

The file `Women1f.csv` from `library(car)` contains the data drawn from a survey of 263 married Canadian women. It includes `partic`, the labor-force participation, with 3 levels (not.work, parttime, and fulltime), `hincome`, the husband's income (000s), and, `children`, the presence of children in the household with 2 levels (absent and present).

- a) Fit a multinomial model to predict the labor-force participation with husband income and presence of children as predictors
- b) Predict the probability for each level of the labor-force participation.
- c) Plot the predicted probabilities for labor force participation (separate plots for children absent and present).

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library(car)
set.seed(101) # to reproduce the results in the text
head(Womenlf)
#   partic hincome children region
#1 not.work      15  present Ontario
#2 not.work      13  present Ontario
#3 not.work      45  present Ontario
#4 not.work      23  present Ontario
#5 not.work      19  present Ontario
#6 not.work       7  present Ontario
str(Womenlf)
# 'data.frame': 263 obs. of 4 variables:
# $ partic : Factor w/ 3 levels "fulltime","not.work",...: 2 2 2 2 2 2 2 1 2 2 ...
# $ hincome : int 15 13 45 23 19 7 15 7 15 23 ...
# $ children: Factor w/ 2 levels "absent","present": 2 2 2 2 2 2 2 2 2 2 ...
# $ region : Factor w/ 5 levels "Atlantic","BC",...: 3 3 3 3 3 3 3 3 3 3 ...

library(nnet)
d0 = Womenlf
Womenlf$partic <- factor(Womenlf$partic,levels=c("not.work", "parttime", "fulltime"))
# relevele
levels(d0$partic)
# [1] "fulltime" "not.work" "parttime"
levels(Womenlf$partic)
# [1] "not.work" "parttime" "fulltime"

mod.multinom <- multinom(partic~hincome+children,Womenlf)
summary(mod.multinom)

#Coefficients:
#           (Intercept)      hincome childrenpresent
#parttime  -1.432321  0.006893838      0.02145558
#fulltime   1.982842 -0.097232073     -2.55860537

#Std. Errors:
#           (Intercept)      hincome childrenpresent
#parttime   0.5924627 0.02345484      0.4690352
#fulltime   0.4841789 0.02809599      0.3621999

#Residual Deviance: 422.8819
#AIC

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summary(Women1f)
#      partic      hincome      children      region
# not.work:155   Min.    : 1.00   absent : 79   Atlantic: 30
# parttime: 42   1st Qu.:10.00   present:184 BC      : 29
# fulltime: 66   Median :14.00                      Ontario :108
#               Mean    :14.76                      Prairie  : 31
#               3rd Qu.:19.00                      Quebec   : 65
#               Max.    :45.00

Predictors <- expand.grid(hincome=1:45,children=c("absent", "present"))
summary(Predictors)
#      hincome      children
# Min.      : 1   absent :45
# 1st Qu.:12   present:45
# Median :23
# Mean    :23
# 3rd Qu.:34
# Max.    :45

dim(Predictors)
# [1] 90  2

p.fit <- predict(mod.multinom, newdata=Predictors, type="probs")

head(d0)
#      partic hincome children region
#1 not.work    15  present Ontario
#2 not.work    13  present Ontario
#3 not.work    45  present Ontario
#4 not.work    23  present Ontario
#5 not.work    19  present Ontario
#6 not.work     7  present Ontario

d1 = data.frame(Predictors,p.fit)
head(d1)
# hincome children not.work parttime fulltime
#1      1   absent 0.1277013 0.03070011 0.8415986
#2      2   absent 0.1384694 0.03351911 0.8280115
#3      3   absent 0.1499377 0.03654631 0.8135159
#4      4   absent 0.1621165 0.03978814 0.7980954
#5      5   absent 0.1750098 0.04324967 0.7817406
#6      6   absent 0.1886151 0.04693435 0.7644506

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# plots
par(mfrow=c(1, 2))
xaxis = 1:45
plot(xaxis,d1[1:45,3],type="l",ylim=c(0,1),xlab="Husband's Income",
      ylab="Fitted Probability",main="Children Absent") # not working
lines(xaxis,d1[1:45,4], lty=2) # part-time
lines(xaxis,d1[1:45,5], lty=3) # full-time
legend("topright", lty=1:3, lwd=3, cex=0.75, inset=0.01,
      legend=c("not working", "part-time", "full-time"))

grid()
xaxis = 46:90
plot(xaxis, d1[46:90,3], type="l",ylim=c(0,1),xlab="Husband's Income",
      ylab="",main="Children Present") # not working
lines(xaxis, d1[46:90,4], lty=2) # part-time
lines(xaxis, d1[46:90,5], lty=3) # full-time
grid()
par(mfrow=c(1, 1))

Anova(mod.multinom)
# Analysis of Deviance Table (Type II tests)
#Response: partic
#
#      LR Chisq Df Pr(>Chisq)
#hincome    15.153  2  0.0005123 ***
#children   63.559  2  1.579e-14 ***

mod.multinom.1 <- update(mod.multinom, . ~ . - region)
summary(mod.multinom.1, Wald=T)

#Coefficients:
#      (Intercept)      hincome childrenpresent
#parttime    -1.432321  0.006893838      0.02145558
#fulltime     1.982842 -0.097232073     -2.55860537

#Std. Errors:
#      (Intercept)      hincome childrenpresent
#parttime    0.5924627 0.02345484      0.4690352
#fulltime    0.4841789 0.02809599      0.3621999

#Value/SE (Wald statistics):
#      (Intercept)      hincome childrenpresent
#parttime    -2.417573  0.2939197      0.04574407
#fulltime     4.095266 -3.4607098     -7.06407045

#Residual Deviance: 422.8819
#AIC: 434.8819

```

