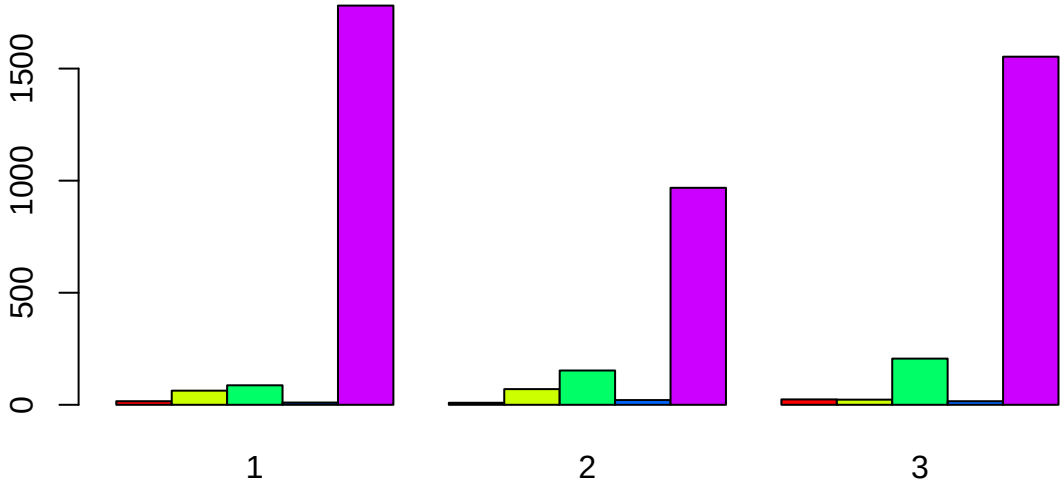

Prop. of classes by race
marg
0.0
0.2
0.4
0.6
0.8
1.0
ner−Indian−Eskimo
sian−Pac−Islander
Black
Other
White

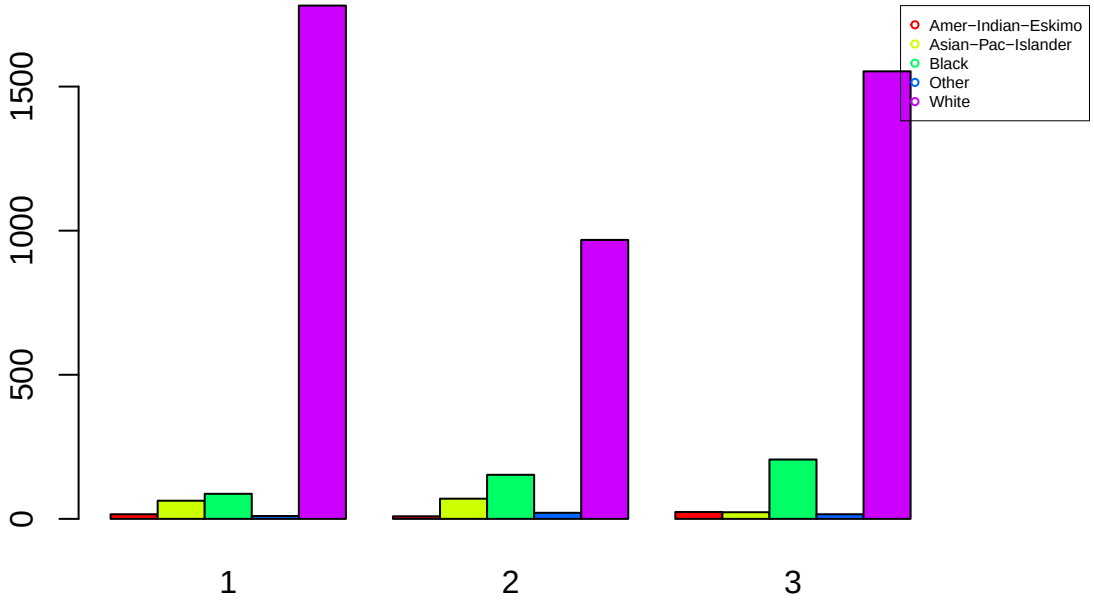



```
## [1] "Cross Table:"
##                       P
##                         1    2    3
##   Amer-Indian-Eskimo   16    9   24
##   Asian-Pac-Islander   63   70   23
##   Black                87  153  206
##   Other                10   21   16
##   White              1781  968 1553
## [1] "Distribucions condicionades a columnes:"
##
## P   Amer-Indian-Eskimo Asian-Pac-Islander     Black     Other     White
##   1          0.3265306          0.4038462 0.1950673 0.2127660 0.4139935
##   2          0.1836735          0.4487179 0.3430493 0.4468085 0.2250116
##   3          0.4897959          0.1474359 0.4618834 0.3404255 0.3609949
```


0
500
1000
1500
1
2
3

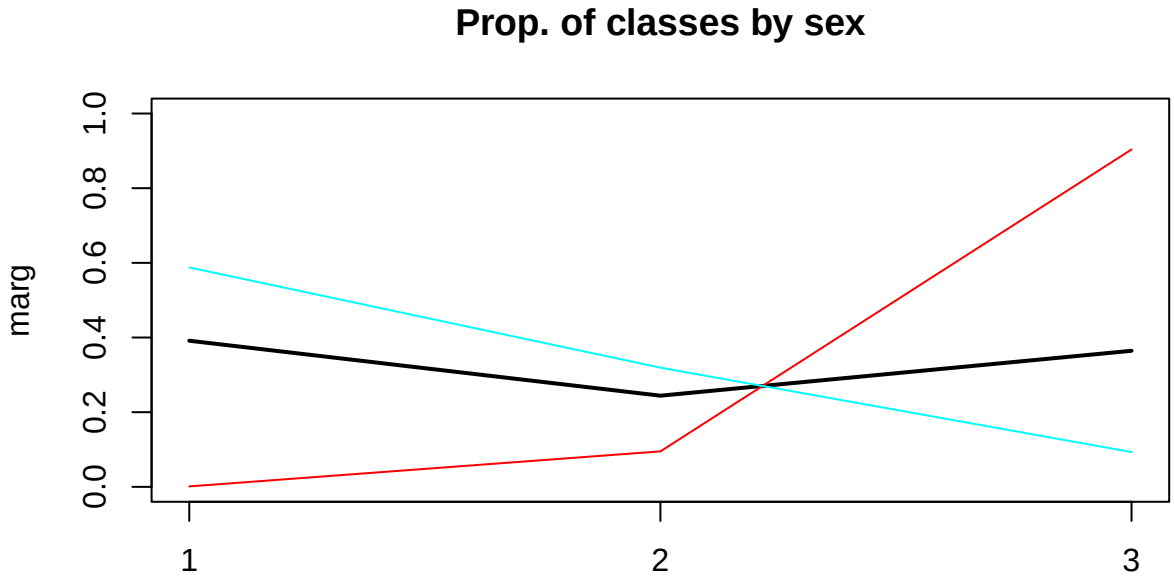

Amer−Indian−Eskimo
Asian−Pac−Islander
Black
Other
White
0
500
1000
1500
1
2
3

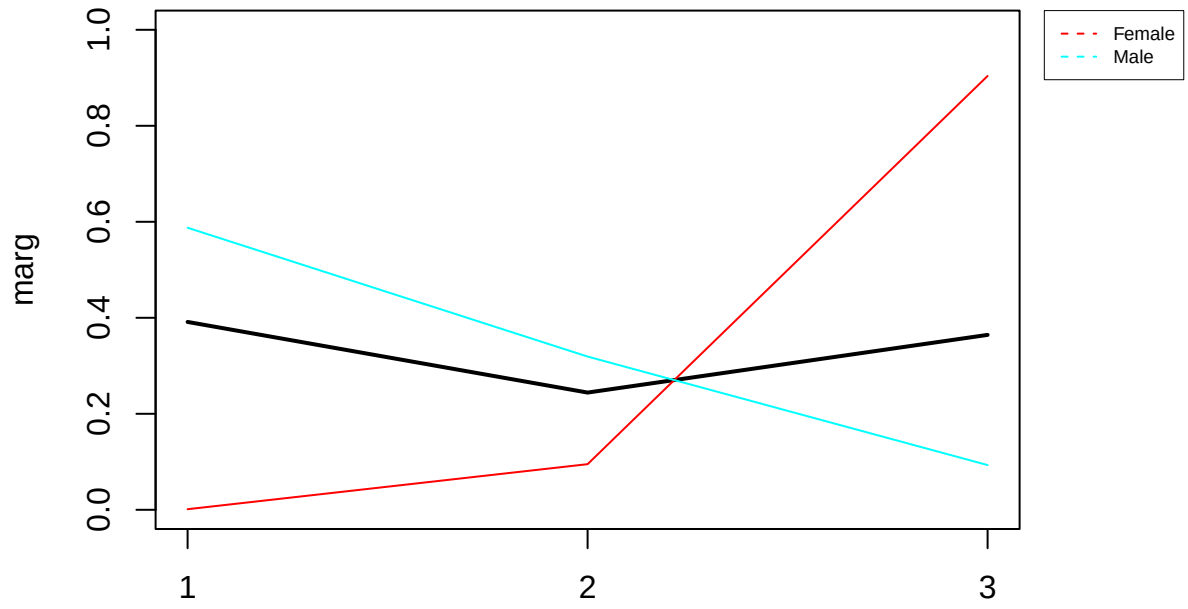

0
500
1000
1500
1
2
3



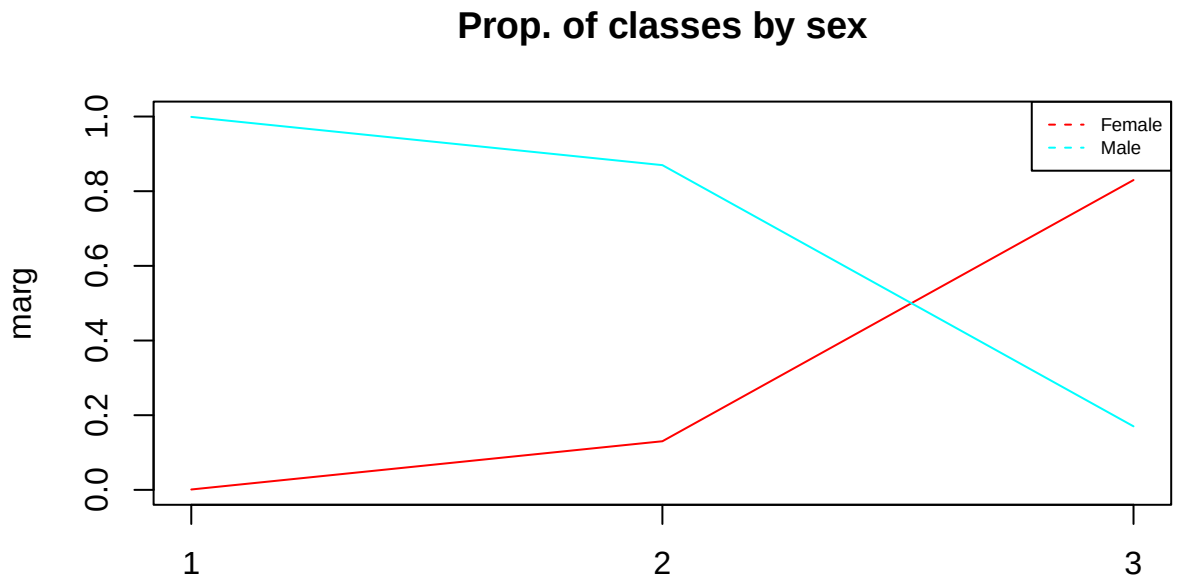

```
## [1] "Test Chi quadrat: "
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 147.75, df = 8, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P   Amer-Indian-Eskimo Asian-Pac-Islander       Black       Other       White
##   1        0.008175779        0.032192131 0.044455800 0.005109862 0.910066428
##   2        0.007371007        0.057330057 0.125307125 0.017199017 0.792792793
##   3        0.013172338        0.012623491 0.113062569 0.008781559 0.852360044
##
## $vtest
##    Xquali
## P   Amer-Indian-Eskimo Asian-Pac-Islander      Black      Other      White
##   1         -0.9349750          0.3235966 -8.9016856 -2.5210857  8.1264236
##   2         -0.9910740          6.0408825  5.0915893  3.2484873 -7.8406934
##   3          1.8329003         -5.7207371  4.4823472 -0.3431371 -1.2420612
##
## $pval
##    Xquali
## P   Amer-Indian-Eskimo Asian-Pac-Islander        Black        Other
##   1       1.749006e-01       3.731217e-01 0.000000e+00 5.849668e-03
```

```
##   2       1.608247e-01       7.663678e-10 1.775373e-07 5.801019e-04
##   3       3.340870e-02       5.303145e-09 3.691325e-06 3.657477e-01
##    Xquali
## P          White
##   1 2.210710e-16
##   2 2.220446e-15
##   3 1.071070e-01
##
## [1] "Variable sex"
## [1] "Categories=" "Female"      "Male"
```

