Supervied Learning Assignment

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R Markdown

This is an R Markdown of a walkthrough for our assignment. The dataset we used was taken from UCI machine learning repository, Which can be found here: https://archive.ics.uci.edu/ml/datasets/Census+Income

A link to the R Shiny app can be found here: https://markglewis.shinyapps.io/IncomePrediction/

To begin install the following packages

```
#import packages;
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

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

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

```
library(reshape2)
library(ggplot2)
library(Hmisc)
```

```
## Loading required package: lattice

## Loading required package: survival

## Loading required package: Formula

##
## Attaching package: 'Hmisc'

## The following objects are masked from 'package:dplyr':
##
##     src, summarize

## The following objects are masked from 'package:base':
##
##     format.pval, units
```

```
library(corrplot)
```

```
## corrplot 0.84 loaded
```

```
library(mice)
```

```
##
## Attaching package: 'mice'
```

```
## The following objects are masked from 'package:base':
##
##     cbind, rbind
```

```
library(VIM)
```

```
## Loading required package: colorspace
```

```
## Loading required package: grid
```

```
## Loading required package: data.table
```

```
##
## Attaching package: 'data.table'
```

```
## The following objects are masked from 'package:reshape2':
##
##     dcast, melt
```

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

```
## VIM is ready to use.
##  Since version 4.0.0 the GUI is in its own package VIMGUI.
##
##           Please use the package to use the new (and old) GUI.
```

```
## Suggestions and bug-reports can be submitted at: https://github.com/alexkowa/VIM/issues
```

```
##
## Attaching package: 'VIM'
```

```
## The following object is masked from 'package:datasets':
##
##     sleep
```

```
library(pROC)
```

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

##
## Attaching package: 'pROC'

## The following object is masked from 'package:colorspace':
##
##     coords

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

```
library(caret)
```

```
##
## Attaching package: 'caret'

## The following object is masked from 'package:survival':
##
##     cluster
```

```
library(sqldf)
```

```
## Loading required package: gsubfn

## Loading required package: proto

## Loading required package: RSQLite
```

```
library(rpart)
```

```
##
## Attaching package: 'rpart'

## The following object is masked from 'package:survival':
##
##     solder
```

```
library(e1071)
```

```
##
## Attaching package: 'e1071'

## The following object is masked from 'package:Hmisc':
##
##     impute
```

```
library(C50)
```

Import the data set and rename the Columns for readability

```
## [1] "C:/code/ML York/Assignment 1"
```

```
## 'data.frame':    32561 obs. of  16 variables:
##  $ age           : int  39 50 38 53 28 37 49 52 31 42 ...
##  $ workclass     : Factor w/ 9 levels " ?"," Federal-gov",..: 8 7 5 5 5 5 5 7 5 5 ...
##  $ fnlwgt        : int  77516 83311 215646 234721 338409 284582 160187 209642 45781 159449 ...
##  $ education     : Factor w/ 16 levels " 10th"," 11th",..: 10 10 12 2 10 13 7 12 13 10 ...
##  $ education-num : int  13 13 9 7 13 14 5 9 14 13 ...
##  $ marStat       : Factor w/ 7 levels " Divorced"," Married-AF-spouse",..: 5 3 1 3 3 3 4 3 5 3 ...
##  $ occupation    : Factor w/ 15 levels " ?"," Adm-clerical",..: 2 5 7 7 11 5 9 5 11 5 ...
##  $ relationship  : Factor w/ 6 levels " Husband"," Not-in-family",..: 2 1 2 1 6 6 2 1 2 1 ...
##  $ race          : Factor w/ 5 levels " Amer-Indian-Eskimo",..: 5 5 5 3 3 5 3 5 5 5 ...
##  $ sex           : Factor w/ 2 levels " Female"," Male": 2 2 2 2 1 1 1 2 1 2 ...
##  $ capital-gain  : int  2174 0 0 0 0 0 0 0 14084 5178 ...
##  $ capital-loss  : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ hrs-per-week  : int  40 13 40 40 40 40 16 45 50 40 ...
##  $ native-country: Factor w/ 42 levels " ?"," Cambodia",..: 40 40 40 40 6 40 24 40 40 40 ...
##  $ income        : Factor w/ 2 levels " <=50K"," >50K": 1 1 1 1 1 1 1 2 2 2 ...
##  $ ID            : int  1 2 3 4 5 6 7 8 9 10 ...
```