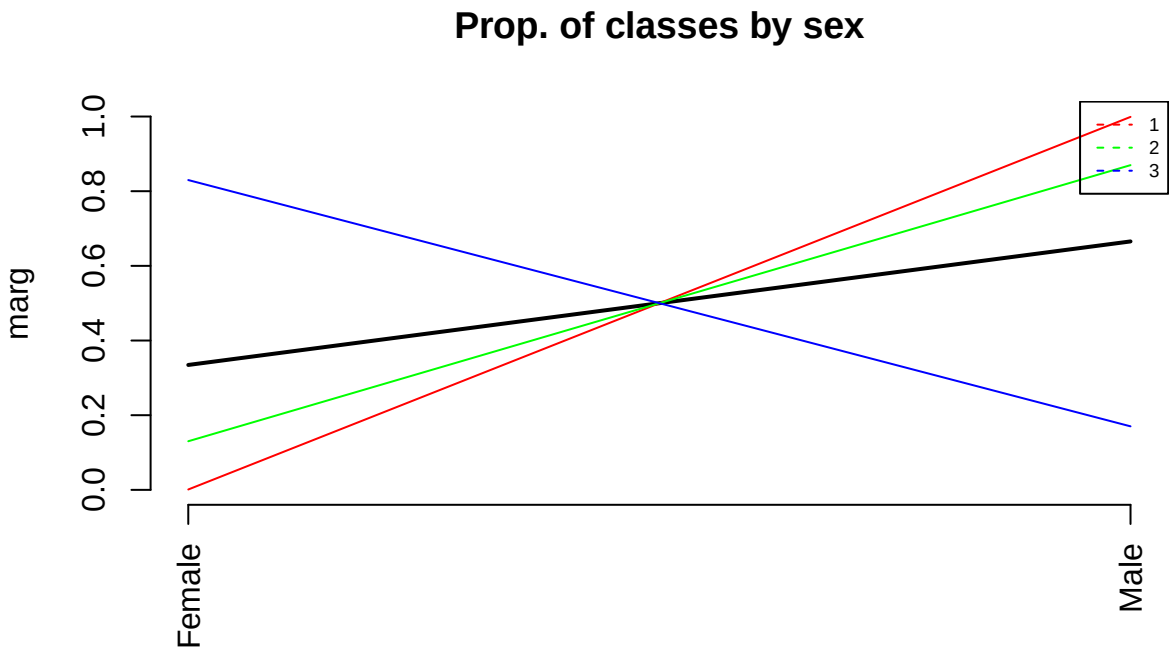


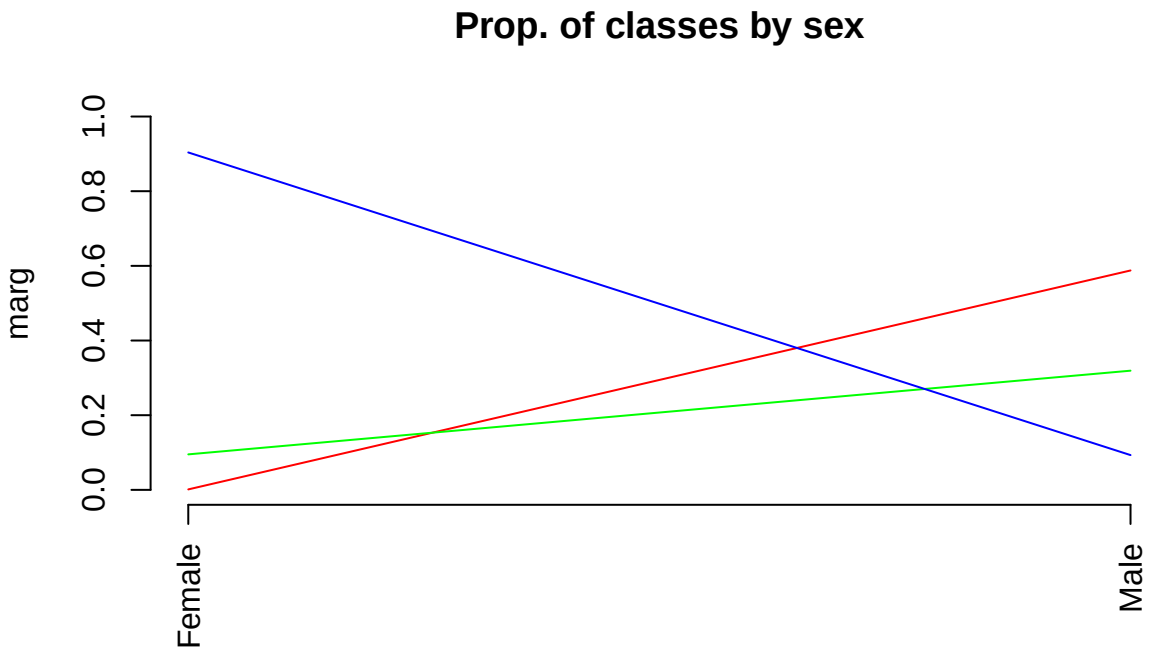


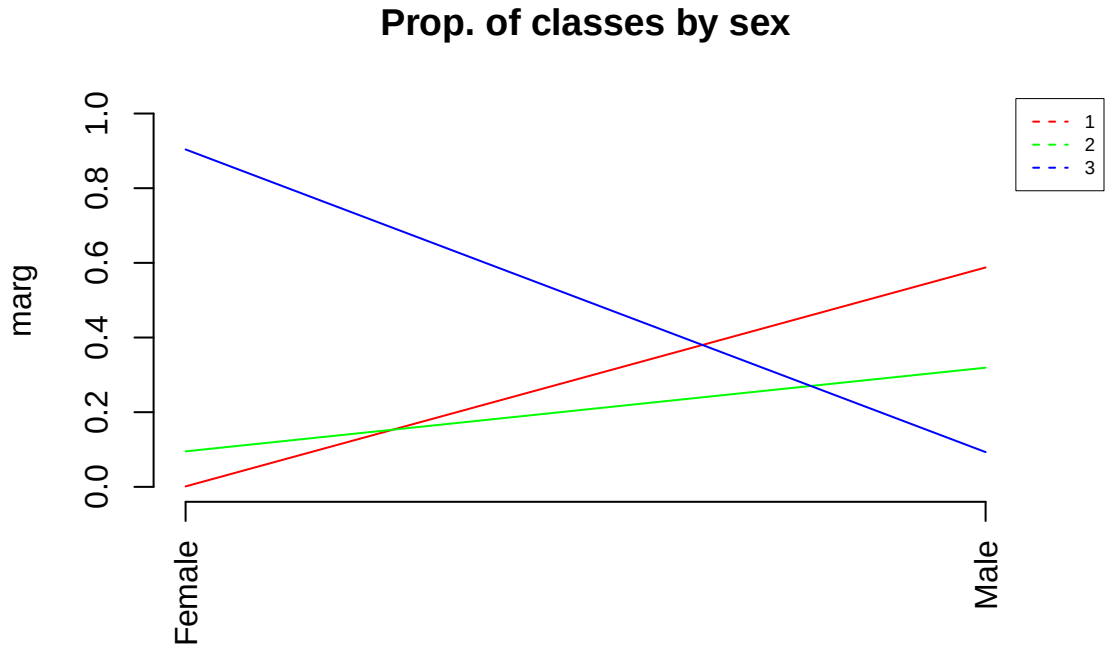

```
## [1] "Categories=" "Female"      "Male"
```



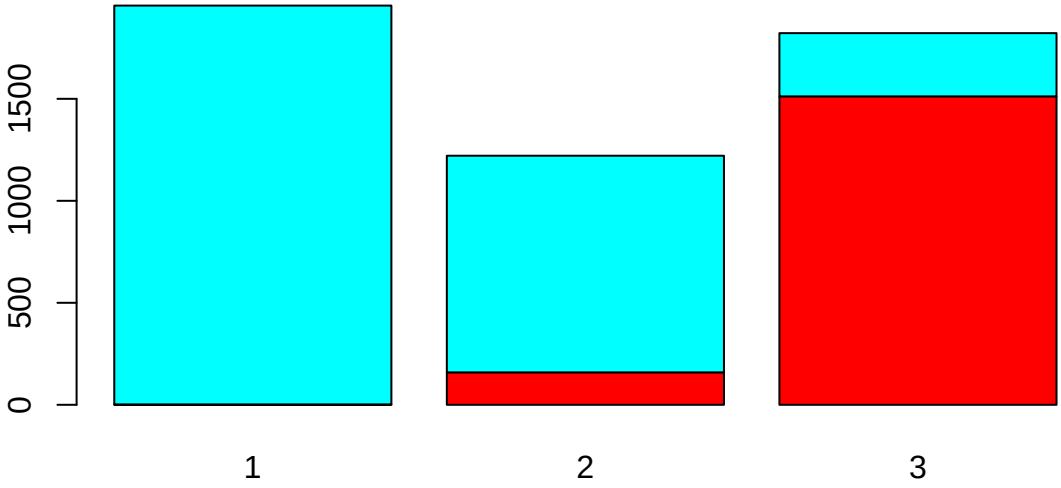

```
## [1] "Categories=" "Female"      "Male"
```

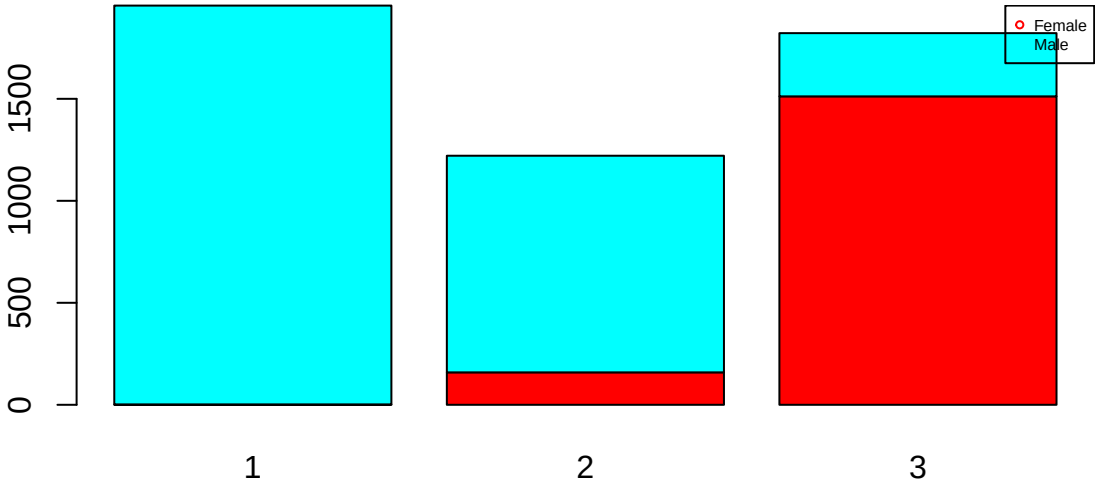

Prop. of classes by sex
marg
0.0
0.2
0.4
0.6
0.8
1.0
Female
Male
1
2
3

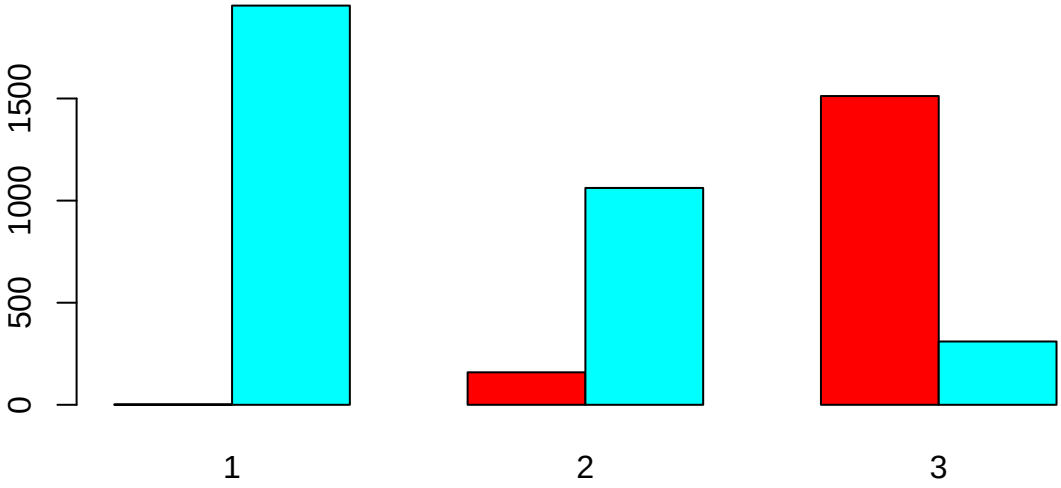

Prop. of classes by sex
marg
0.0
0.2
0.4
0.6
0.8
1.0
Female
Male

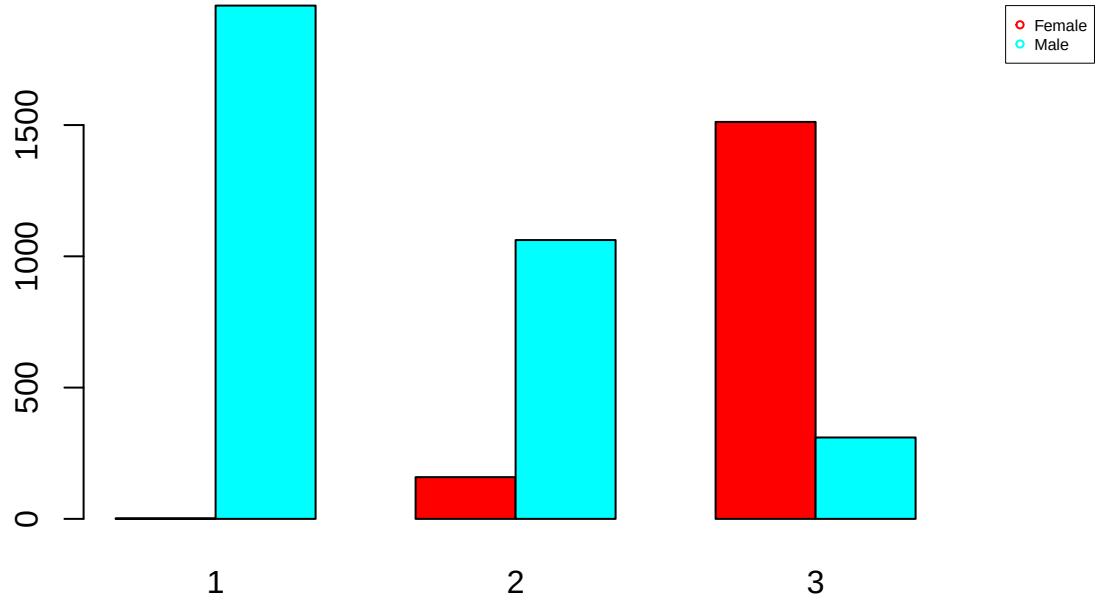



```
## [1] "Cross Table:"
##         P
##             1    2    3
##   Female    2  159 1512
##   Male   1955 1062  310
## [1] "Distribucions condicionades a columnes:"
##
## P        Female        Male
##   1 0.001195457 0.587616471
##   2 0.095038852 0.319206492
##   3 0.903765690 0.093177036
```


0
500
1000
1500
1
2
3

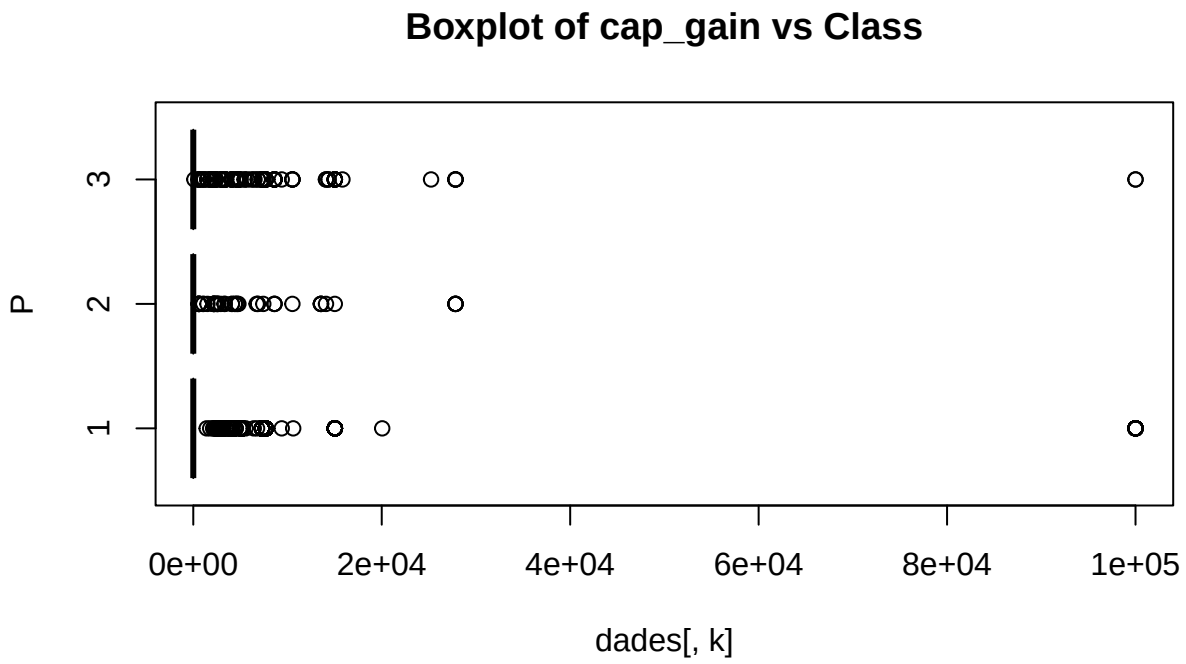

Female
Male
0
500
1000
1500
1
2
3

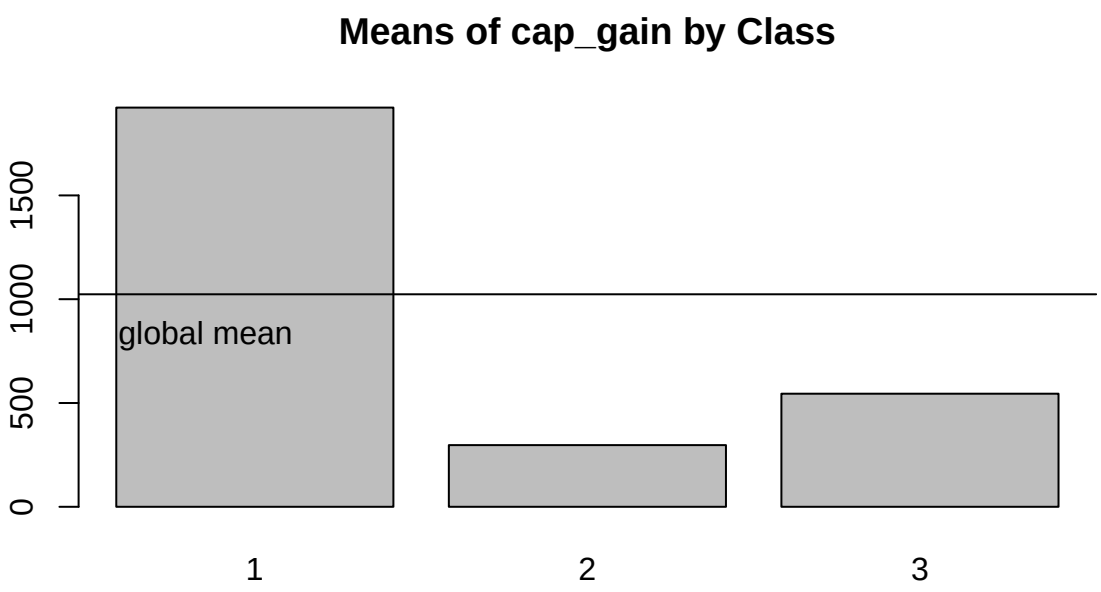

0
500
1000
1500
1
2
3



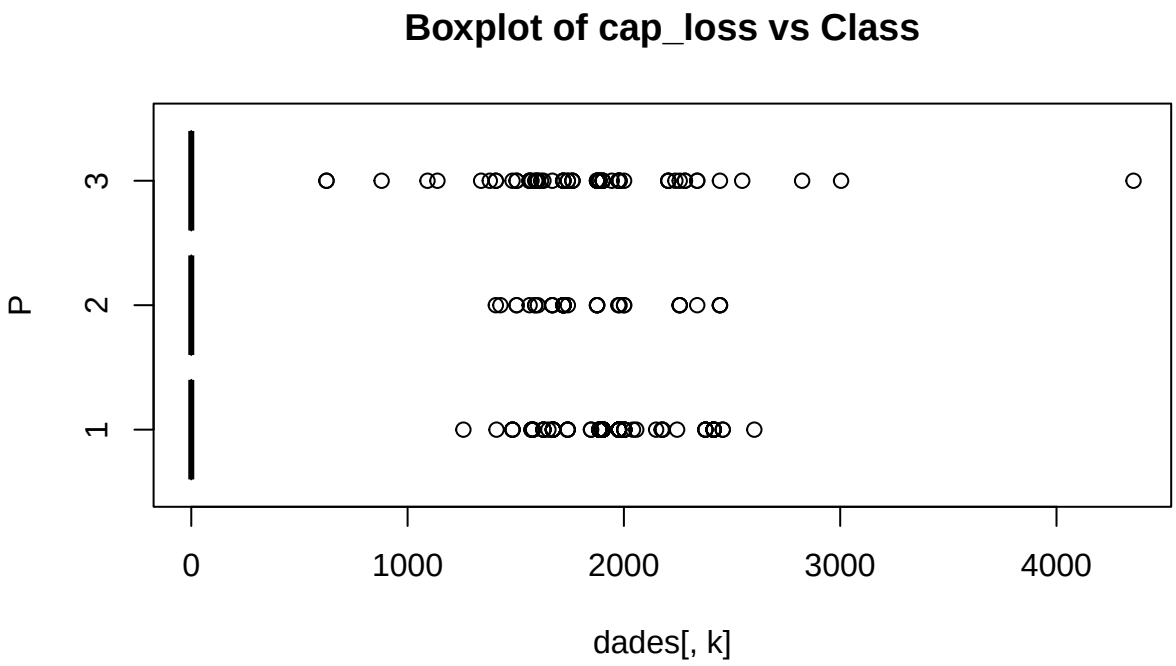

```
## [1] "Test Chi quadrat: "
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 3214.4, df = 2, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P        Female        Male
##   1 0.001021972 0.998978028
##   2 0.130221130 0.869778870
##   3 0.829857300 0.170142700
##
## $vtest
##    Xquali
## P      Female      Male
##   1 -40.08875  40.08875
##   2 -17.40949  17.40949
##   3  56.19643 -56.19643
##
## $pval
##    Xquali
## P         Female         Male
##   1 0.000000e+00 0.000000e+00
```

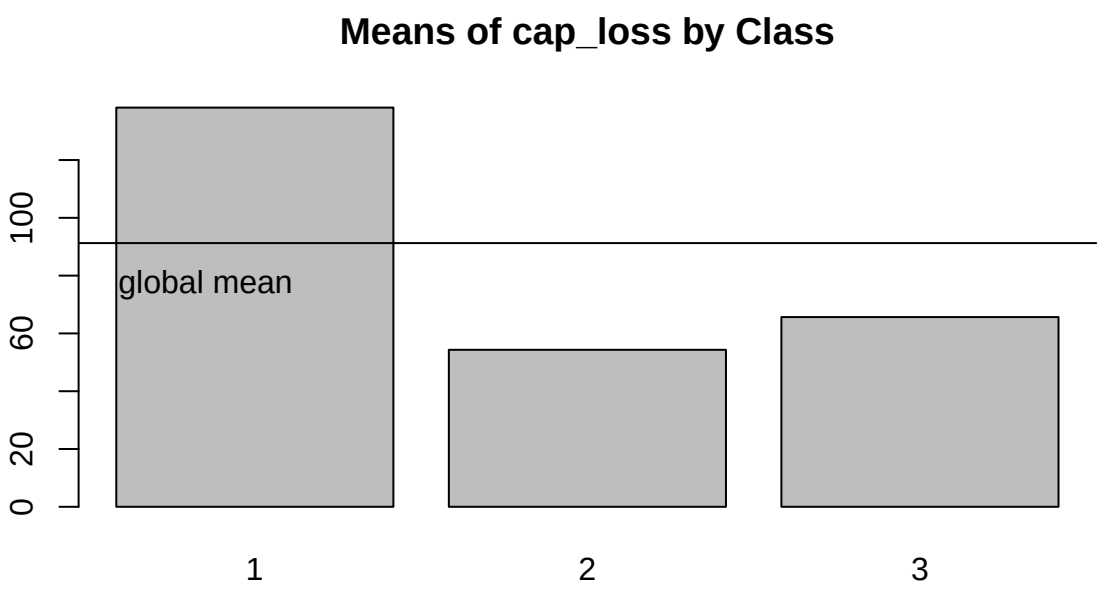
```
##   2 0.000000e+00 3.495277e-68
##   3 0.000000e+00 0.000000e+00
##
## [1] "Anàlisi per classes de la Variable: cap_gain"
```



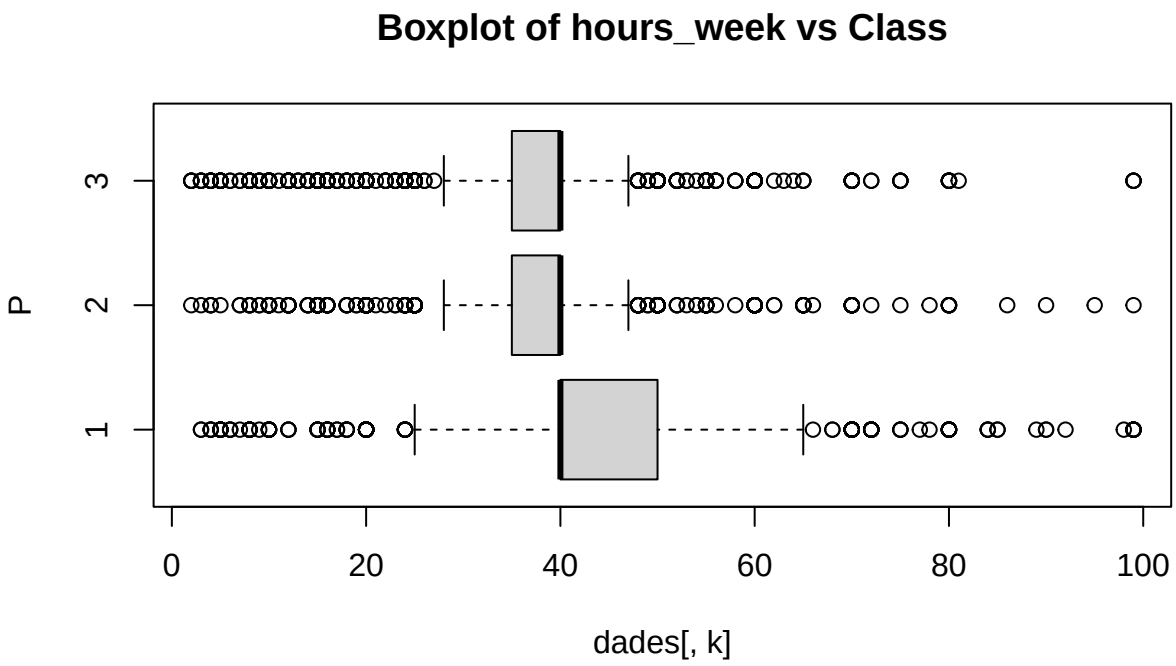


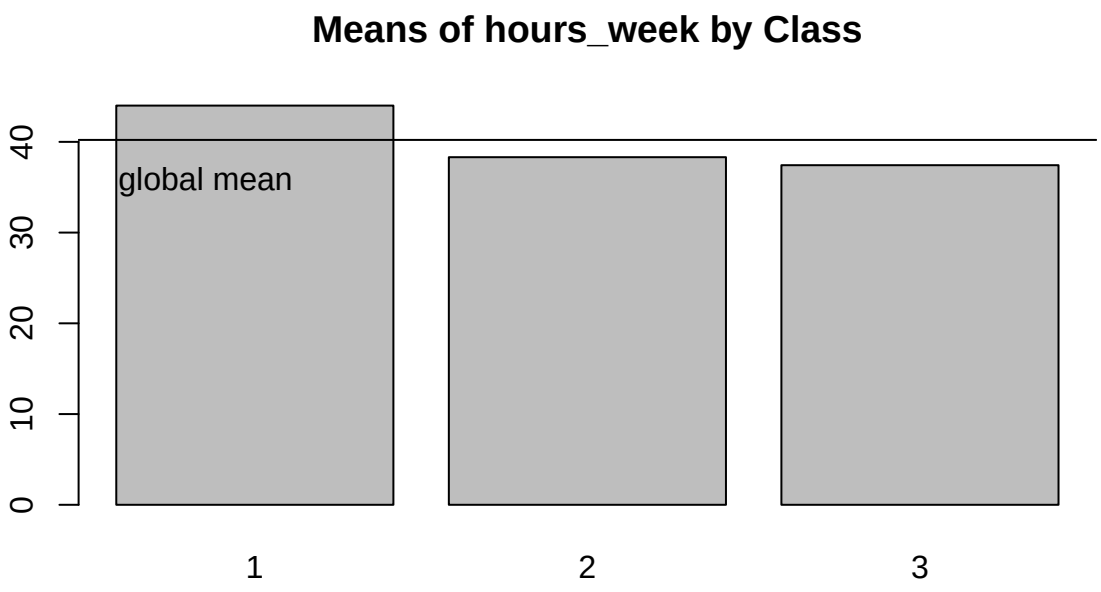

```
## [1] "Estadístics per groups:"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       0       0       0    1923       0   99999
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.0     0.0     0.0   297.1     0.0 27828.0
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.0     0.0     0.0   544.8     0.0 99999.0
## [1] "p-valueANOVA: 2.01817862825246e-10"
## [1] "p-value Kruskal-Wallis: 1.64878128351474e-19"
## [1] "p-values ValorsTest: "
## [1] 6.363026e-13 2.332985e-05 1.746724e-04
## [1] "Anàlisi per classes de la Variable: cap_loss"
```


Boxplot of cap_loss vs Class
P
3
2
1
0
1000
2000
3000
4000
dades[, k]