```
##       age                    workclass         fnlwgt       
##  Min.   :17.00    Private         :22696   Min.   :  12285  
##  1st Qu.:28.00    Self-emp-not-inc: 2541   1st Qu.: 117827  
##  Median :37.00    Local-gov       : 2093   Median : 178356  
##  Mean   :38.58    ?               : 1836   Mean   : 189778  
##  3rd Qu.:48.00    State-gov       : 1298   3rd Qu.: 237051  
##  Max.   :90.00    Self-emp-inc    : 1116   Max.   :1484705  
##                  (Other)          :  981                    
##          education     education-num                    marStat     
##   HS-grad     :10501   Min.   : 1.00    Divorced             : 4443  
##   Some-college: 7291   1st Qu.: 9.00    Married-AF-spouse    :   23  
##   Bachelors   : 5355   Median :10.00    Married-civ-spouse   :14976  
##   Masters     : 1723   Mean   :10.08    Married-spouse-absent:  418  
##   Assoc-voc   : 1382   3rd Qu.:12.00    Never-married        :10683  
##   11th        : 1175   Max.   :16.00    Separated            : 1025  
##  (Other)      : 5134                    Widowed              :  993  
##             occupation            relationship  
##   Prof-specialty :4140    Husband       :13193  
##   Craft-repair   :4099    Not-in-family : 8305  
##   Exec-managerial:4066    Other-relative:  981  
##   Adm-clerical   :3770    Own-child     : 5068  
##   Sales          :3650    Unmarried     : 3446  
##   Other-service  :3295    Wife          : 1568  
##  (Other)         :9541                          
##                   race            sex         capital-gain   
##   Amer-Indian-Eskimo:  311    Female:10771   Min.   :    0  
##   Asian-Pac-Islander: 1039    Male  :21790   1st Qu.:    0  
##   Black             : 3124                   Median :    0  
##   Other             :  271                   Mean   : 1078  
```

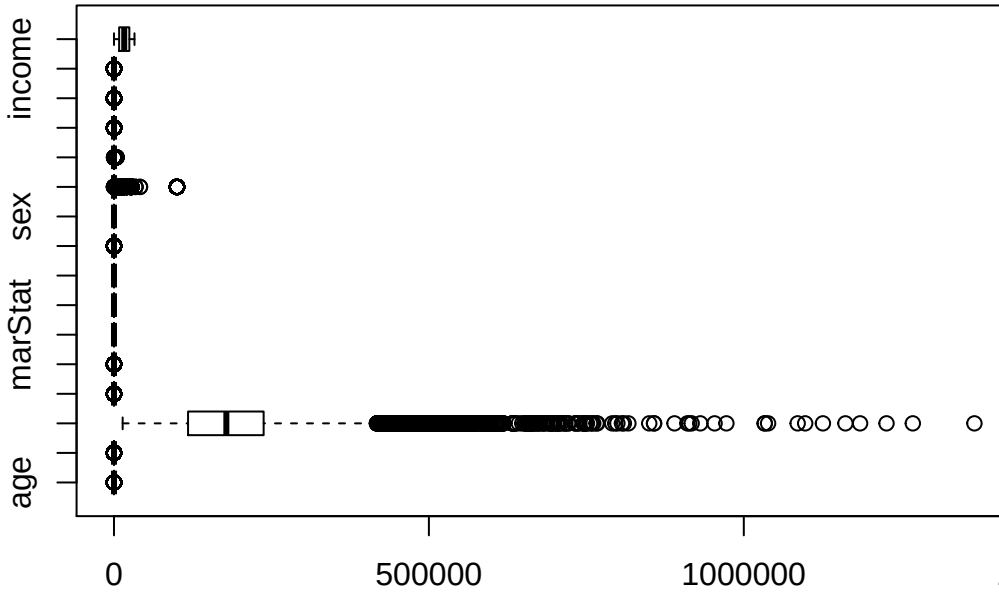
```
##   White             :27816                  3rd Qu.:    0
##                                             Max.   :99999
##
##   capital-loss     hrs-per-week          native-country     income
##  Min.   :   0.0   Min.   : 1.00    United-States:29170    <=50K:24720
##  1st Qu.:   0.0   1st Qu.:40.00    Mexico       :  643    >50K : 7841
##  Median :   0.0   Median :40.00    ?            :  583
##  Mean   :  87.3   Mean   :40.44    Philippines  :  198
##  3rd Qu.:   0.0   3rd Qu.:45.00    Germany      :  137
##  Max.   :4356.0   Max.   :99.00    Canada       :  121
##                                   (Other)      : 1709
##        ID
##  Min.   :    1
##  1st Qu.: 8141
##  Median :16281
##  Mean   :16281
##  3rd Qu.:24421
##  Max.   :32561
##
```

Search for missing data

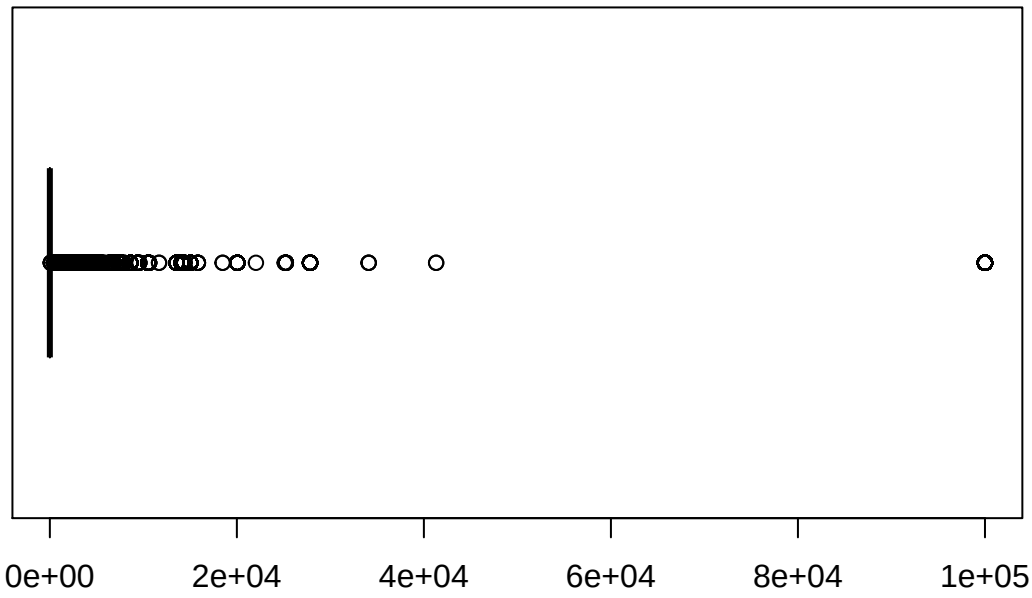
```
## [1] 4262
```

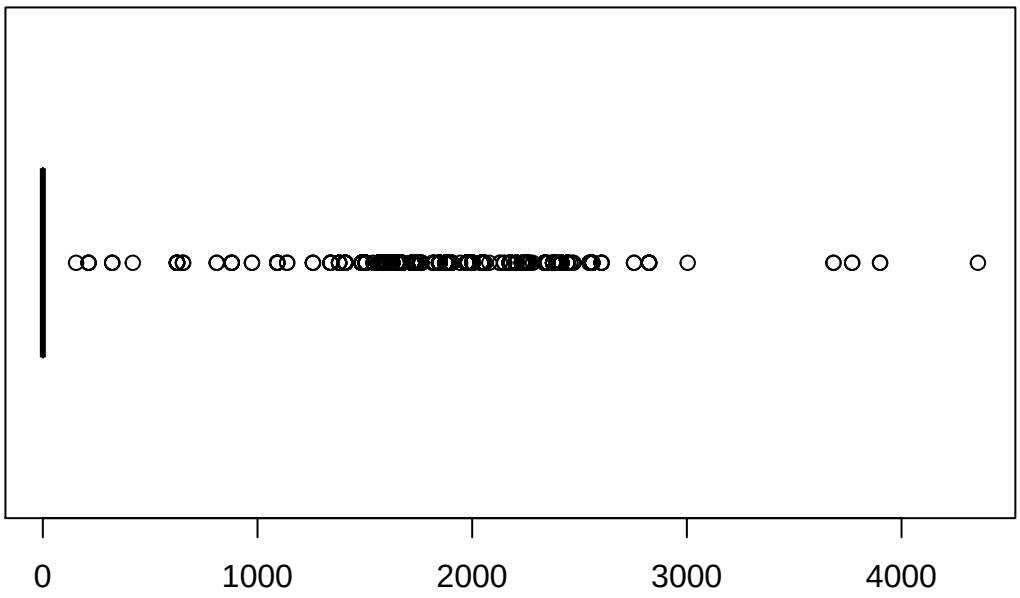
```
## [1] 0.008180799
```

Erase rows with missing data



Find any outliers in the dataset

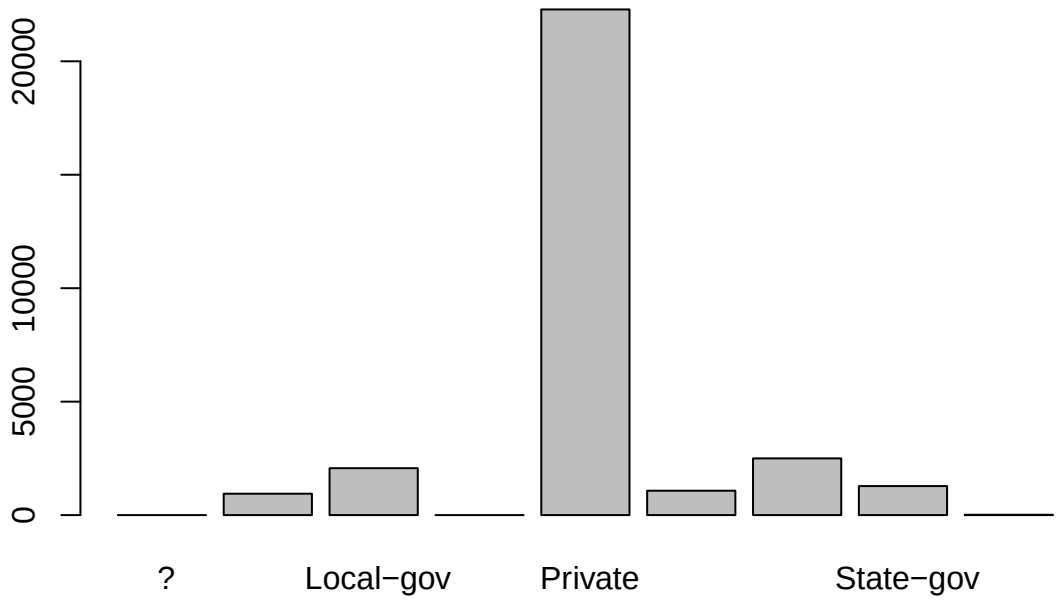

0e+00
2e+04
4e+04
6e+04
8e+04
1e+05

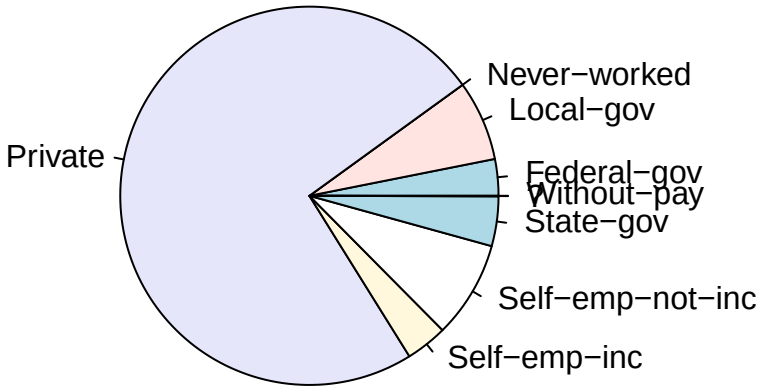


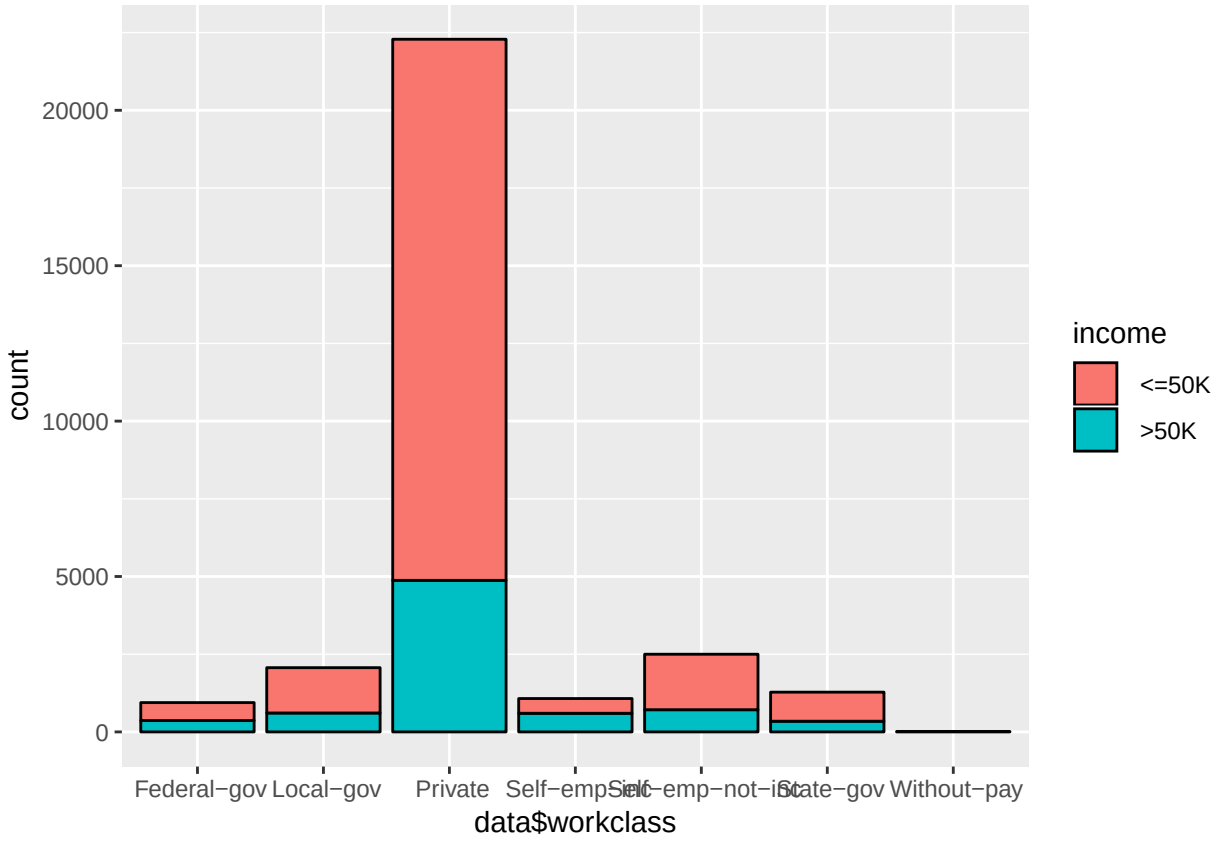
The most outliers and inconsistency are: fnlwgt data$'capital - gaindata$'capital-loss data$'native-country

Let's do some more data exploration

```
## workclass
##             ?   Federal-gov     Local-gov  Never-worked       Private
##             0           943          2067             0         22286
##  Self-emp-inc
##          1074
```


0
5000
10000
20000
?
Local−gov
Private
State−gov

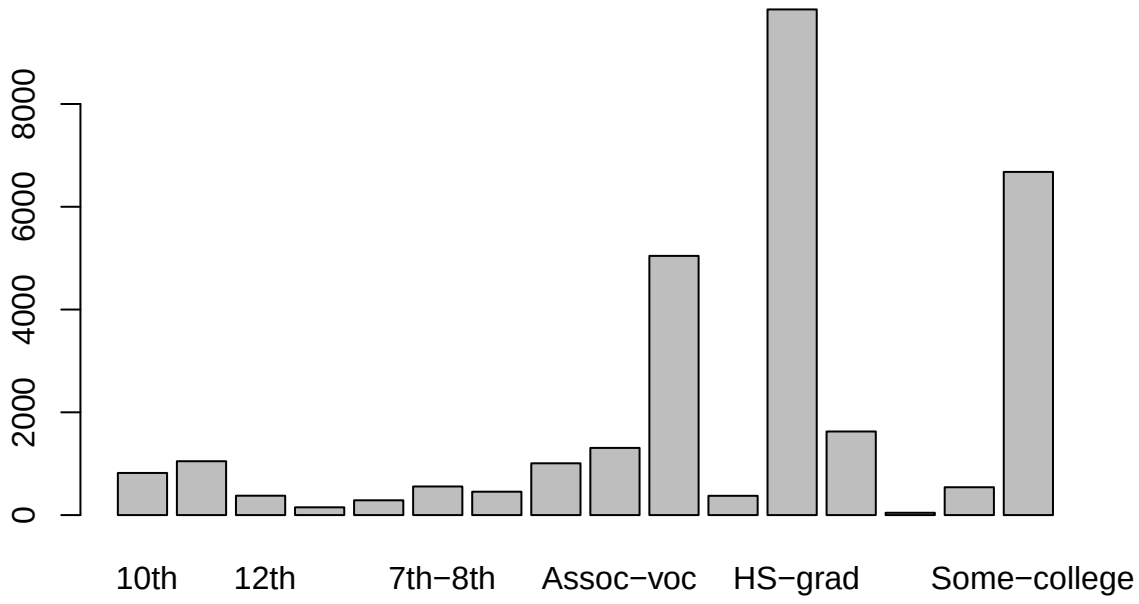

Never−worked
Local−gov
Private
Federal−gov
?
Without−pay
State−gov
Self−emp−not−inc
Self−emp−inc

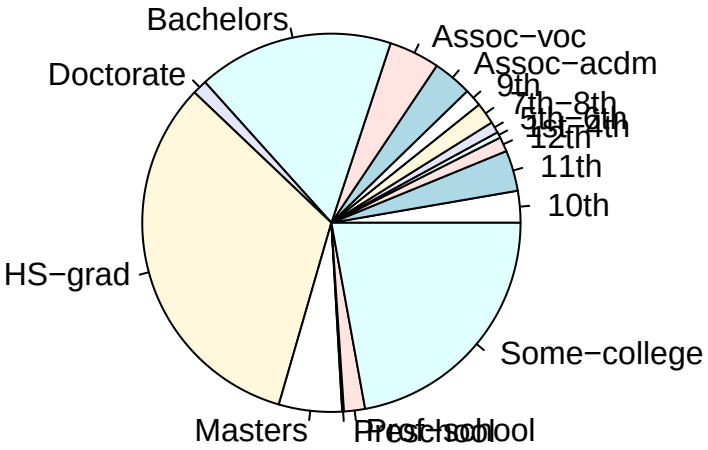


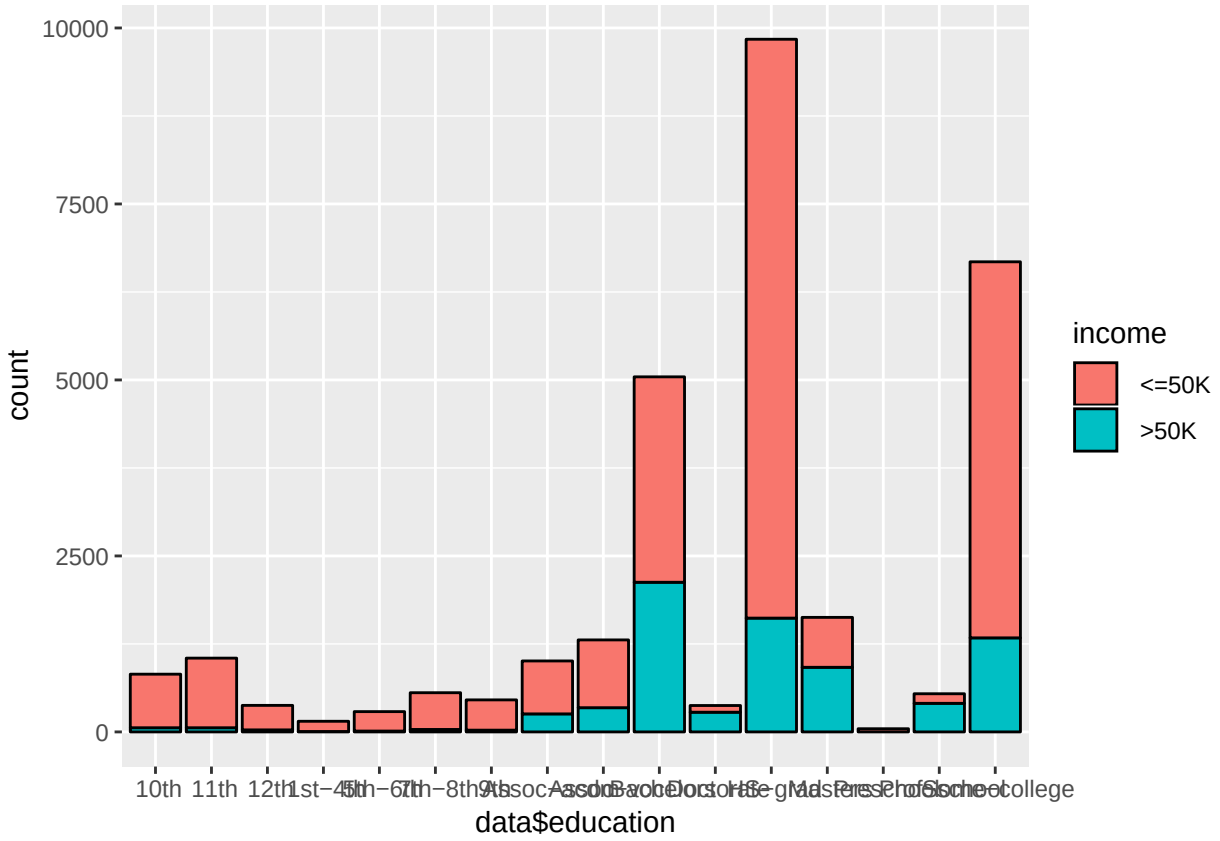
As illustrated, the vast majority of people earn less than $50K and work for private companies. This would imply that the dataset is not balanced and biased towards low income individuals.

```
## The following objects are masked from data (pos = 3):
##
##     age, capital-gain, capital-loss, education, education-num,
##     fnlwgt, hrs-per-week, ID, income, marStat, native-country,
##     occupation, race, relationship, sex, workclass

## education
##     10th     11th     12th  1st-4th  5th-6th  7th-8th
##      820     1048      377      151      288      557
```


0
2000
4000
6000
8000
10th
12th
7th−8th
Assoc−voc
HS−grad
Some−college


Bachelors
Assoc−voc
Assoc−acdm
9th
7th−8th
12th
11th
10th
Doctorate
HS−grad
Some−college
Masters
Prof−school



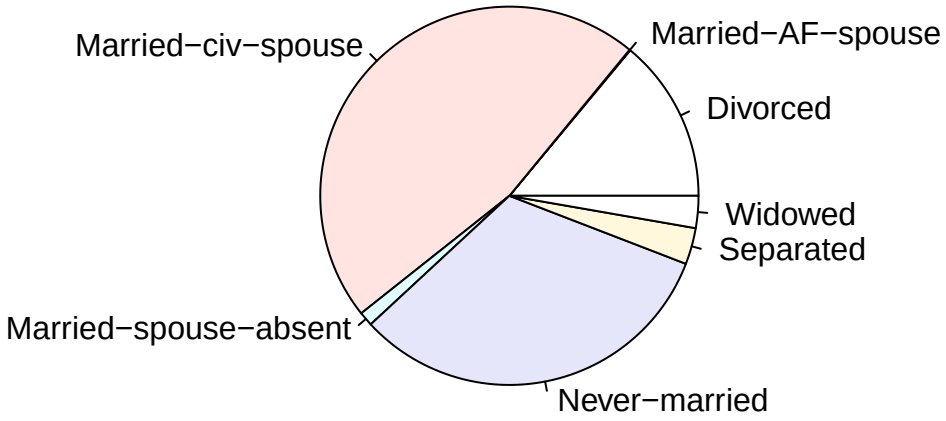
Data shows a pretty even spread When it comes to education.

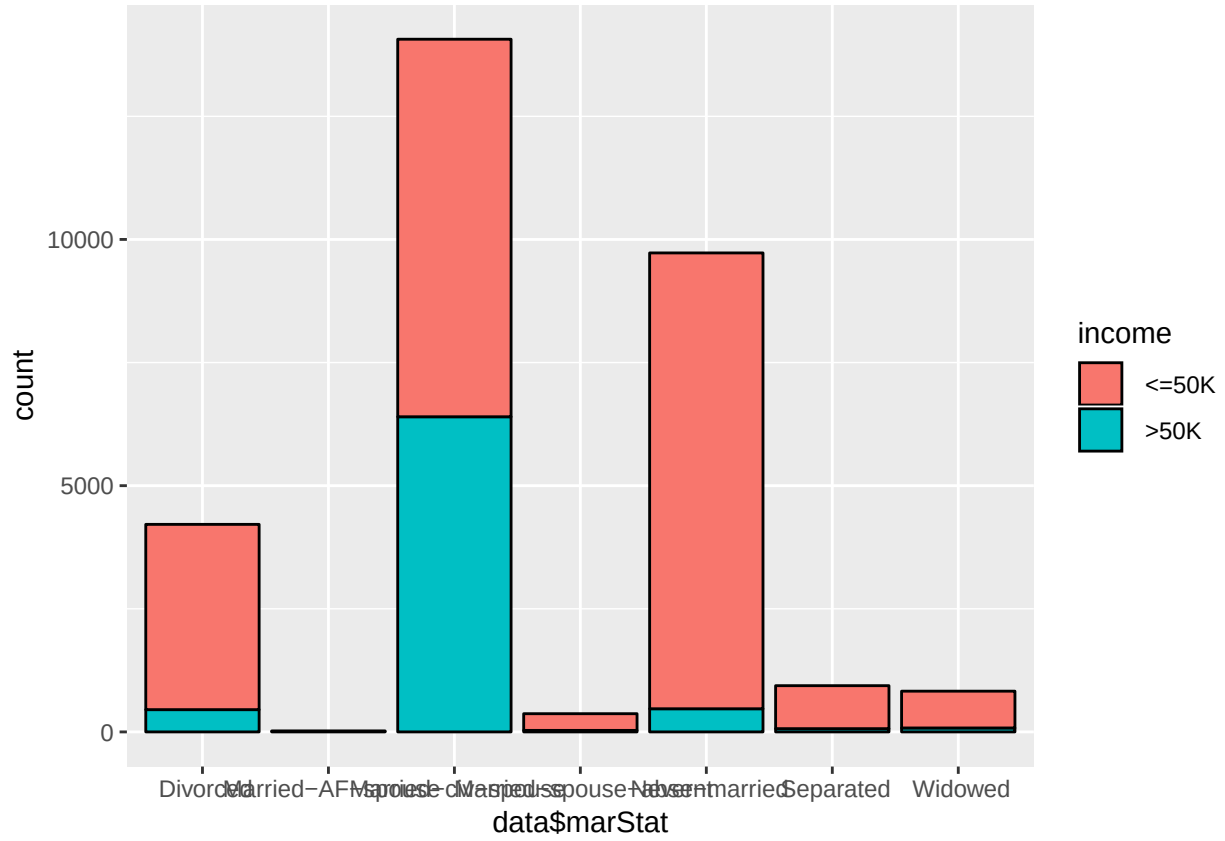
```
## The following objects are masked from data (pos = 3):
##
##     age, capital-gain, capital-loss, education, education-num,
##     fnlwgt, hrs-per-week, ID, income, marStat, native-country,
##     occupation, race, relationship, sex, workclass