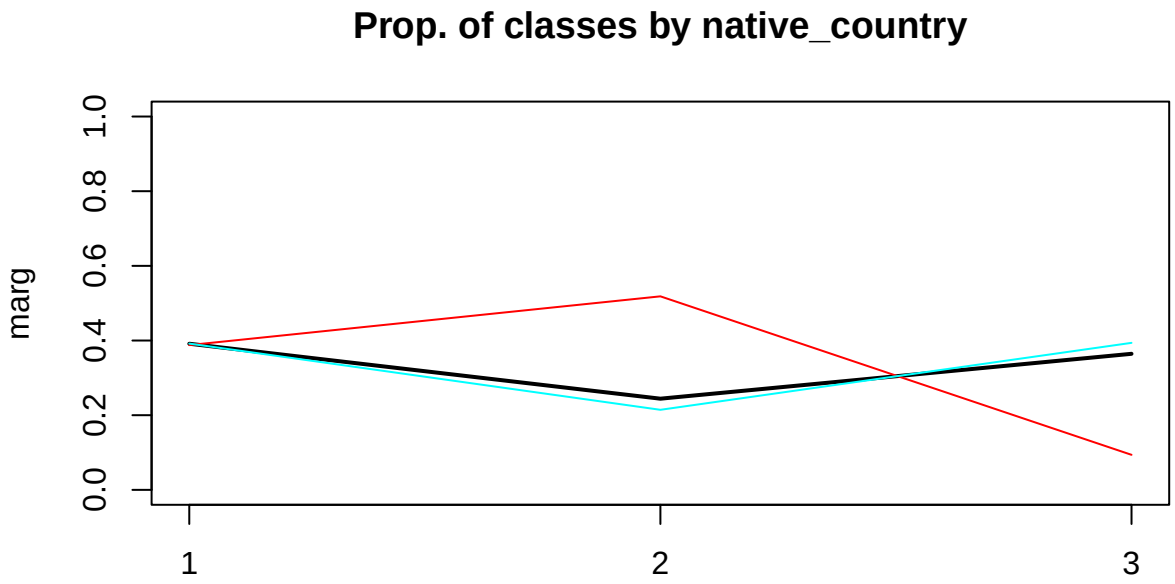


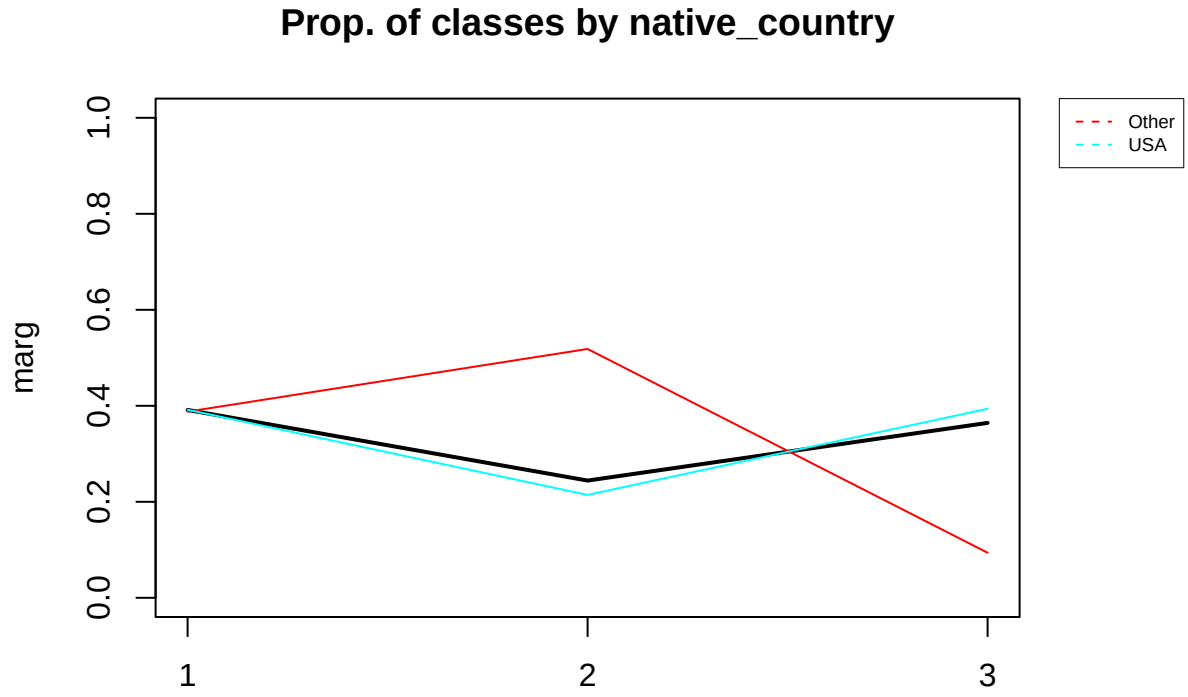

```
## [1] "Estadístics per groups:"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     0.0     0.0     0.0   138.2     0.0  2603.0
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   54.33    0.00 2444.00
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00    0.00    0.00   65.66    0.00 4356.00
## [1] "p-valueANOVA: 9.61265012137871e-09"
## [1] "p-value Kruskal-Wallis: 2.10298545751866e-09"
## [1] "p-values ValorsTest: "
## [1] 6.588531e-11 1.635098e-04 4.530013e-04
## [1] "Anàlisi per classes de la Variable: hours_week"
```


Boxplot of hours_week vs Class
P
3
2
1
0
20
40
60
80
100
dades[, k]

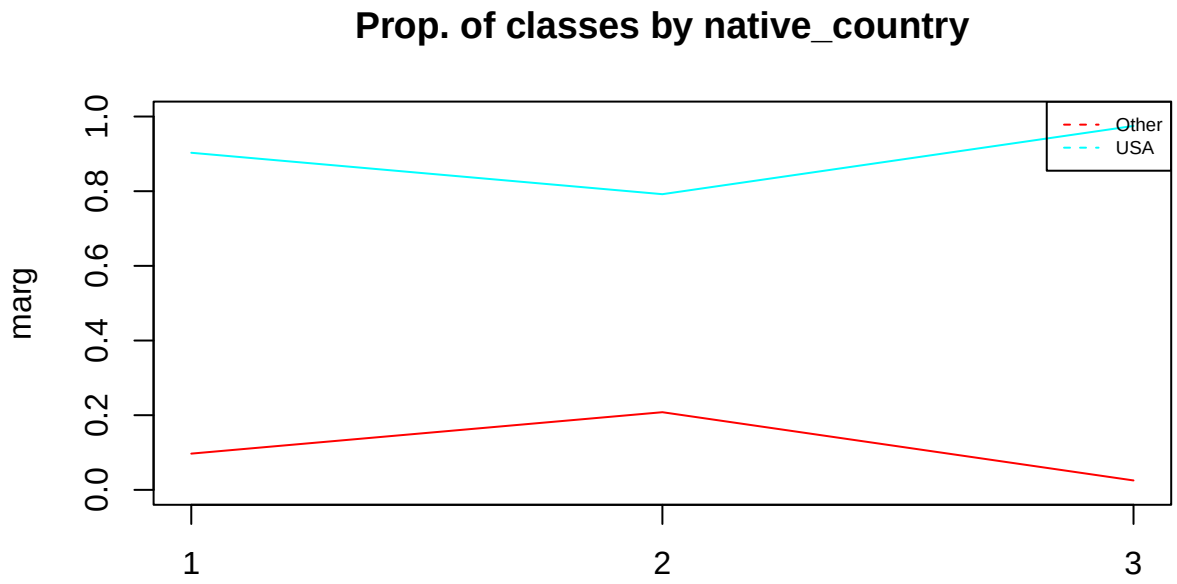



```
## [1] "Estadístics per groups:"
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       3      40      40      44      50      99
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2.00   35.00   40.00   38.31   40.00   99.00
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    2.00   35.00   40.00   37.43   40.00   99.00
## [1] "p-valueANOVA: 1.14181725805632e-66"
## [1] "p-value Kruskal-Wallis: 6.19411685035705e-85"
## [1] "p-values ValorsTest: "
## [1] 6.124643e-64 5.816605e-10 0.000000e+00
## [1] "Variable native_country"
## [1] "Categories=" "Other"       "USA"
```

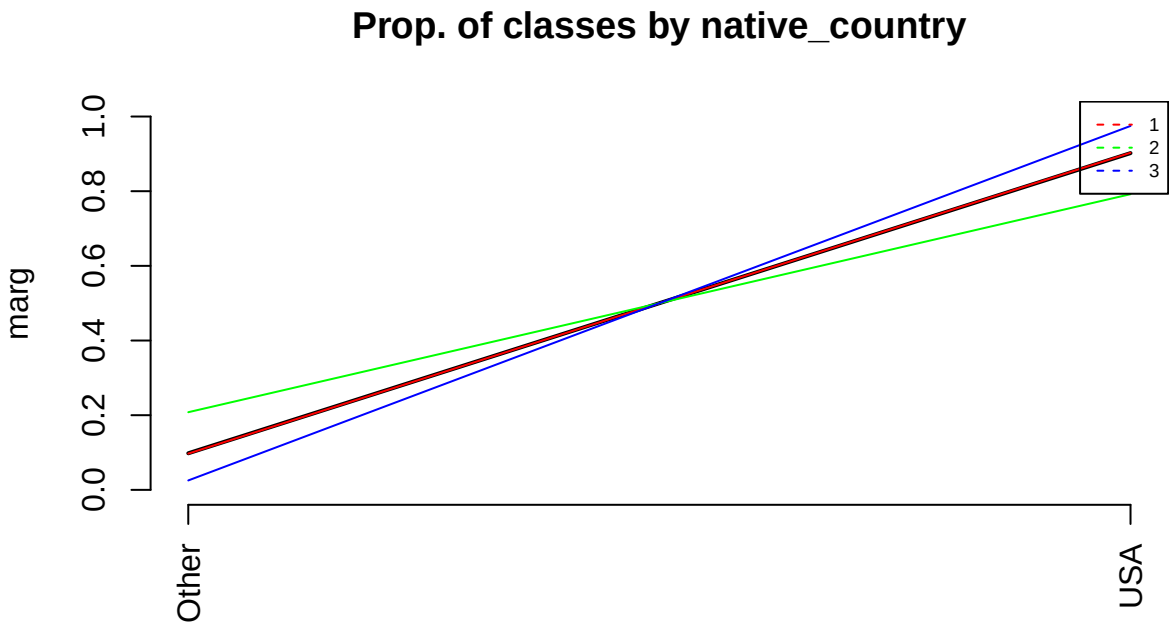

Prop. of classes by native_country
marg
0.0
0.2
0.4
0.6
0.8
1.0
1
2
3

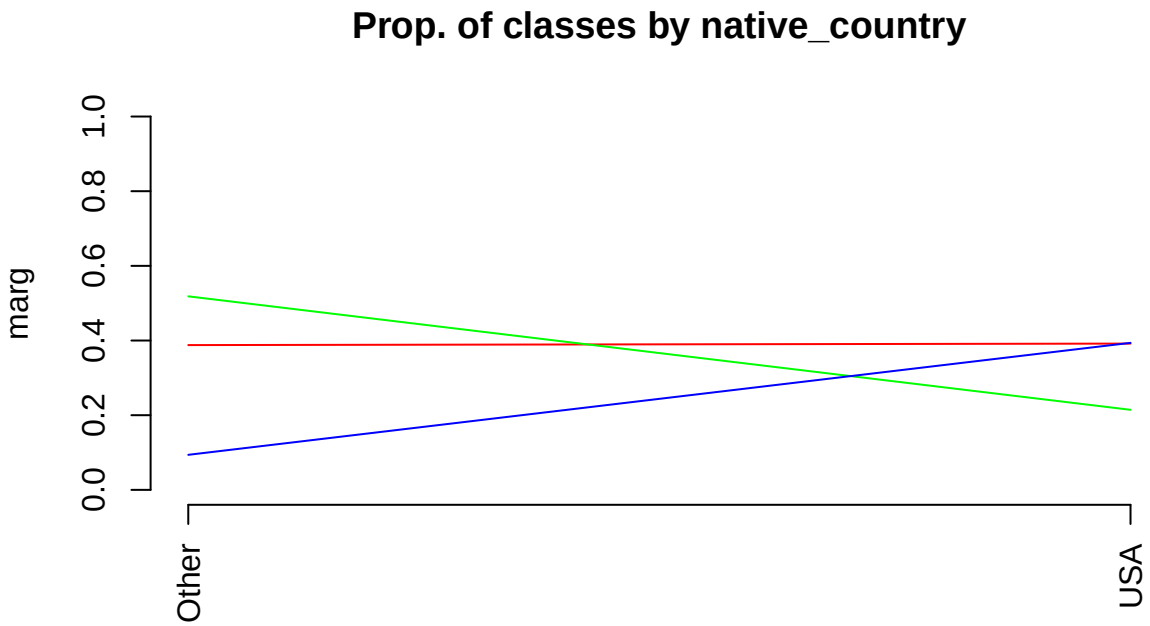


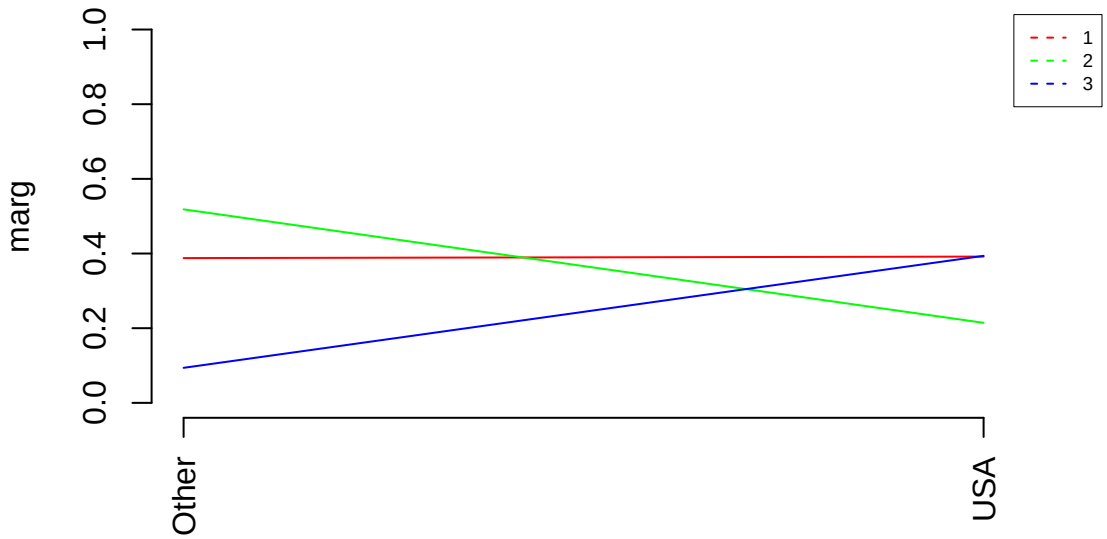

```
## [1] "Categories=" "Other"       "USA"
```



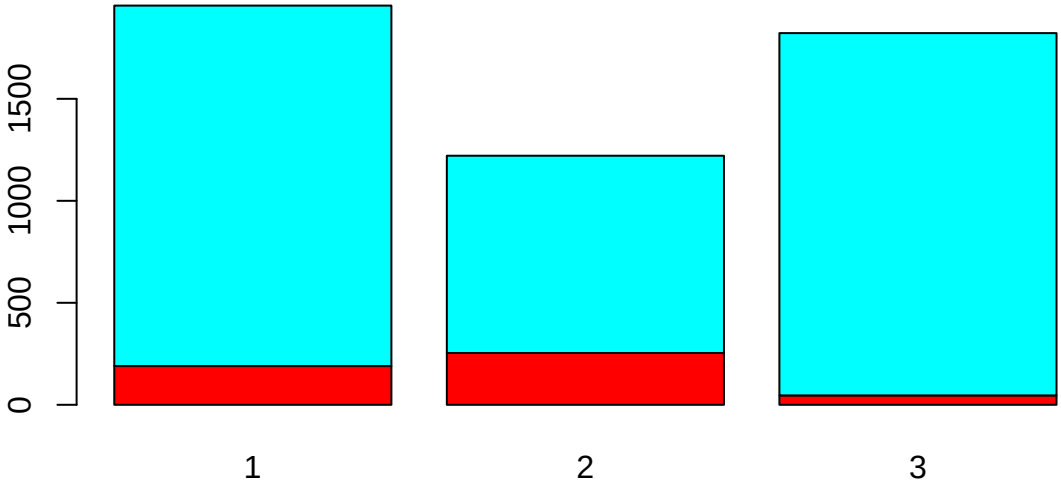

```
## [1] "Categories=" "Other"       "USA"
```

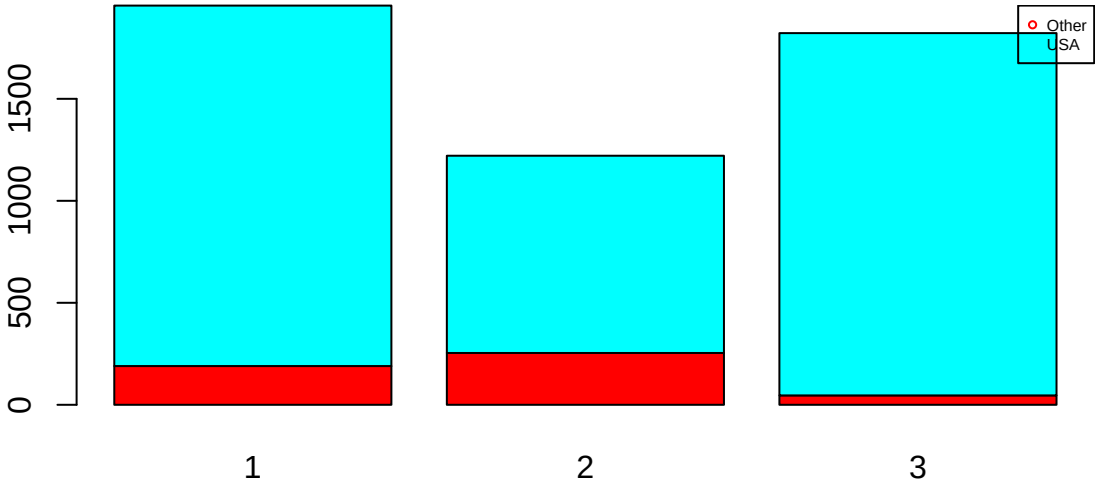

Prop. of classes by native_country
marg
0.0
0.2
0.4
0.6
0.8
1.0
Other
USA
1
2
3

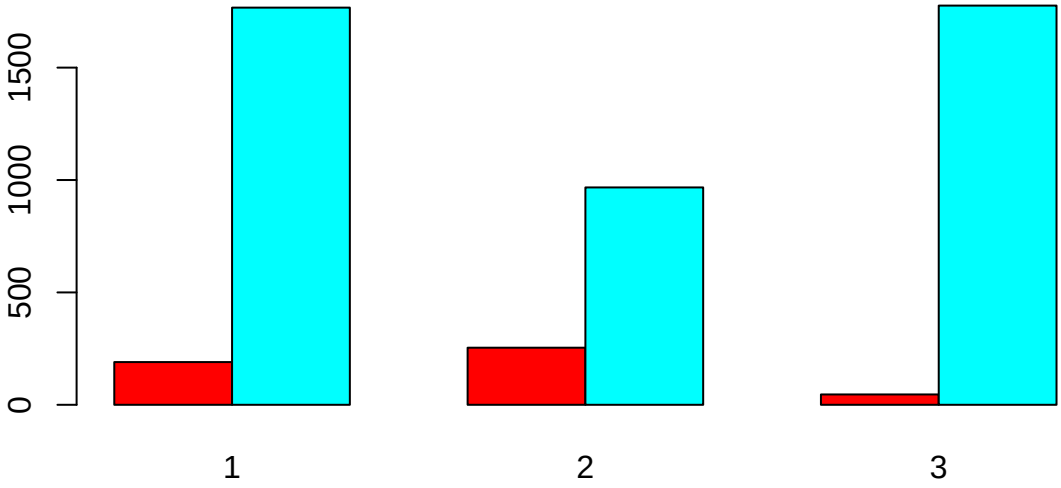

Prop. of classes by native_country
marg
0.0
0.2
0.4
0.6
0.8
1.0
Other
USA

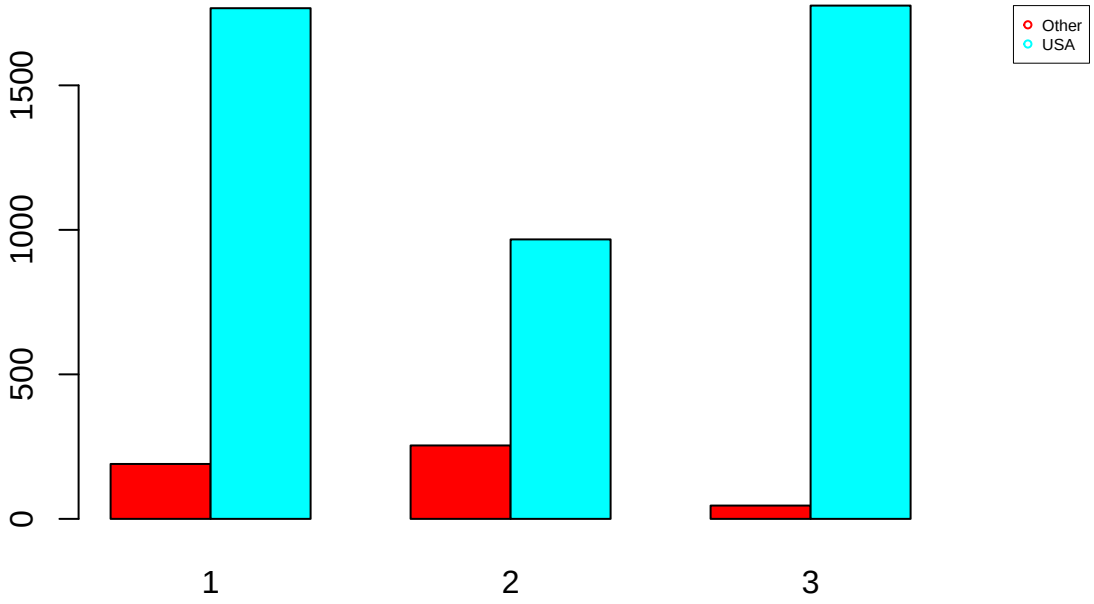



```
## [1] "Cross Table:"
##        P
##            1    2    3
##   Other  190  254   46
##   USA   1767  967 1776
## [1] "Distribucions condicionades a columnes:"
##
## P        Other        USA
##   1 0.38775510 0.39179601
##   2 0.51836735 0.21441242
##   3 0.09387755 0.39379157
```


0
500
1000
1500
1
2
3


0
500
1000
1500
1
2
3
Other
USA


0
500
1000
1500
1
2
3




```
## [1] "Test Chi quadrat: "
##
##  Pearson's Chi-squared test
##
## data:  dades[, k] and as.factor(P)
## X-squared = 276.33, df = 2, p-value < 2.2e-16
##
## [1] "valorsTest:"
## $rowpf
##    Xquali
## P        Other        USA
##   1 0.09708738 0.90291262
##   2 0.20802621 0.79197379
##   3 0.02524698 0.97475302
##
## $vtest
##    Xquali
## P         Other         USA
##   1  -0.1740619   0.1740619
##   2  14.8742209 -14.8742209
##   3 -13.1013773  13.1013773
##
## $pval
##    Xquali
## P          Other          USA
##   1 4.309084e-01 4.309084e-01
```

```
##   2 2.422967e-50 0.000000e+00
##   3 0.000000e+00 1.616682e-39
```

```
#descriptors de les classes més significatius. Afegir info qualits
for (c in 1:length(levels(as.factor(P)))) {
  if(!is.na(levels(as.factor(P))[c])){
    print(paste("P.values per class:",levels(as.factor(P))[c]));
    print(sort(pvalk[c,]), digits=3)
  }
}
```

```
## [1] "P.values per class: 1"
##      workclass        marital     occupation   relationship           race
##       0.00e+00       0.00e+00       0.00e+00       0.00e+00       0.00e+00
##            sex native_country            age     hours_week       cap_gain
##       0.00e+00       0.00e+00      9.36e-115       6.12e-64       6.36e-13
##       cap_loss        edu_num
##       6.59e-11       8.90e-07
## [1] "P.values per class: 2"
##            age      workclass        marital     occupation   relationship
##       0.00e+00       0.00e+00       0.00e+00       0.00e+00       0.00e+00
##           race            sex native_country        edu_num     hours_week
##       0.00e+00       0.00e+00       0.00e+00       2.29e-13       5.82e-10
##       cap_gain       cap_loss
##       2.33e-05       1.64e-04
## [1] "P.values per class: 3"
##      workclass        marital     occupation   relationship           race
##       0.000000       0.000000       0.000000       0.000000       0.000000
##            sex     hours_week native_country       cap_gain            age
##       0.000000       0.000000       0.000000       0.000175       0.000427
##       cap_loss        edu_num
##       0.000453       0.051825
```

#PCA # 1. Load Libraries and Data

```
library(dplyr)
```

```
##
## Adjuntando el paquete: 'dplyr'
```