## The following objects are masked from data (pos = 4):
##
##     age, capital-gain, capital-loss, education, education-num,
##     fnlwgt, hrs-per-week, ID, income, marStat, native-country,
##     occupation, race, relationship, sex, workclass

## marStat
##               Divorced      Married-AF-spouse     Married-civ-spouse
##                   4214                     21                  14065
##  Married-spouse-absent          Never-married              Separated
##                    370                   9726                    939
```

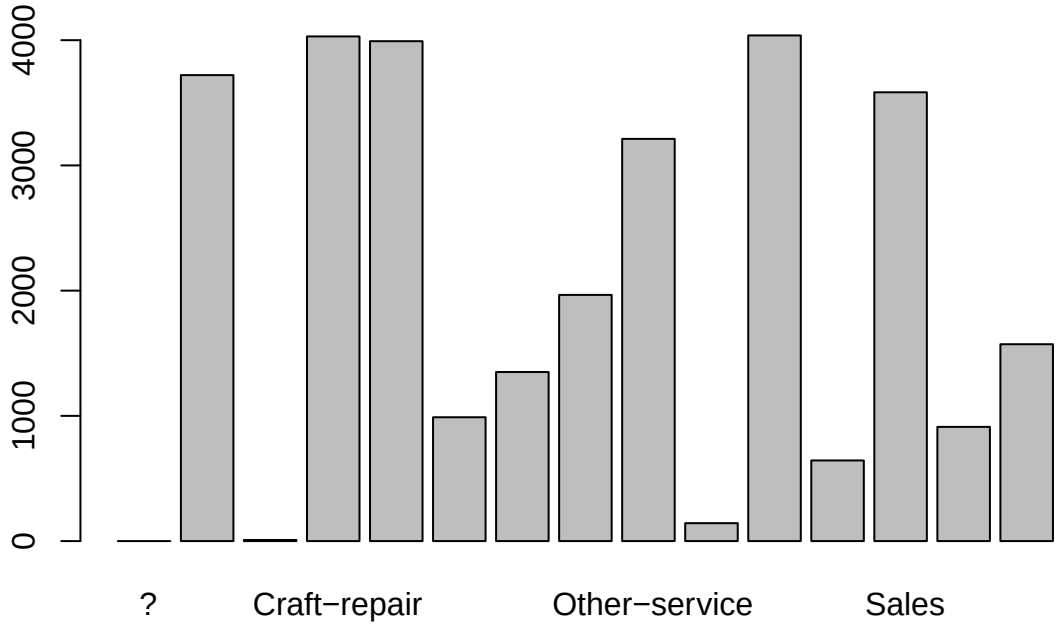

0
2000
6000
10000
14000
Divorced
Married−civ−spouse
Separated

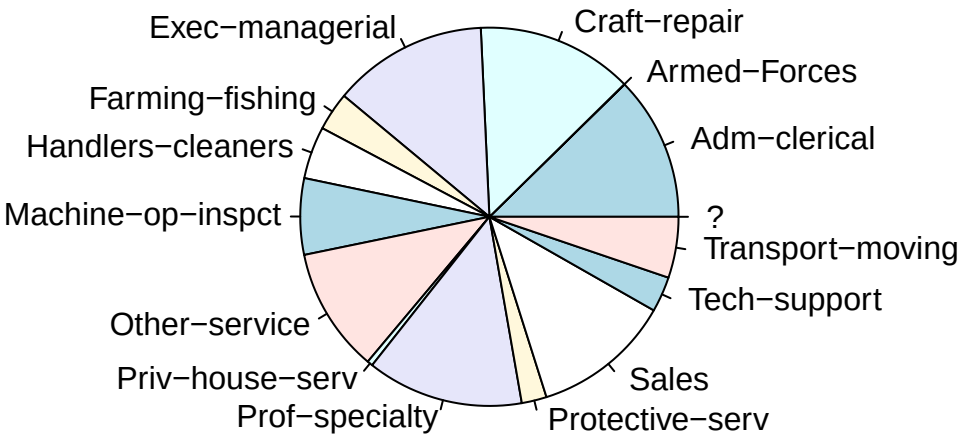

Married−civ−spouse
Married−AF−spouse
Divorced
Widowed
Separated
Married−spouse−absent
Never−married

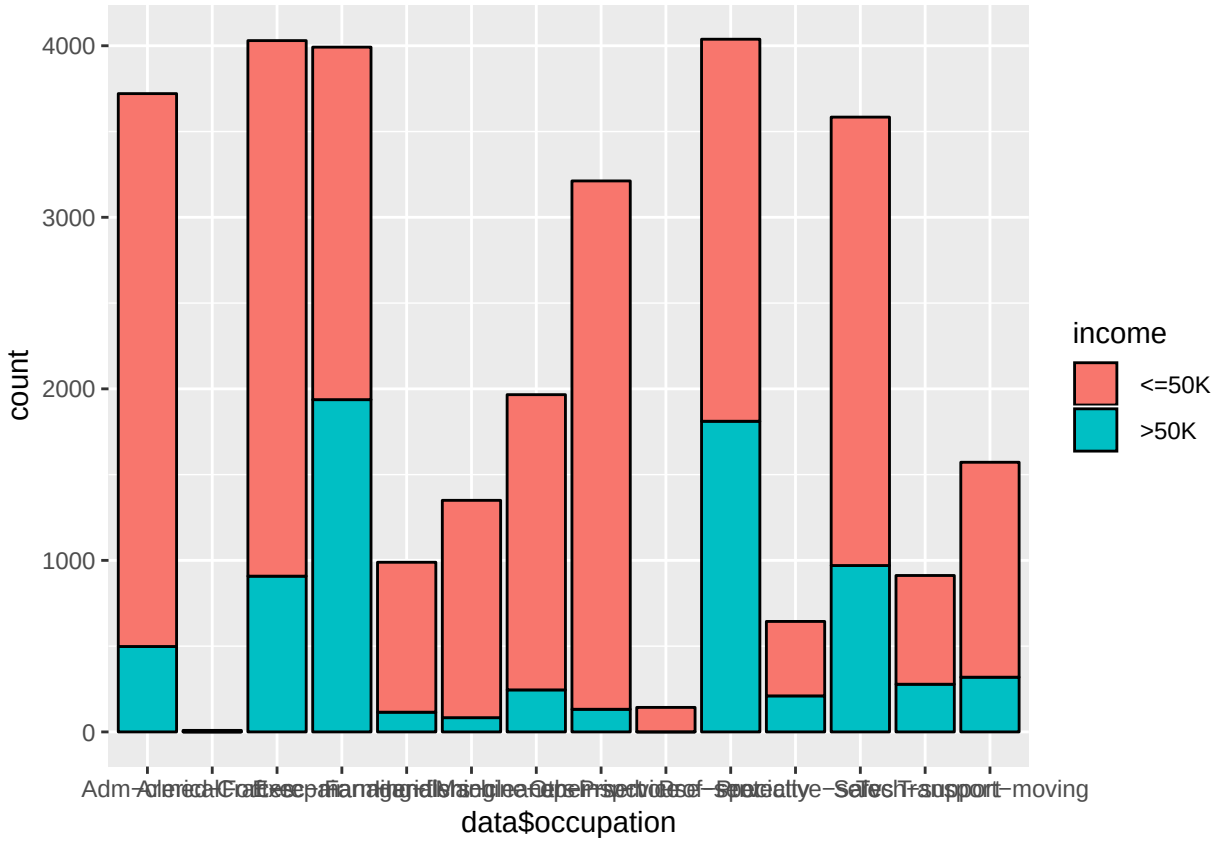


Doesn't seem appropriately representative