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

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

```
setwd("C:/Users/Ericd/Pictures/ADEI")
dd <- read.csv("adult_def.csv", stringsAsFactors = TRUE);
set.seed(123)
samp <- sample(48842, 5000)
dd <- dd[samp,]
objects()
```

```
##  [1] "actives"         "c"               "c1"              "c2"
##  [5] "cdg"             "colperc"         "d"               "dades"
##  [9] "dcon"            "dd"              "dissimMatrix"    "distMatrix"
```

```
## [13] "h1"              "k"               "K"               "kw"
## [17] "marg"            "n"               "nameP"           "nc"
## [21] "o"               "P"               "paleta"          "pvalk"
## [25] "rowperc"         "s"               "samp"            "table"
## [29] "ValorTestXnum"   "ValorTestXquali"
```

```
attributes(dd)
```

```
## $names
##  [1] "age"            "workclass"      "fnlwgt"         "edu_num"
##  [5] "marital"        "occupation"     "relationship"   "race"
##  [9] "sex"            "cap_gain"       "cap_loss"       "hours_week"
## [13] "native_country" "income"         "income_integer"
##
## $row.names
##    [1]  2986 29925 29710 37529  2757 45404 46435 38938  9642 31313 14183 15180
##   [13] 27168 24173  9097 30538 28981  7989 13536 24541  6216 17983 29394 28825
##   [25] 41237    41 14426 40159  7284 43782 28502 11473 42802 43042 12301  6134
##   [37] 33523 21812 39895  9640 19742  9326 26510 20960 14403  5967 45221 48306
##   [49] 43244 28799 26836 12049 15150  5027 47982 32606 16152 25559 14215 14287
##   [61] 23194 24558 34976 14491 17413 12048 40503 34724 38126 20477 17369 31542
##   [73] 37001 21069 40632 30575 43204 37544 33753 18891 11284 16579 44196 45932
##   [85] 26801 44983 25902 36717 28078  3833 26028 43406 41488 47485 47626 14536
##   [97] 17533 26503 37783 22763 32953   413 10762 48182 30571 42521  8986 14745
##  [109] 25946 14804 43928  6601  6790   618 47802 31517   539 32263 30453  3625
##  [121] 15582 19392 46137  2211  2286 18762 32281 42039  7826 14751 24263 25449
##  [133] 40849 10687 27455 12637 20193  1165 31665 22467 29826 13689 18496 13795
##  [145] 19419 15703  6623  8983 37769 29479  5407 44617 32634 12585 21085  1835
##  [157] 42221 21099 41043 25442 36940 40153 31919 10563 38265 10848 46438 48803
##  [169] 44128 22925  3814  8176 28583 10833 17746 45299 29133    31 46195 45072
##  [181]  7588 44449  4620 45980  3247 24016  5242 11667 33027 22369  5409 25931
##  [193] 11256 23900  2450 44500  1673 19851 45064 48434 17993  6007 18144 25243
##  [205] 13431 38467 34728  1060 13179 42846 27753 46468  1204 32117 24111  9919
##  [217] 43694 38191  3984  7880 22119  2096 44990 20873 24522  6333  2894 24696
##  [229] 23883 19955 47818 14417 27380 25244 41009  5596 40276 37167  3696 22974
##  [241] 46707  4913 10301 11372 34165 18547 38488 13238 29370 46843 36086 11187
##  [253] 16635 41603  9182 38210  6312 23316 17049 41405 24671 28112 34134 47800
##  [265] 25196   242  7071 47048 40160  1498 20698    79  9723 39149 34599  4518
##  [277] 16346  4695 32102 13353 15489 31606  9448 27020 42824 16436 26691 42887
##  [289] 30237  1230 35556 32076 26715 18388 16990 23977  3080 31315 43755 45555
##  [301]  9123  8263 36810 20400  4972  3509 48101 47241 37492 43072  6373 48257
##  [313]  7860 17220   602  8523 47606 46867 28577  7877  2777 30712 17749  7488
##  [325] 35916 11126 34564 44143 45430 41409  9739 19512 14607 35817 24963 35560
##  [337] 38245 33510  4682  3421 37765 34827 20943  2748 44859 36352 13376 39084
##  [349] 10400  1553 32128 27365 10605 22402 19927 10216  2882  4015 27913 29465
##  [361]  9174 37320  7657 31351  3017 17656 42155   459 27463 46642 41099 10044
##  [373] 28390 14666 26226 25658  7132 38920 31319 19360 28871 22344 33227 48715
##  [385] 18300 25871 20878 29851 36385 35602  8539 35914 36671 29343 47159 34162
##  [397] 48538   860 35351 18117 15954 46910 11341 24243 46738  8905 36829 41218
##  [409]  1963 23294 11269 27103 17819  1923 31466  5178  8482 40931 13102 47695
##  [421] 34696 43289 25640 16011 37262 12636 20547  3804 37247 37015 37208 18876
##  [433] 17017 26566 26584 41184  9104 39264 24378 13763 13590 15828  4750 18807
##  [445] 26334 48451 26034 41609 13797  8848 38947 36378 12791  7196 25245 47061
##  [457] 10333 35533 33285 34214  2647 14816 34796 18191 38582  2826 46122 20393
##  [469] 21086 28852 18304  2761 47651 33471    76 16029 37853 40302  9597  4297
```

```
##  [481] 47529 37106 36344 40838 25703 18082 35998 33749 34490 19879 48068 37294
##  [493] 31859 36380  8946  6529 23985 15524  7053 16719  2222 22135 23404 25191
##  [505] 32164 42040 20995 40459 11166 35046 29919 16322 42611 39155   318  1627
##  [517] 31167 32035 10402 28613 19586 38376 11735 12053 40211 40133 23248  4968
##  [529] 12336 15395 44447 24728 30541 15546 15117 32580 10550 47854 20479 22040
##  [541] 38046  6511 28535 19685 25008 33838 48815 32661 28999 17711 48224  7635
##  [553] 47505  7789 12447  9020 30341  4298 25948 47534  7348  3167 27481   756
##  [565] 13157 28676 15114 36480 28419 39116 14600 27525 24934 12546   887 28360
##  [577]   914 27422 14405 45533 27148 16385 15198 31218 36234 18176 27903  5799
##  [589] 25932 20874 18653 20474 14478 10943  1789 23506 28434 32638  5483  6847
##  [601] 41125 25618 22849 38854  4961 11688 19260  8181  3004  8390 30774 47868
##  [613] 25775 22642 15017  1565 12248 33037 42886 16876  6534 47332 25082 34174
##  [625]  2437 42079 26219 25593 18771 36623 43025 41513 18671 35326 21556  2315
##  [637] 39113  5459 42775 12305  5576 46937 38983 40332  4176 33598 48389 24730
##  [649] 20570 42965 12921 29278 39404   352   384 24163 40818 32763 26283  1191
##  [661] 32496 22660 41885 39396 30006 16707 30933 17832 40197  4588 24135  2304
##  [673] 21771 33442 43901  3277 38179 33979 39150 45174 30536 29444   303 26638
##  [685] 32817 13637 20696 20624 31566  1003 15390 19373  4676 37984 21973 45332
##  [697] 14632 44090 24226  9008 22784  9348 16090 25681 39460 36573 35113 17955
##  [709] 36091 47698 40269 37039 41194  5392 45030  9563 31880 32710 24790  4869
##  [721] 28650  2473 10549 18937 43801 42984 16886 17562 31072 10174 16021 13939
##  [733] 23569  2910 37272 35544 42459 21079 12334 30092 13448  9046 29573 16461
##  [745] 10847 10260 29397  9471 33714 40393  3649 14539 17521 39886 12530 15886
##  [757]   232 28709 12893 16433 37831 47788 37856 14610 11455 13092 31389 48617
##  [769] 10666  8374 44078   674 17674 26234 25855  3211 45669  7103 42083 20665
##  [781] 19743  1762 27251  4425 23162 47086 13344 18420 32385 14407  1607 43391
##  [793] 14303  1611 34337 24825  9813 36839 33778 11855  3271  6506 25392 46339
##  [805] 10557 19807 26367  8155 46129 28623 29417 27955  3302 43315 30526  1847
##  [817] 11276 38756  8412 46971  1201 39234 46355 18535 44088  7111  6764 41939
##  [829] 20024 41452  3366  1448 21542 12083 42481 30549 16087 42868 18970 15483
##  [841] 22312  8260  1308 16951 20439  2002 29708  3288 32984 11159  7242 35716
##  [853] 27644 15611 40703 12467 44010 21336   328 41788 43474 38461 34622 45776
##  [865] 15127  5190 36313 13835 46988  4798 10247  4809 23948 30457 47840  4343
##  [877] 15571 27682 46776 17226 43536 37450 26818 30856 16225 30552   528 24743
##  [889]  9150 46577   663 30867 35730 39959 20475 43097 30481 44237   793 48731
##  [901] 28476 22232 25036 32489 25605 34867 44288 16007  3802  3632 38026 22300
##  [913] 16648 29532 39728 13054 22253  6502  3103 48599 38557 32411 11080 20992
##  [925] 20316 16680 48570 41032 46346 17194 19310  9291 43648 20627 30402 34565
##  [937] 17670 15569 41100 41570 21634 41615 11722  5083 36008 32798  6025 10075
##  [949] 12781 10185 27056 36904 12606 15238 28438 20260 34888 29782  2038  5081
##  [961]  6403  9386 37023 25197  6813 19460 40656 10355 12199 33557 22054 26365
##  [973] 38436 10021 45764 33415 10870  2946 30603  6440 40315 30213 11621 17089
##  [985]  4738   743 39798 46479 43069 17890 11683 44850 35532  8328 10857  9332
##  [997]  1873 29127 23053 47797 20876 38288 47461 41311 27336 32727 22510 19508
## [1009] 37135  6877 10956  7753 27949 30696 11978   970  6668 34648  7748 36194
## [1021] 28865 30247 18907 24581 27049 18421 37679 23770 26438  4288 20303 38269
## [1033]   613 30529 30504 26286 42842 36517  4824 39739 25361  8561 46600 25356
## [1045] 24056 14130 24755 36997 24247 33596 26602 47647 45876 17161 13073 17770
## [1057]  2405 26557 13596 21727 24799  6493  9737 17477 45512 39907  2873 11181
## [1069] 25554 42976  5291 36719 18575 48818 25961 28528 20029 41277 46999 46078
## [1081] 39196 15492  6045 43740  9042  6145 24008 25102 35080  4159 44198 30699
## [1093] 40635 12837  5251 12387 28283 12285  3203 17158 25295  5087 29587  9315
## [1105]  1936 14987 12492 20318 43319 22549 18559  8980  4399 44574 41042 43202
## [1117] 32485 43703  2959  2136 27818  9940 47351 21650 27655 13800 29169  5456
```

```
## [1129]  2021  7432 47155 41580 11274  3527 47022  9293  2173 28362 21587 42279
## [1141] 45408  6207 15786 18608 26198  5301 11918 40281  3493 11860 46697 34454
## [1153]  8314 16123 10729 44396 37223 22340 27772 44587 14174 10597 15656 43972
## [1165] 21811 47918  8062 32864 15850  9013  6140 44349 25882 14964 33497 48808
## [1177]  2539  1055  5751 22262 41892 20390 45075 34250 47784 35546 21846 27771
## [1189] 47915 39750  2859 41063 26024 47782   474  4846 38407 46804 44140 37425
## [1201] 22781 34845 33445 38942 41094 37175 39374   316 26454  8807 33190 16402
## [1213] 43367 18669 22345 19935 18585 14892 30677  9546 39794 27695  6531 17072
## [1225] 47866  6431 12724  1004 20294 36840 33878 40492 33338 16491  4392 39077
## [1237] 29649 13741 35153 48219  7234 40937  8259 39842 38052 27825 27351  4645
## [1249] 31845 40493 42752 37296 27268 31978 30398 44320 48204 39546 17235  9063
## [1261] 11496 12716 45371 18751 28178 39808 33058 14257 15835 14669 28338 16766
## [1273] 36871 40522 18892  9248 37983 34963 11608 42632 25641 40816 16151  2970
## [1285] 47296 34503  5247 23979 15588 20308 16444 24256 37225 10728 41019 11857
## [1297] 48294 10865 25944 41301 23947 40663 26711 18582 46415  4193 48211  4427
## [1309] 26921 24848 37389   854  3831 25288  9098 20517 12366 37625 28509 30463
## [1321] 44780 26380 12426  7868 35421 28866  1158 31322 29049 44106 42434  6239
## [1333] 12614 32414 18217 46313  5932 40322 25788 36684 40859 31410 37807 19126
## [1345] 40645 15396 11204 38297 43968 23631 12976 31805 21512 44818 30735 32674
## [1357] 45081  7354 27649 14664  9901 40528 43544 32940 22170 22094 27294 40116
## [1369] 48684  9349  3059 19416 13217 14686  6078  5525  9321 10610 46152 21502
## [1381] 32677 17458 44404 18468 33439 18186 33602 10358 11117 45098  7807 11989
## [1393]  4356  3855 10491 46624  1746 20497 30922  5103 37695   287  3066 18818
## [1405]  8313  2963 46191  1042  3214  7902 15069 37771 27837 22342 33020 29010
## [1417] 30827 14806 46494   964 35184 47689 23797 38791 33495 13160 10118 31519
## [1429]  2936 37150 19711 15215 48579 26539 14292  2665  7395 48814 35846 39371
## [1441] 21904 12539 46226 10909 15971 26094 20002 22363   260 39285 11521 17394
## [1453]  8864 29515 25306 45311  1274 40830  1723 35255  7188 32757 37491     5
## [1465]  1994  3957 27134 37971 18015  5072 22158 16438 11390 45324 45219   718
## [1477] 11004  3009 45204 33967 41074  8931 27353 18253 20587  9552 44511 27743
## [1489]  9247   543 16907 26802 32668 39661 43979 28601 40564 44334 39182 32463
## [1501]  4547 12411 38190 20026 10241 38048 13239 17427 45580 17988 30318 40811
## [1513]  8509 40441  2421 45585 44730 19833  3178 38577 37699  8024 22928 46741
## [1525] 23642 39214 23331 33857 21719  2581 31513    55 19463 44601 12143 46118
## [1537] 14834  9659   910 39014 39723  7831 19193 13700 29677 11934  9130 11058
## [1549] 24738  1962 47424 42461 47377 39962  3180 32893 35850  3386 33101 40884
## [1561] 14566 23380 26260 16245 28332 26808 18419 36204 28638  2403 20997  5858
## [1573] 11430  2422 24530 38088 26194 28260 45750 30455 31460  3798 24482  4905
## [1585] 40040 40665 33258 23522 12453   706 33382 34148 13584  6402 10478 41330
## [1597] 16294 22248 37465 19442 34224 20256 38603 25479 23939 11602 25113 37857
## [1609] 42623 19076 28947 20644 22132  5872 34792 44653 17156  1278 23897 23568
## [1621] 35301 26439 45599 41721  5264 37476 47710 35321 45789 20230 13452  9411
## [1633] 35576 46082  1841 24038  1272 10330 46781  1714  8464 46977 11464 47429
## [1645] 36854 18466 46139 46871 26753  1604 38443 48109 39956 45898 32614 27470
## [1657] 19698 18059 14759 17138 36933 43962   812 13472 10454 40289 26625 26379
## [1669] 47601 22413 22382  3642 48810 12044  8448 32900 10267 29937 46345 28508
## [1681] 10317 22999  1548 42772 35873 15041  5008 13071 40744  9745 27877  3753
## [1693] 18157 44074  7429 24453 42246 34890  6187 12762  2435 38717 47966  4359
## [1705] 12440 19128 24603 22597 34868 36522 25458 27328  3728 42749 12131  4002
## [1717] 26299  6383 36290 10191 28521 41674 37098  6951 10641 43941 17490   701
## [1729] 46125 22506  7120 24568 43643 30435 36231 13201 40171 45699   113 22558
## [1741]   206 21259 24027 25012 15792 36387 43824 29927 45374 45207  3339 35953
## [1753] 37978 30723 36456  5723 42074 40127  3540 27920 30334 29720 16925 20222
## [1765] 31451 33930   948 37986 28414 26793  7874 18060  1202 29306  6875 12100
```

```
## [1777]  7200 47278 35304  4992 36558 17242 10026  3838 46218 38258 11799 39574
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## [4717] 16425 26523 37515  6897  7280 12685 23657   106 17503 22785 27675 44003
## [4729] 15007  4861 35313  4734 31307 11088    50 13502 31717 29652 32617 44312
## [4741] 35760 43773  4702  3480 33099  8731 14136 14995 14241 30056 39039 47599
## [4753]   615 17083  7885 28165 14801 33825  9814 45068 46256  4648 39994 44379
## [4765] 48498  8309 47527 12686 37920 14444 12312 42826 40608 15888 47898 46623
## [4777] 41900 37473 19376 28550 22550 24958 10889 32314 12200 14260 38634  5617
## [4789]  5899 47513  7814 16882 21483 19514  6192  7163 15798 40187 38872 24511
## [4801] 29101 23915 43558 31485 39831 20434 30533 20882 19010 12290 47462  7392
## [4813]  2463 32221 12262  5915 20114 16914 30469  4538 20994 32131 35439 13486
## [4825] 46823 44341 16551 15570 17160 17946 43642  8557 37466  6798 40802 13365
## [4837] 15702   933 12353  3716 12592 48275 42853 15544  3921 39088 29837 33789
## [4849] 25747 26327  9407  2784 30294 26766 27585    10 39781  2148 18895 44716
## [4861] 29271 39517 12664 41883 39976 27987 30401  7486 18775 29304 41355  7960
## [4873]  9308 26911 47238 42672 32898  6911 16221  1519 38409 35012 42577 28571
## [4885] 32970 31383 28046 35120 37502 39624 17314 32465 20149  2898 35423 15473
## [4897] 18362 25021 16685  9935  8789 27215 47216 26279 47665 41633 24288 15760
## [4909] 39219 46970 47140  7276 28655 31812 39617 37105 38918  2242  6777 20942
## [4921] 31706 11294 40654 24442 17906 37443 37328   705 30899 27425 39813  2056
## [4933] 24571  5379 17279 23956 30700  9398  1155 14308 19471 20337 21927 23602
## [4945] 12527 10352 18066  1440 38649 36425 20006 31887  3829 44606  8511 24942
## [4957] 22453 33449  8201  7453  8776 18205 48433 46261 10584 40524  4622 33371
## [4969] 11804 38230  1491 38982 31540 21653 30885 26607   746 34041 45787 48166
## [4981]  7916 28479 15510 33990 18067 12250 12594 27962 28126 16787 26744 26412
## [4993] 20268 31534 48709 37076 16250  3743 42899 17331
##
```

```
## $class
## [1] "data.frame"
```

```
# Remove unwanted columns
dd <- dd[, !(names(dd) %in% c("fnlwgt", "income_integer", "income"))]
```

2. Initial Exploration

```
# DATA VISUALIZATION
attach(dd)
```

```
## The following objects are masked from dd (pos = 5):
##
##     age, cap_gain, cap_loss, edu_num, hours_week, marital,
##     native_country, occupation, race, relationship, sex, workclass
```

```
names(dd)
```

```
##  [1] "age"            "workclass"      "edu_num"        "marital"
##  [5] "occupation"     "relationship"   "race"           "sex"
##  [9] "cap_gain"       "cap_loss"       "hours_week"     "native_country"
```

```
# Check classes of variables
sapply(dd, class)
```

```
##            age      workclass        edu_num        marital     occupation
##      "integer"       "factor"      "integer"       "factor"       "factor"
##   relationship           race            sex       cap_gain       cap_loss
##       "factor"       "factor"       "factor"      "integer"      "integer"
##     hours_week native_country
##      "integer"       "factor"
```

3. Selection of Continuous Variables

```
# List of numeric variables
numeriques <- which(sapply(dd, is.numeric))
numeriques
```

```
##        age    edu_num   cap_gain   cap_loss hours_week
##          1          3          9         10         11
```

```
# Create data frame with continuous variables
dcon <- dd[, numeriques]
sapply(dcon, class)
```

```
##        age    edu_num   cap_gain   cap_loss hours_week
##  "integer"  "integer"  "integer"  "integer"  "integer"
```

```
# Note: If there were missing data, one should handle it before PCA
```

4. Principal Component Analysis on Continuous Variables

```
pc1 <- prcomp(dcon, scale = TRUE)
class(pc1)
```

```
## [1] "prcomp"
```

```
attributes(pc1)
```

```
## $names
## [1] "sdev"     "rotation" "center"   "scale"    "x"
##
## $class
## [1] "prcomp"
```

```
print(pc1)
```

```
## Standard deviations (1, .., p=5):
## [1] 1.1359158 1.0158971 0.9921132 0.9390746 0.9008322
##
## Rotation (n x k) = (5 x 5):
##                   PC1         PC2        PC3        PC4        PC5
## age        -0.3704399  0.23545900 -0.7962627  0.1200863  0.3985955
## edu_num    -0.5400647 -0.11720509  0.4760640 -0.3076046  0.6110119
## cap_gain   -0.4743027 -0.50977180 -0.2562210 -0.4152172 -0.5264172
## cap_loss   -0.2433951  0.81837612  0.1274668 -0.3697389 -0.3436054
## hours_week -0.5356306  0.03486056  0.2396494  0.7627886 -0.2694555
```

```
str(pc1)
```

```
## List of 5
##  $ sdev    : num [1:5] 1.136 1.016 0.992 0.939 0.901
##  $ rotation: num [1:5, 1:5] -0.37 -0.54 -0.474 -0.243 -0.536 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:5] "age" "edu_num" "cap_gain" "cap_loss" ...
##   .. ..$ : chr [1:5] "PC1" "PC2" "PC3" "PC4" ...
##  $ center  : Named num [1:5] 38.5 10.1 1023.7 91.3 40.2
##   ..- attr(*, "names")= chr [1:5] "age" "edu_num" "cap_gain" "cap_loss" ...
##  $ scale   : Named num [1:5] 13.84 2.56 7166.66 412.95 12.56
##   ..- attr(*, "names")= chr [1:5] "age" "edu_num" "cap_gain" "cap_loss" ...
##  $ x       : num [1:5000, 1:5] -0.053 0.794 0.714 0.154 0.954 ...
##   ..- attr(*, "dimnames")=List of 2
##   .. ..$ : chr [1:5000] "2986" "29925" "29710" "37529" ...
##   .. ..$ : chr [1:5] "PC1" "PC2" "PC3" "PC4" ...
##  - attr(*, "class")= chr "prcomp"
```

5. Inertia and Variance Percentage

```
# Calculate eigenvalues and inertia
pc1$sdev
```

```
## [1] 1.1359158 1.0158971 0.9921132 0.9390746 0.9008322
```

```
inerProj <- pc1$sdev^2
inerProj
```

```
## [1] 1.2903047 1.0320468 0.9842886 0.8818611 0.8114987
```