```
## occupation
##                 ?      Adm-clerical     Armed-Forces     Craft-repair
##                 0              3721                9             4030
##  Exec-managerial  Farming-fishing
##              3992               989
```

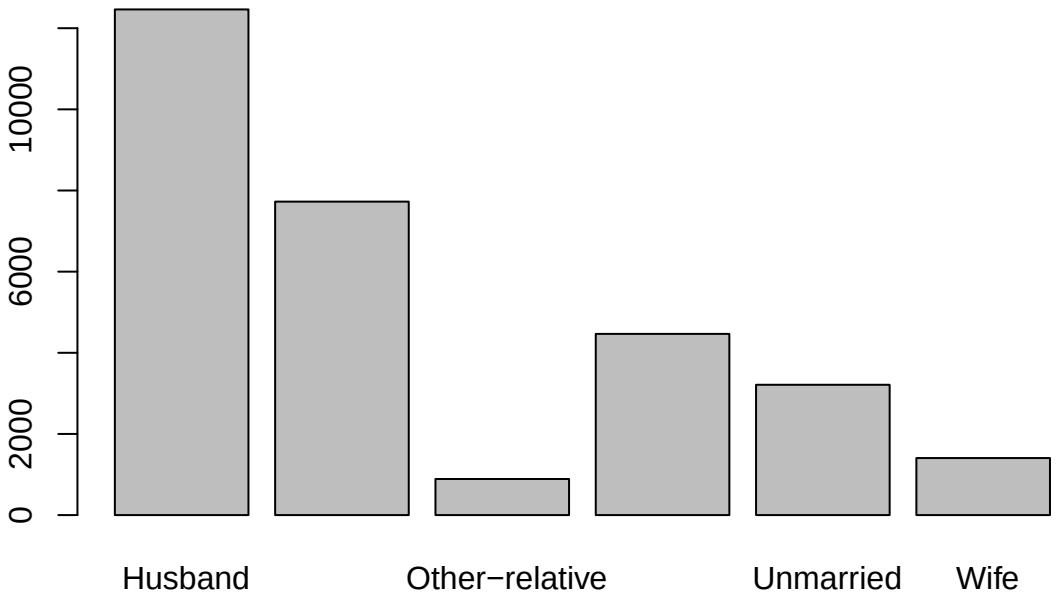

0
1000
2000
3000
4000
?
Craft−repair
Other−service
Sales

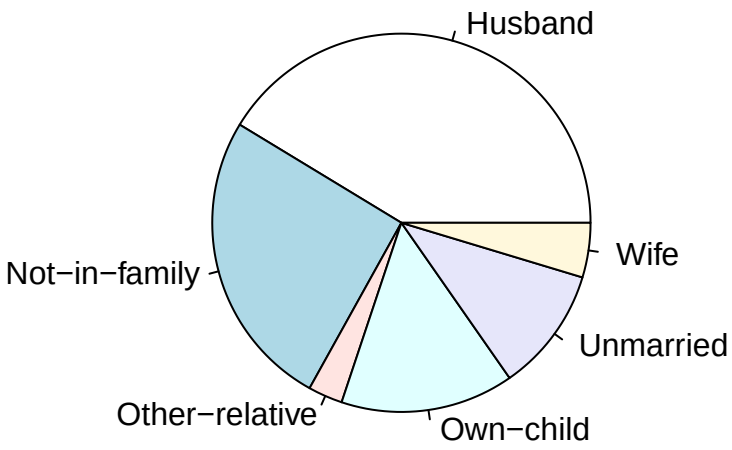

Exec−managerial
Craft−repair
Armed−Forces
Farming−fishing
Adm−clerical
Handlers−cleaners
Machine−op−inspct
?
Transport−moving
Tech−support
Other−service
Priv−house−serv
Sales
Prof−specialty
Protective−serv

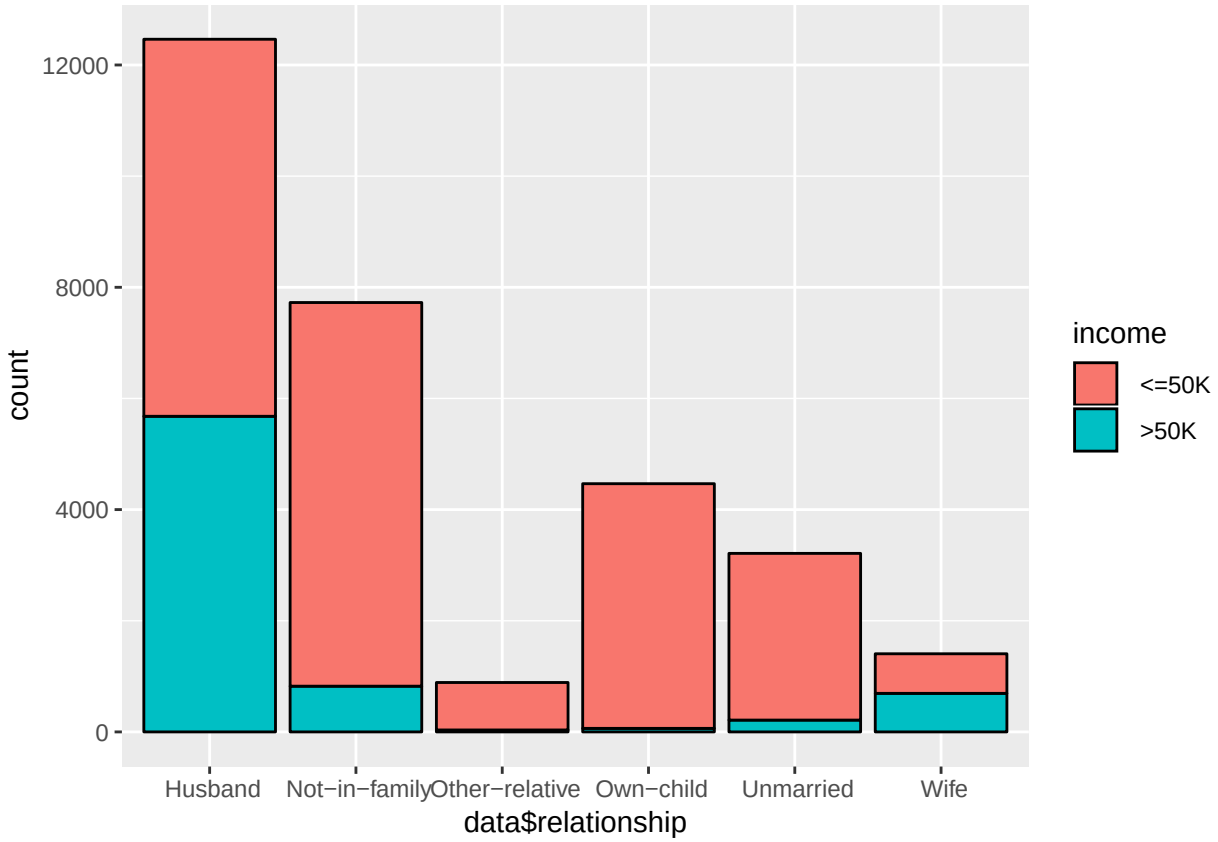


An even spread of different occupations

```
## relationship
##         Husband   Not-in-family  Other-relative       Own-child
##           12463            7726             889            4466
##       Unmarried            Wife
##            3212            1406
```

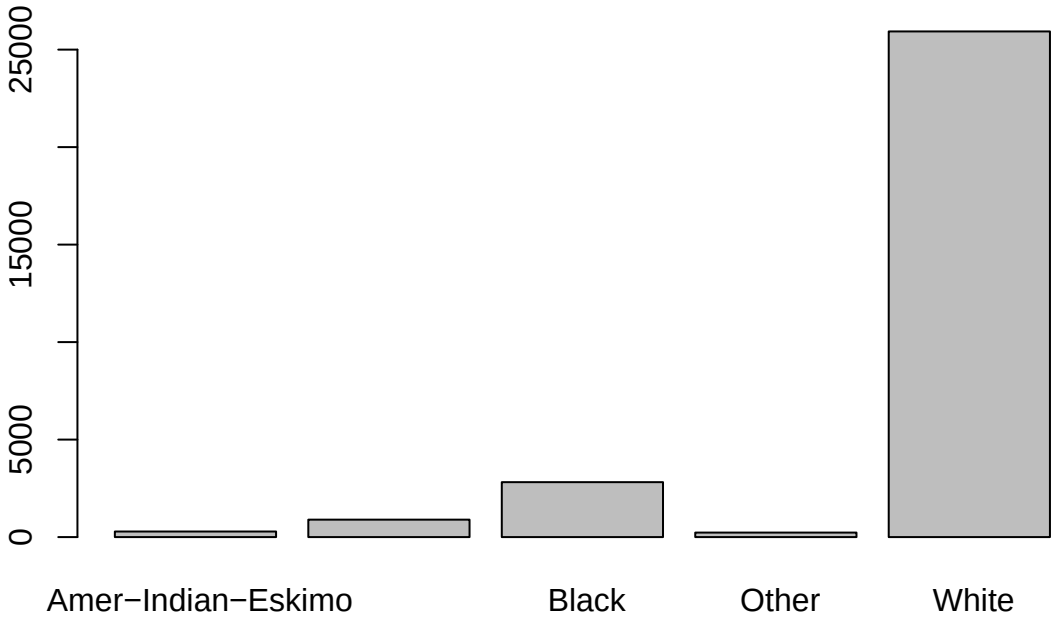

0
2000
6000
10000
Husband
Other−relative
Unmarried
Wife

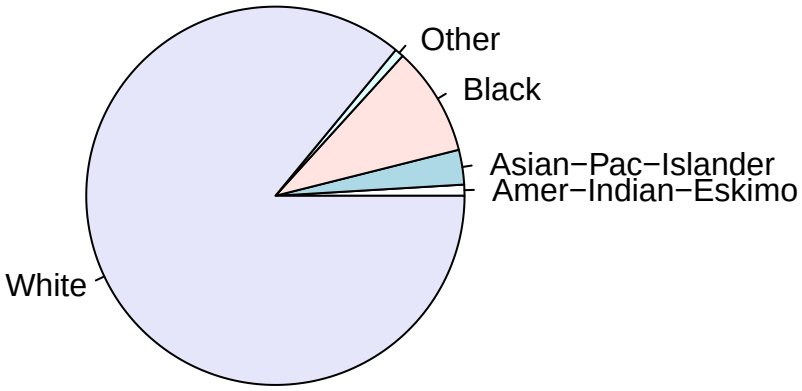

Husband
Wife
Unmarried
Own−child
Other−relative
Not−in−family

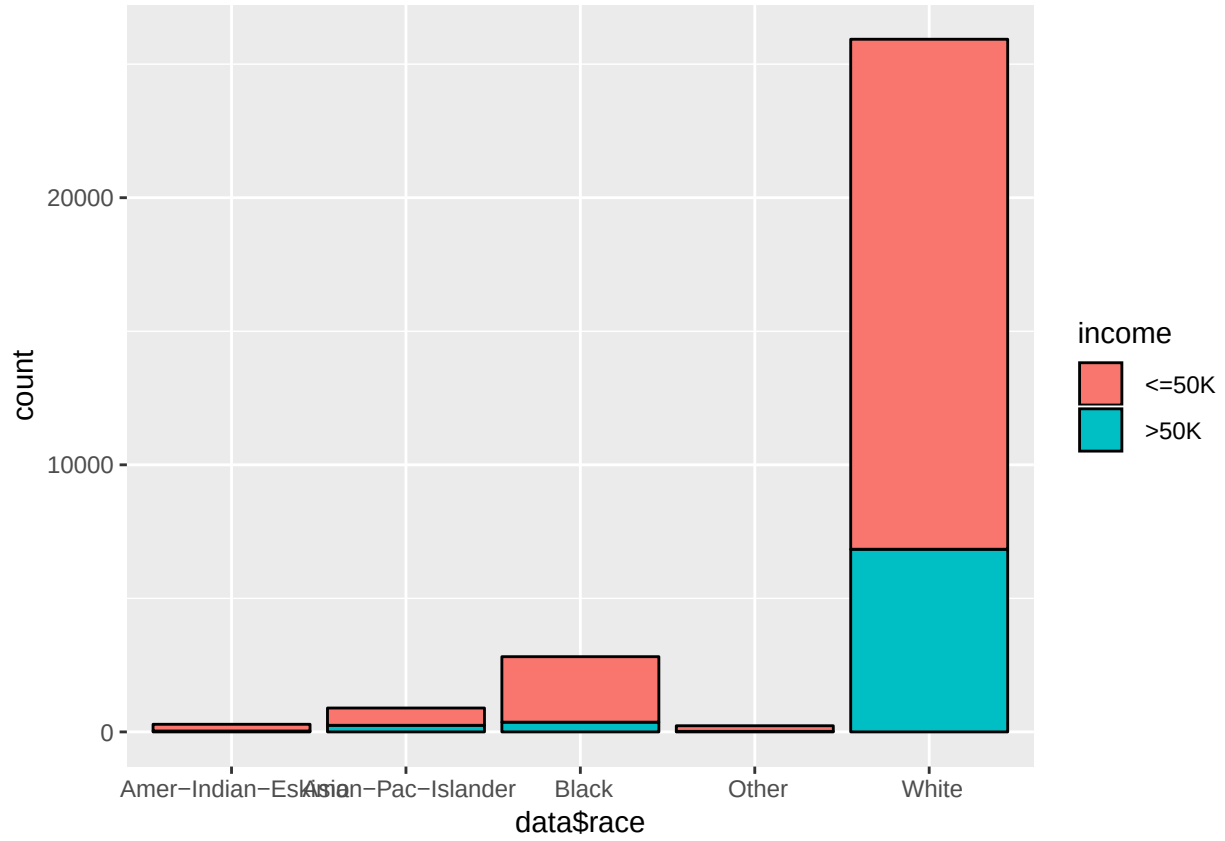


There are more married males than married women in this dataset, which would again introduce bias.