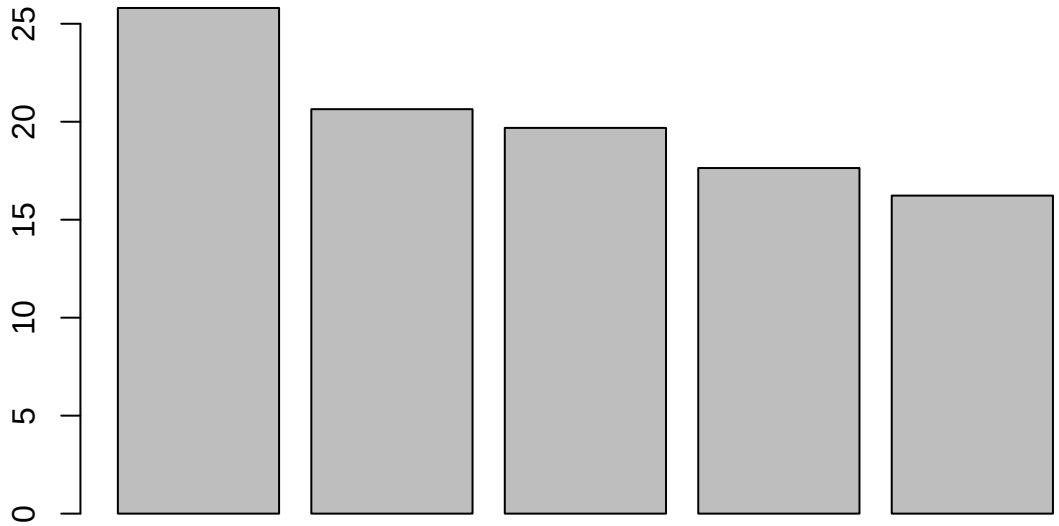
```
totalIner <- sum(inerProj)
totalIner
```

```
## [1] 5
```

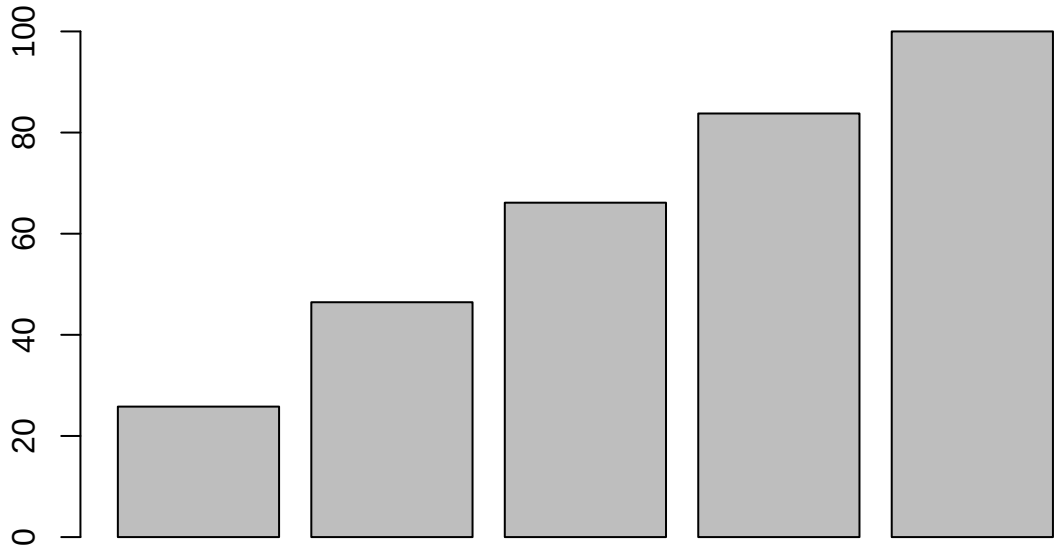
```
pinerEix <- 100 * inerProj / totalIner
pinerEix
```

```
## [1] 25.80609 20.64094 19.68577 17.63722 16.22997
```

```
# Plot individual explained variance
barplot(pinerEix)
```




```
# Plot cumulative explained variance
barplot(100 * cumsum(pc1$sdev[1:dim(dcon)[2]]^2) / dim(dcon)[2])
```




```
percInerAccum <- 100 * cumsum(pc1$sdev[1:dim(dcon)[2]]^2) / dim(dcon)[2]
percInerAccum
```

```
## [1]  25.80609  46.44703  66.13280  83.77003 100.00000
```

6. Selection of Significant Dimensions

```
# Choose first 4 components (~80% total variance)
nd <- 4
print(pc1)
```

```
## Standard deviations (1, .., p=5):
## [1] 1.1359158 1.0158971 0.9921132 0.9390746 0.9008322
##
## Rotation (n x k) = (5 x 5):
##                   PC1         PC2        PC3        PC4        PC5
## age        -0.3704399  0.23545900 -0.7962627  0.1200863  0.3985955
## edu_num    -0.5400647 -0.11720509  0.4760640 -0.3076046  0.6110119
## cap_gain   -0.4743027 -0.50977180 -0.2562210 -0.4152172 -0.5264172
## cap_loss   -0.2433951  0.81837612  0.1274668 -0.3697389 -0.3436054
## hours_week -0.5356306  0.03486056  0.2396494  0.7627886 -0.2694555
```

```
attributes(pc1)
```

```
## $names
## [1] "sdev"     "rotation" "center"   "scale"    "x"
```

```
##
## $class
## [1] "prcomp"
```

```
pc1$rotation
```

```
##                  PC1         PC2        PC3        PC4        PC5
## age        -0.3704399  0.23545900 -0.7962627  0.1200863  0.3985955
## edu_num    -0.5400647 -0.11720509  0.4760640 -0.3076046  0.6110119
## cap_gain   -0.4743027 -0.50977180 -0.2562210 -0.4152172 -0.5264172
## cap_loss   -0.2433951  0.81837612  0.1274668 -0.3697389 -0.3436054
## hours_week -0.5356306  0.03486056  0.2396494  0.7627886 -0.2694555
```

7. Projections in the New Space

```
View(pc1$x)
dim(pc1$x)
```

```
## [1] 5000    5
```

```
dim(dcon)
```

```
## [1] 5000    5
```

```
dcon[2000,]
```

```
##       age edu_num cap_gain cap_loss hours_week
## 33671  42       9        0        0         40
```

```
pc1$x[2000,]
```

```
##           PC1           PC2           PC3           PC4           PC5
##  0.2590887659 -0.0004006728 -0.3945332354  0.2855167304  0.0051248000
```

```
# Store projections
Psi <- pc1$x[, 1:nd]
dim(Psi)
```

```
## [1] 5000    4
```

```
# Example access to projection of a single observation
Psi[2000,]
```

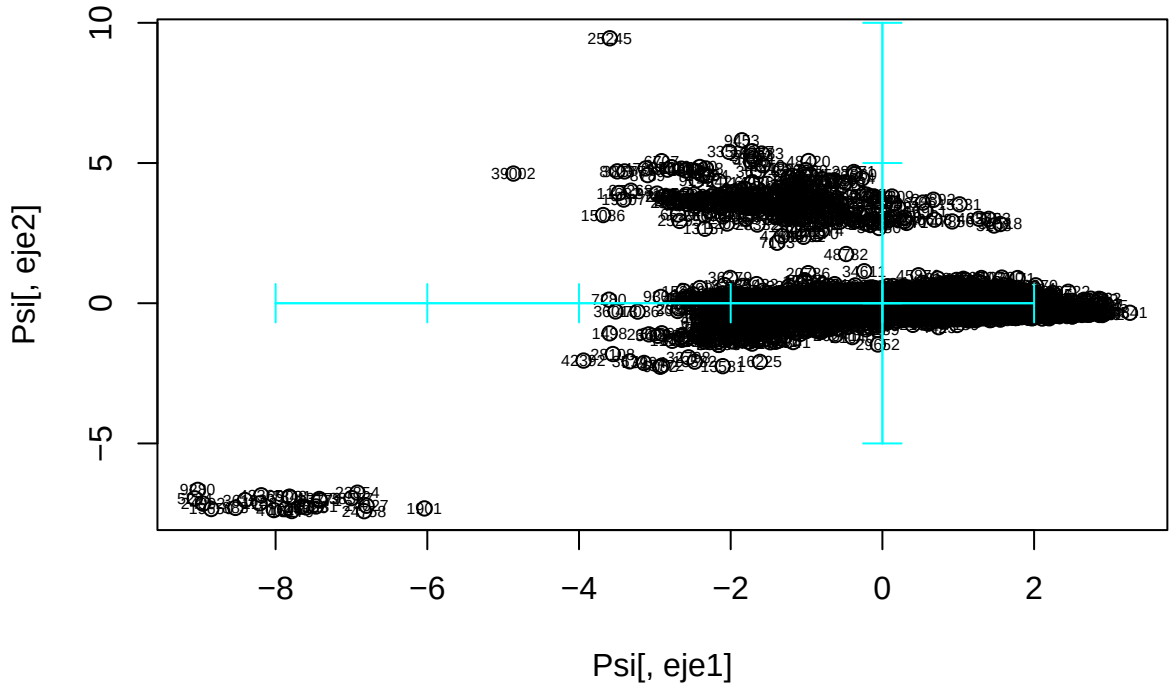
```
##           PC1           PC2           PC3           PC4
##  0.2590887659 -0.0004006728 -0.3945332354  0.2855167304
```

```
# Labels and indices
iden <- row.names(dcon)
etiq <- names(dcon)
ze <- rep(0, length(etiq))
```

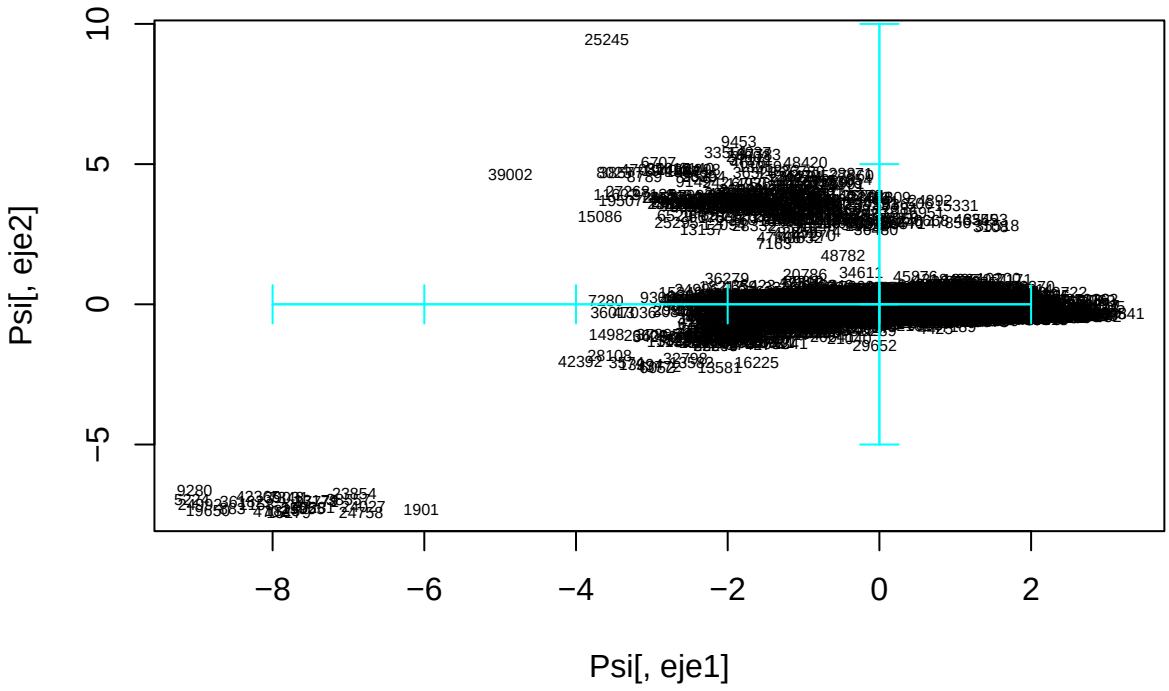
8. Plotting Individuals in the First Plane

```
eje1 <- 1
eje2 <- 2

# Plot with labels
```

```
plot(Psi[, eje1], Psi[, eje2])
text(Psi[, eje1], Psi[, eje2], labels = iden, cex = 0.5)
axis(side = 1, pos = 0, labels = FALSE, col = "cyan")
axis(side = 3, pos = 0, labels = FALSE, col = "cyan")
axis(side = 2, pos = 0, labels = FALSE, col = "cyan")
axis(side = 4, pos = 0, labels = FALSE, col = "cyan")
```

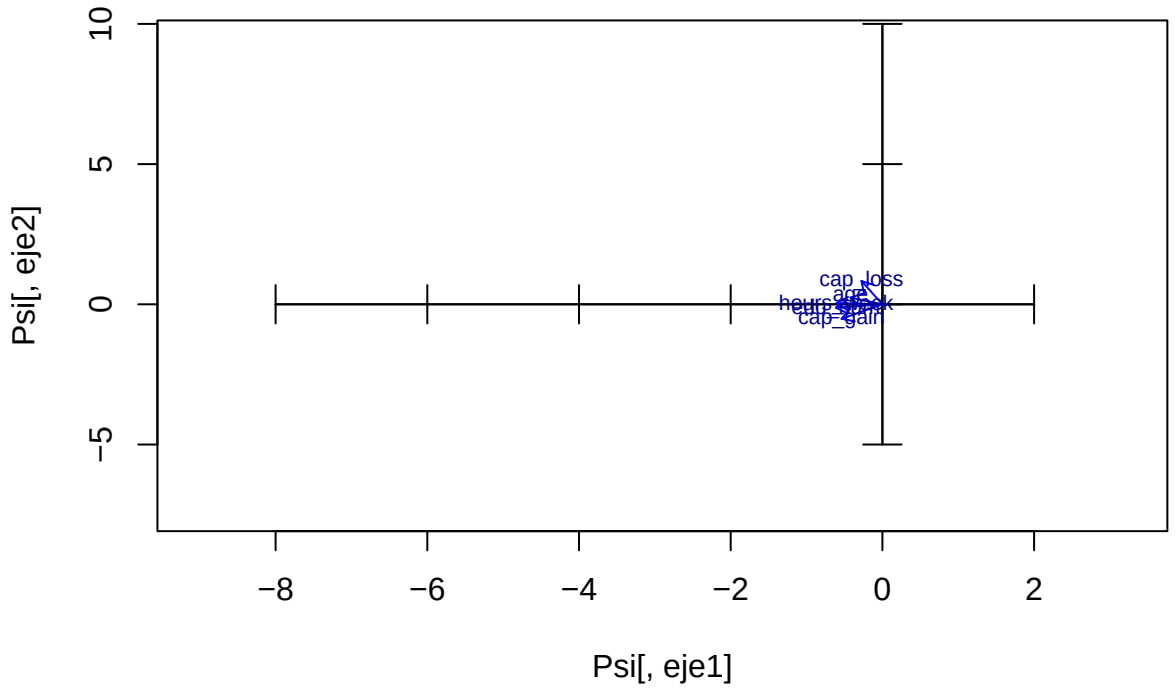



```
# Empty plot with only text
plot(Psi[, eje1], Psi[, eje2], type = "n")
text(Psi[, eje1], Psi[, eje2], labels = iden, cex = 0.5)
axis(side = 1, pos = 0, labels = FALSE, col = "cyan")
axis(side = 3, pos = 0, labels = FALSE, col = "cyan")
axis(side = 2, pos = 0, labels = FALSE, col = "cyan")
axis(side = 4, pos = 0, labels = FALSE, col = "cyan")
```