```
## race
##  Amer-Indian-Eskimo  Asian-Pac-Islander              Black
##                 286                 895               2817
##               Other               White
##                 231               25933
```

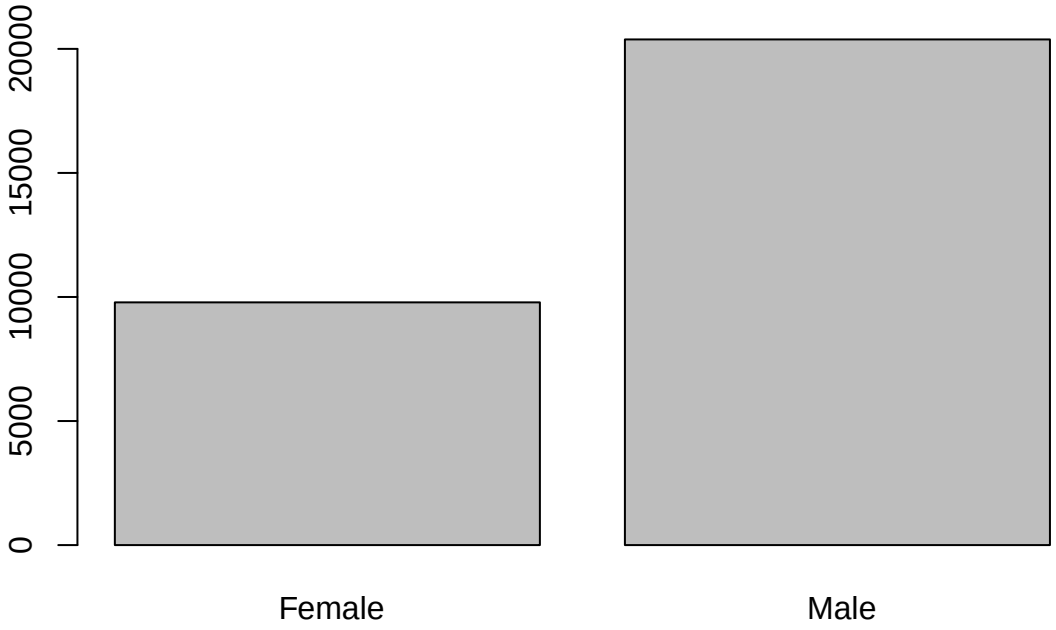

25000
15000
5000
0
Amer−Indian−Eskimo
Black
Other
White

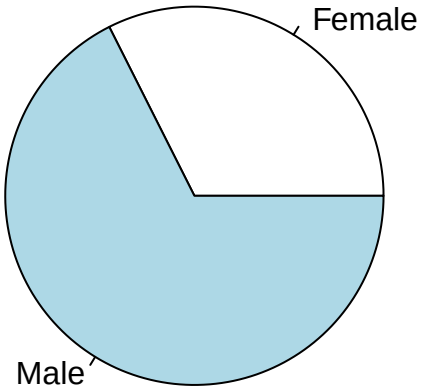

Other
Black
Asian−Pac−Islander
Amer−Indian−Eskimo
White

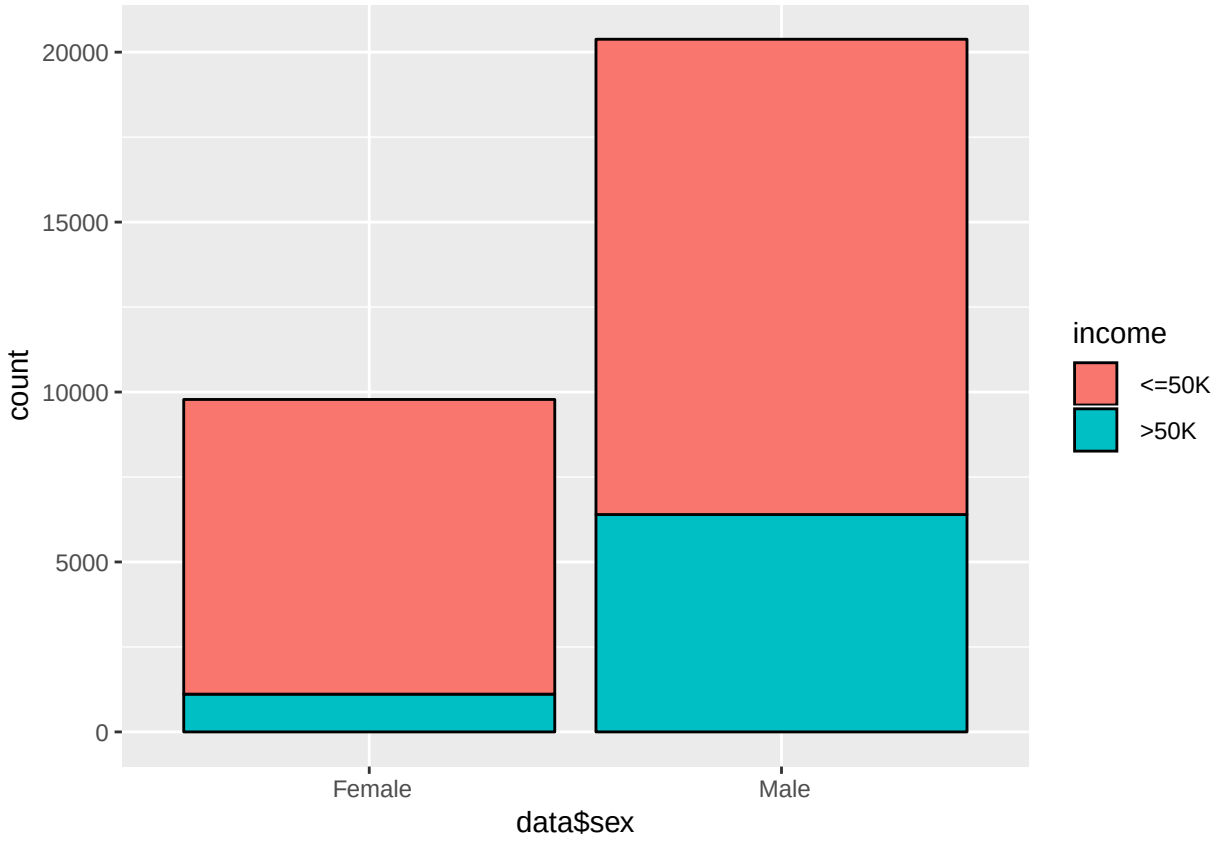


The data clearly has a significant bias at this point

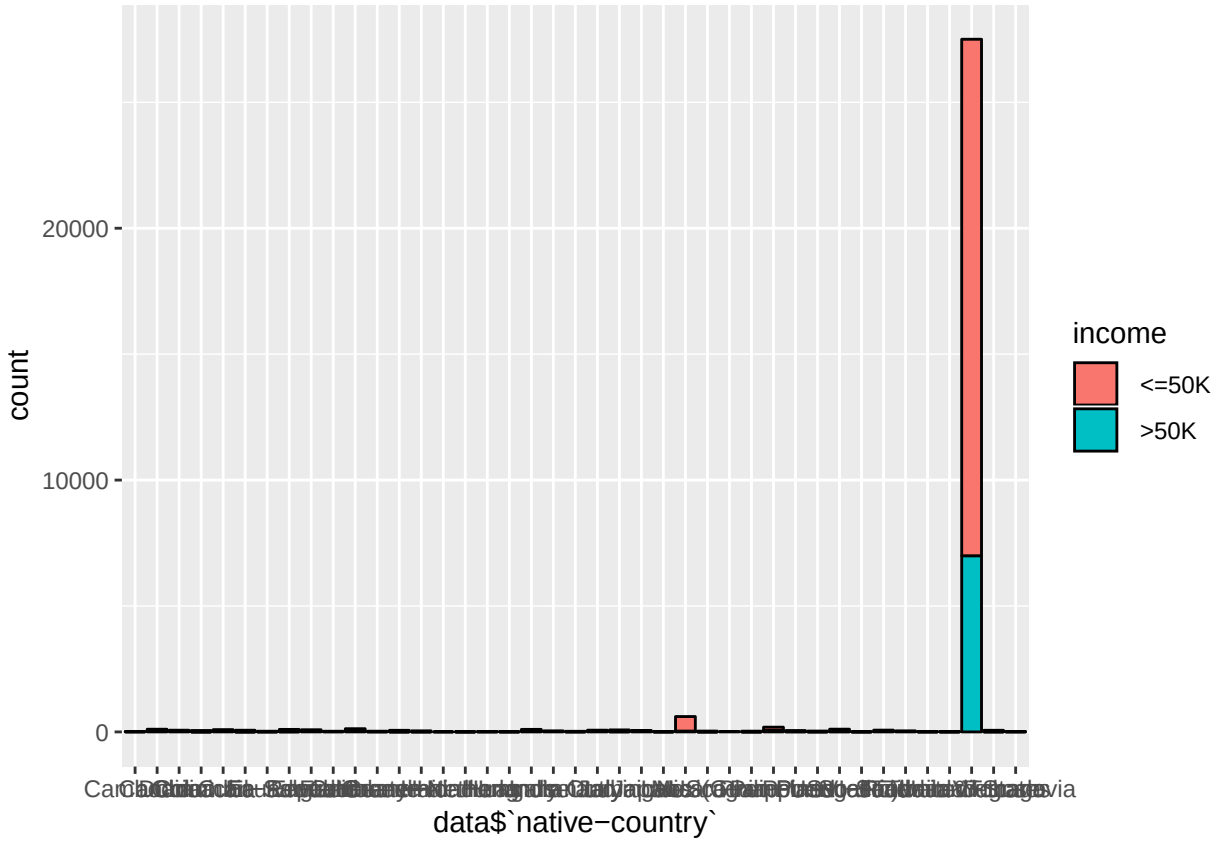
```
## sex
##  Female    Male
##    9782   20380
```

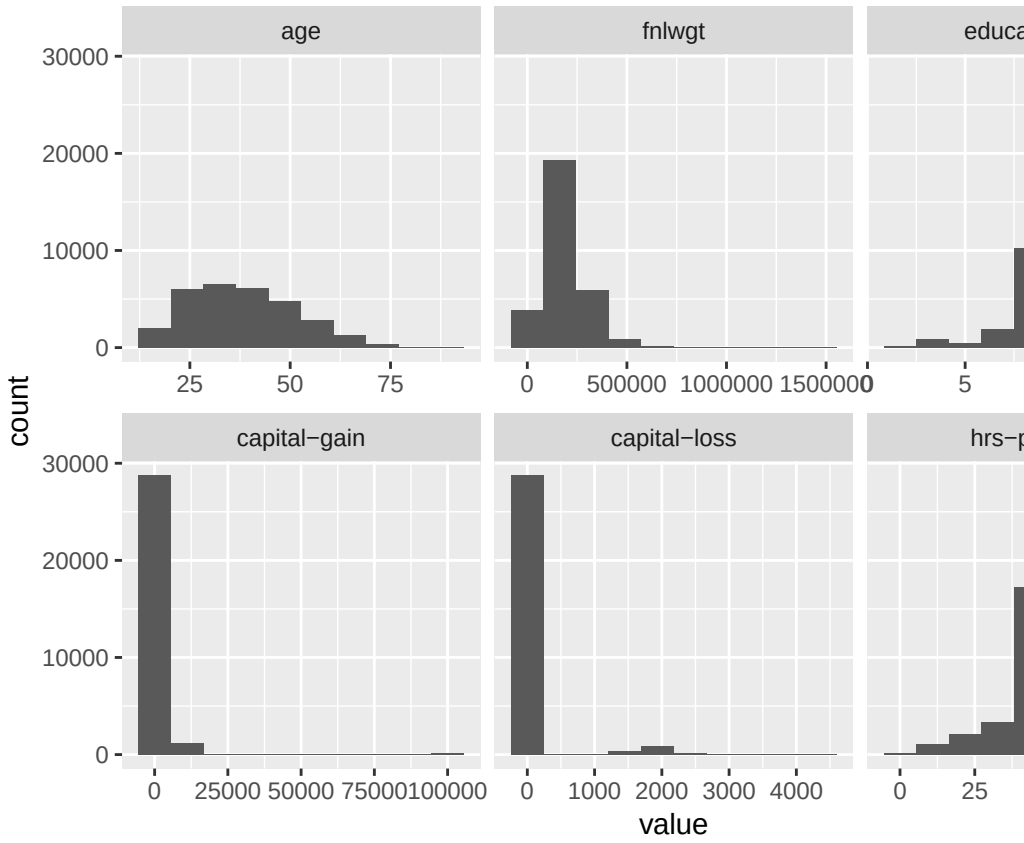

0
5000
10000
15000
20000
Female
Male


Female
Male

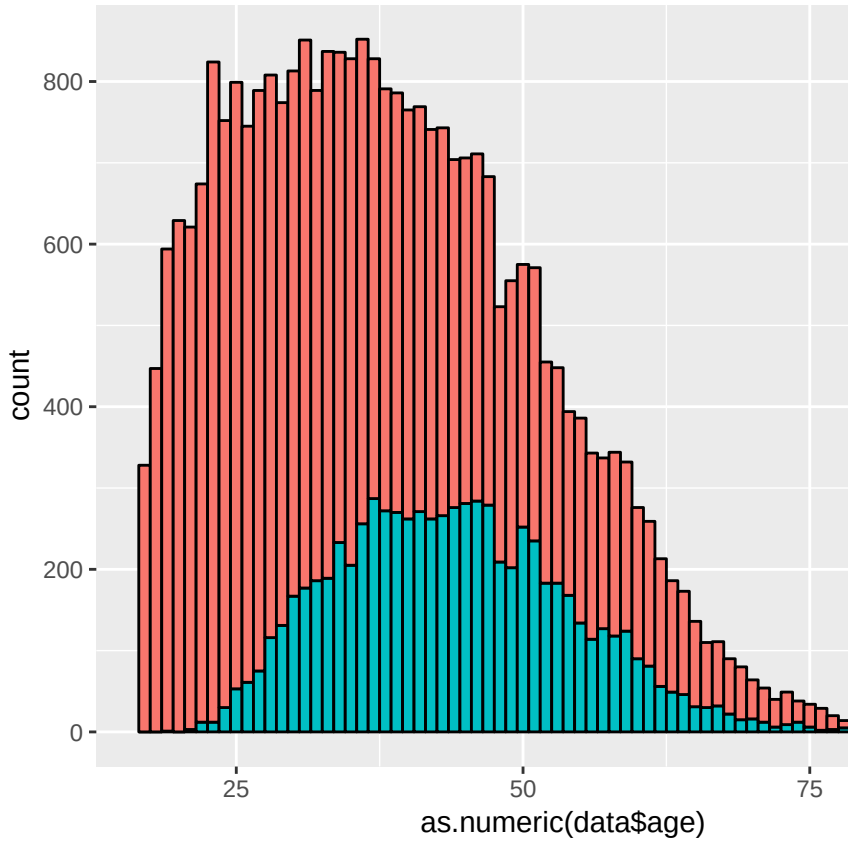

20000
15000
10000
5000
0
count
Female
Male
data$sex
income
<=50K
>50K