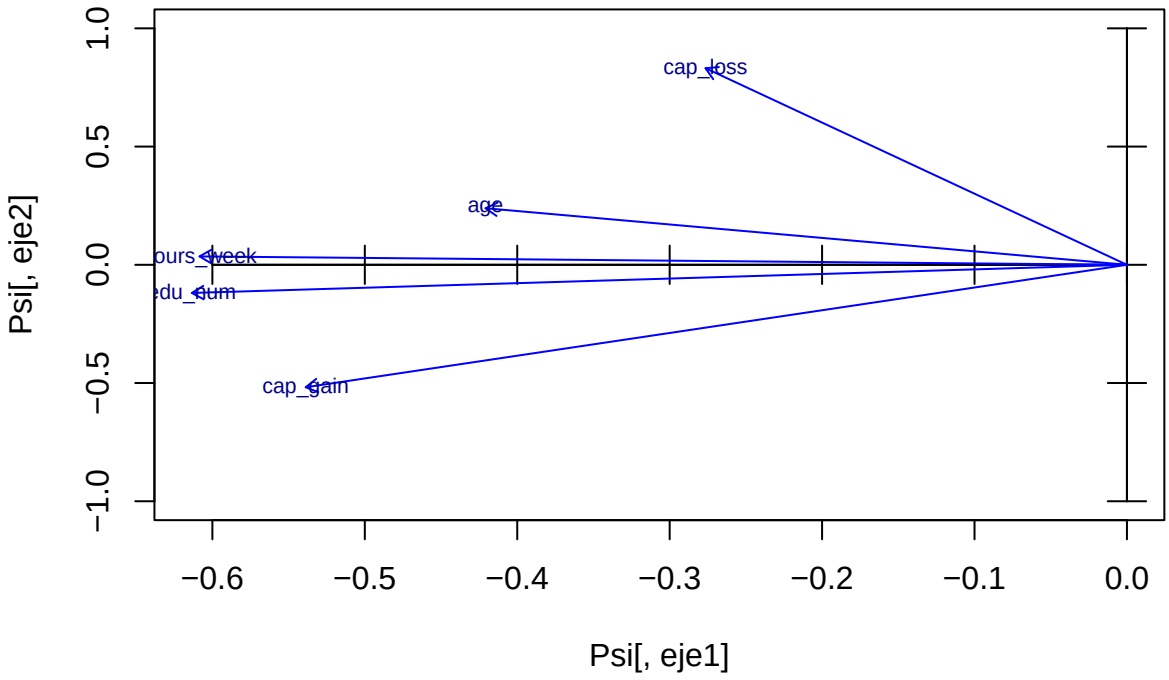


9. Projection of Continuous Variables on the Principal Plane

```
Phi <- cor(dcon, Psi)
View(Phi)
X <- Phi[, eje1]
Y <- Phi[, eje2]

plot(Psi[, eje1], Psi[, eje2], type = "n")
axis(side = 1, pos = 0, labels = FALSE)
axis(side = 3, pos = 0, labels = FALSE)
axis(side = 2, pos = 0, labels = FALSE)
axis(side = 4, pos = 0, labels = FALSE)
arrows(ze, ze, X, Y, length = 0.07, col = "blue")
text(X, Y, labels = etiq, col = "darkblue", cex = 0.7)
```

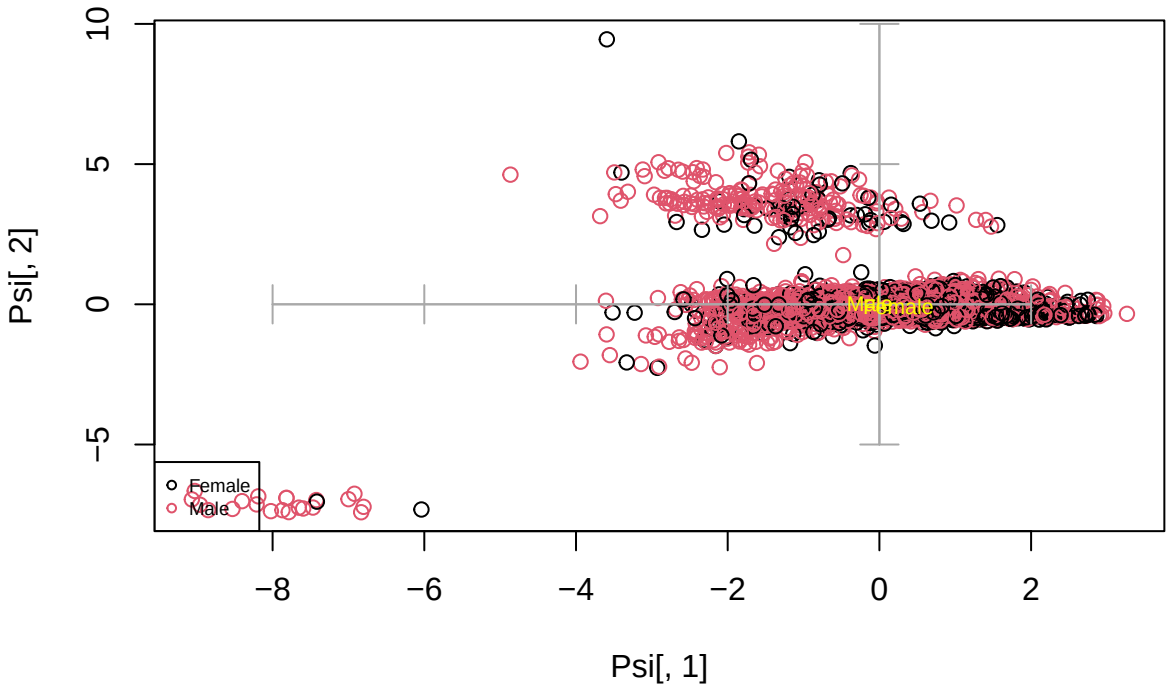



```
# Zoom using variable-based limits
plot(Psi[, eje1], Psi[, eje2], type = "n",
     xlim = c(min(X, 0), max(X, 0)),
     ylim = c(-1, 1))
axis(side = 1, pos = 0, labels = FALSE)
axis(side = 3, pos = 0, labels = FALSE)
axis(side = 2, pos = 0, labels = FALSE)
axis(side = 4, pos = 0, labels = FALSE)
arrows(ze, ze, X, Y, length = 0.07, col = "blue")
text(X, Y, labels = etiq, col = "darkblue", cex = 0.7)
```



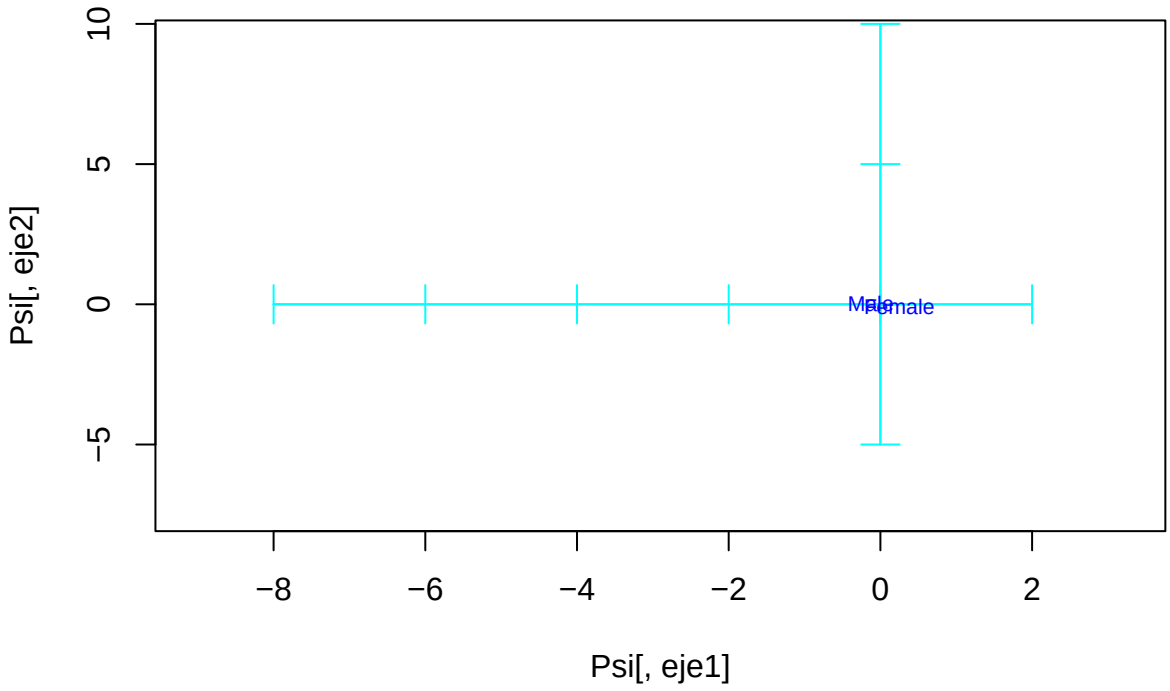
10. Projection of Qualitative Variables (Illustrative Category)

```r
# Example with variable in column 8
varcat <- factor(dd[, 8])
plot(Psi[, 1], Psi[, 2], col = varcat)
axis(side = 1, pos = 0, labels = FALSE, col = "darkgray")
axis(side = 3, pos = 0, labels = FALSE, col = "darkgray")
axis(side = 2, pos = 0, labels = FALSE, col = "darkgray")
axis(side = 4, pos = 0, labels = FALSE, col = "darkgray")
legend("bottomleft", levels(factor(varcat)), pch = 1, col = c(1, 2), cex = 0.6)

k <- 8 # gender (male or female)
varcat <- factor(dd[, k])
fdic1 <- tapply(Psi[, eje1], varcat, mean)
fdic2 <- tapply(Psi[, eje2], varcat, mean)
text(fdic1, fdic2, labels = levels(varcat), col = "yellow", cex = 0.7)
```



11. Projection of Centroids for a Qualitative Variable without Individuals

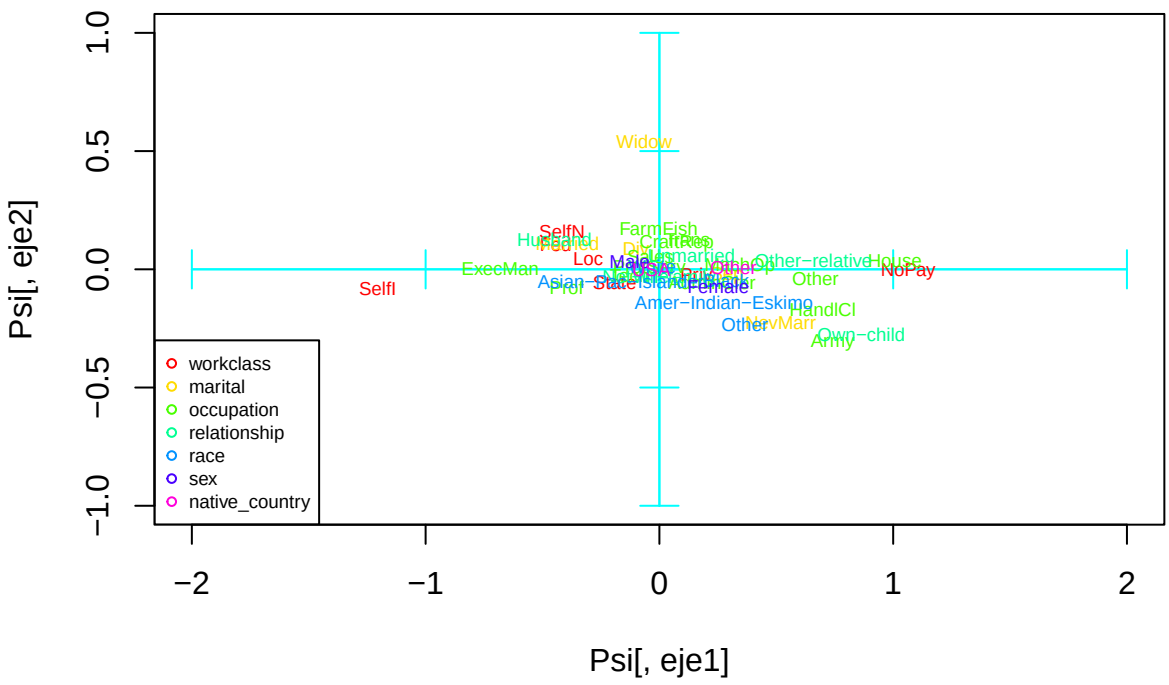
```r
# Empty plot
plot(Psi[, eje1], Psi[, eje2], type = "n")
axis(side = 1, pos = 0, labels = FALSE, col = "cyan")
axis(side = 3, pos = 0, labels = FALSE, col = "cyan")
axis(side = 2, pos = 0, labels = FALSE, col = "cyan")
axis(side = 4, pos = 0, labels = FALSE, col = "cyan")

# Same variable k = 8
# fdic1, fdic2 assumed computed above
text(fdic1, fdic2, labels = levels(varcat), col = "blue", cex = 0.7)
```



12. Joint Projection of All Qualitative Variables

```
x_center <- mean(Psi[, eje1])
y_center <- mean(Psi[, eje2])

plot(Psi[, eje1], Psi[, eje2], type = "n",
     xlim = x_center + c(-2, 2),
     ylim = y_center + c(-1, 1))
axis(side = 1, pos = 0, labels = FALSE, col = "cyan")
axis(side = 3, pos = 0, labels = FALSE, col = "cyan")
axis(side = 2, pos = 0, labels = FALSE, col = "cyan")
axis(side = 4, pos = 0, labels = FALSE, col = "cyan")

dcat <- c(2, 4:8, 12)
colors <- rainbow(length(dcat))
c <- 1
for (k in dcat) {
  seguentColor <- colors[c]
  fdic1 <- tapply(Psi[, eje1], dd[, k], mean)
  fdic2 <- tapply(Psi[, eje2], dd[, k], mean)
  text(fdic1, fdic2, labels = levels(factor(dd[, k])),
       col = seguentColor, cex = 0.6)
  c <- c + 1
}
```

```
legend("bottomleft", names(dd)[dcat], pch = 1, col = colors, cex = 0.6)
```



13. Custom Color Palette and Final Plot

```
colors <- c("red", "blue", "darkgreen",
            "orange", "violet", "magenta", "pink")

plot(Psi[, eje1], Psi[, eje2], type = "n", xlim = c(-1, 1), ylim = c(-3, 1))
axis(side = 1, pos = 0, labels = FALSE, col = "cyan")
axis(side = 3, pos = 0, labels = FALSE, col = "cyan")
axis(side = 2, pos = 0, labels = FALSE, col = "cyan")
axis(side = 4, pos = 0, labels = FALSE, col = "cyan")

arrows(ze, ze, X, Y, length = 0.07, col = "lightgray")
text(X, Y, labels = etiq, col = "gray", cex = 0.7)

c <- 1
for (k in dcat) {
  seguentColor <- colors[c]
  fdic1 <- tapply(Psi[, eje1], dd[, k], mean)
  fdic2 <- tapply(Psi[, eje2], dd[, k], mean)
  text(fdic1, fdic2, labels = levels(factor(dd[, k])),
       col = seguentColor, cex = 0.6)
  c <- c + 1
```

```
}
legend("bottomleft", names(dd)[dcat], pch = 19, col = colors, cex = 0.6)
```