```
## integer(0)
```

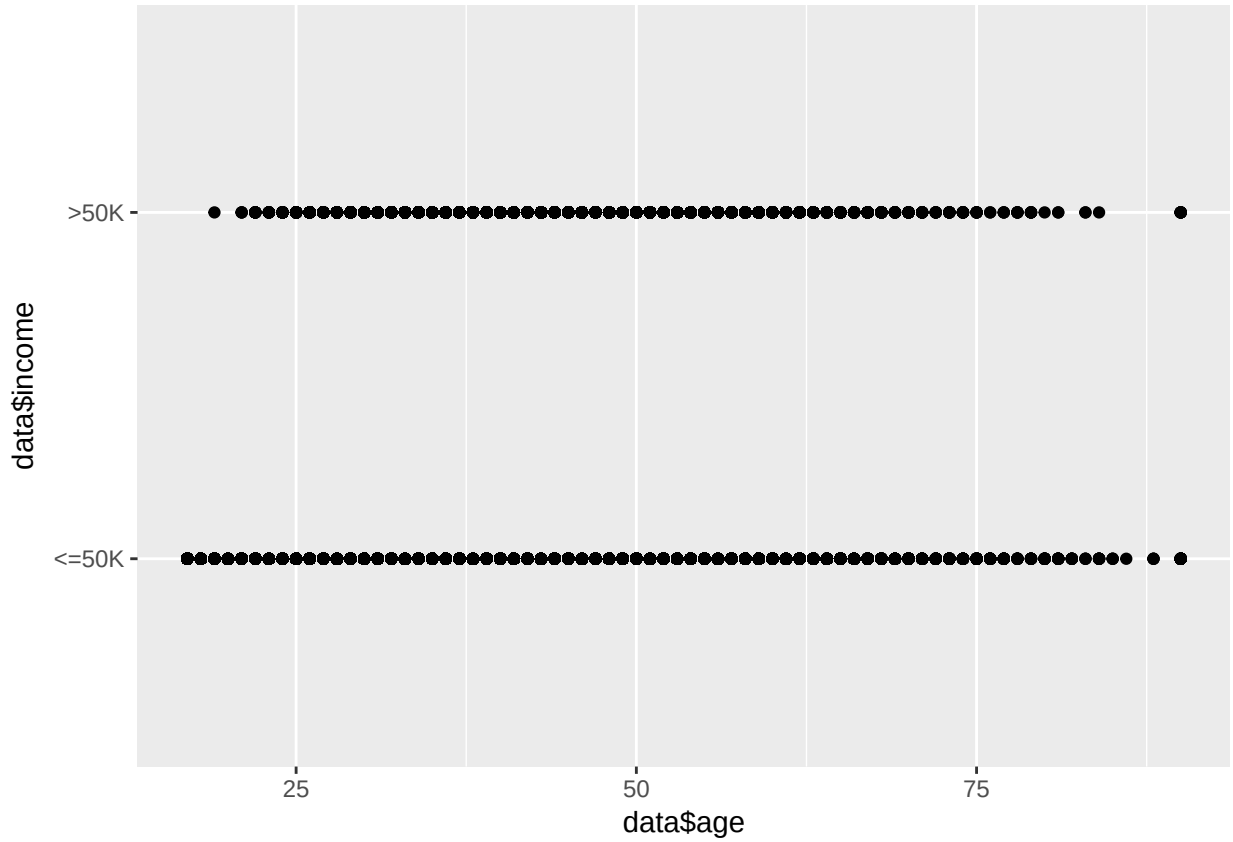

20000
10000
0
count
income
<=50K
>50K
data$`native−country`

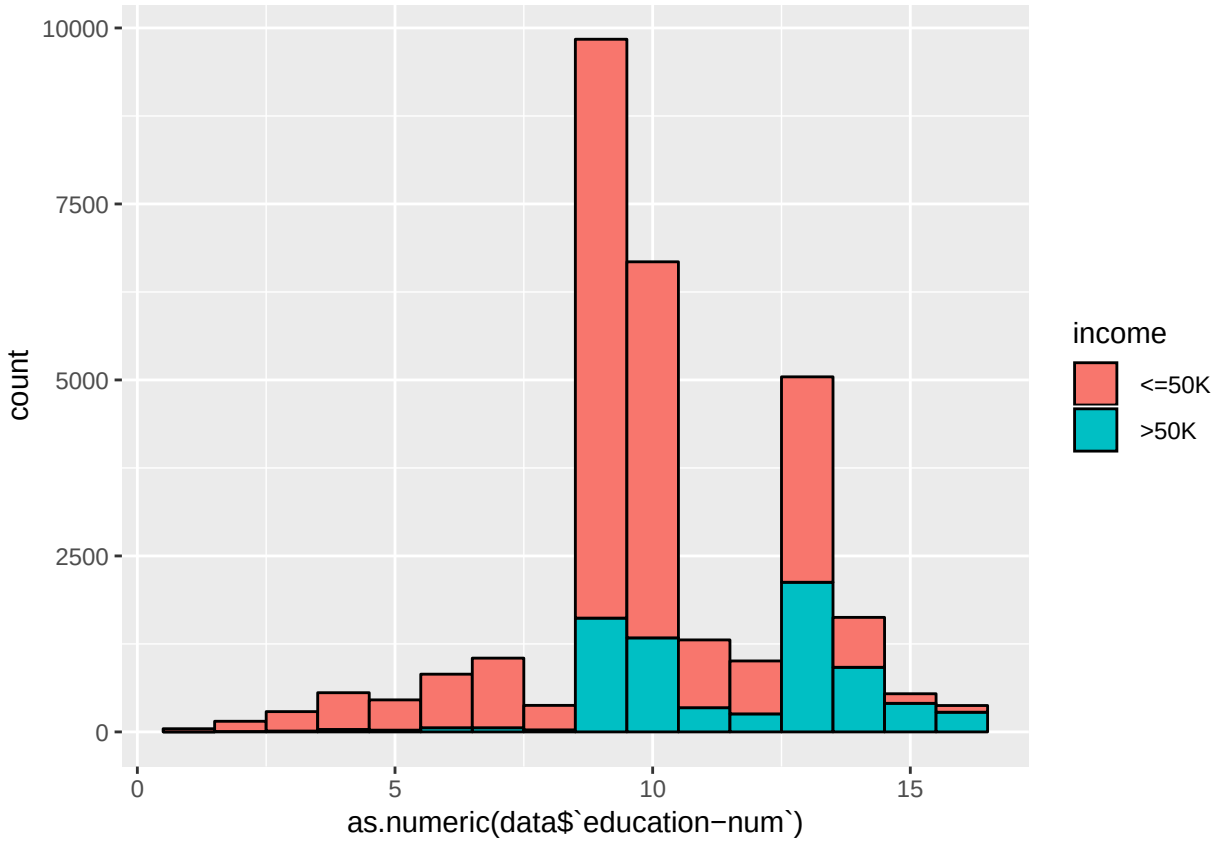


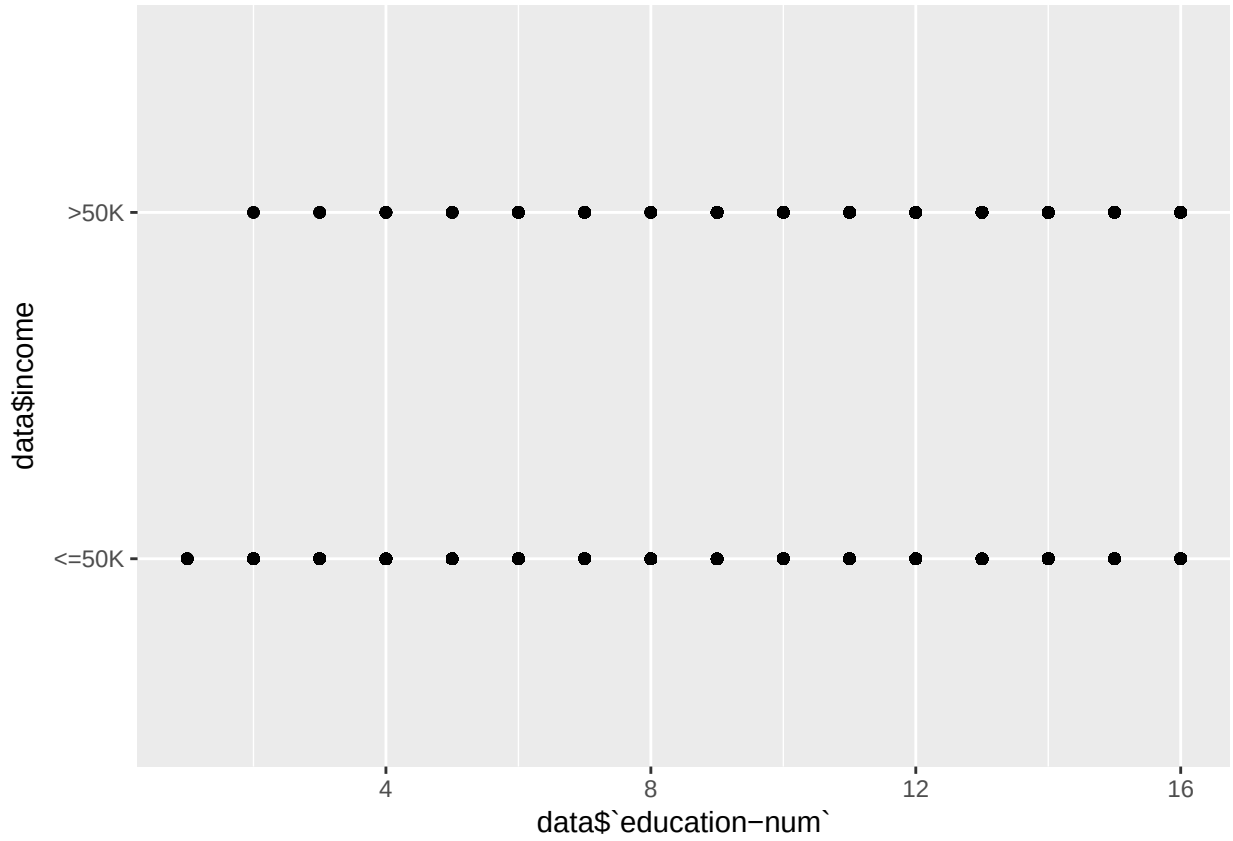
Lets look at all the data side by side

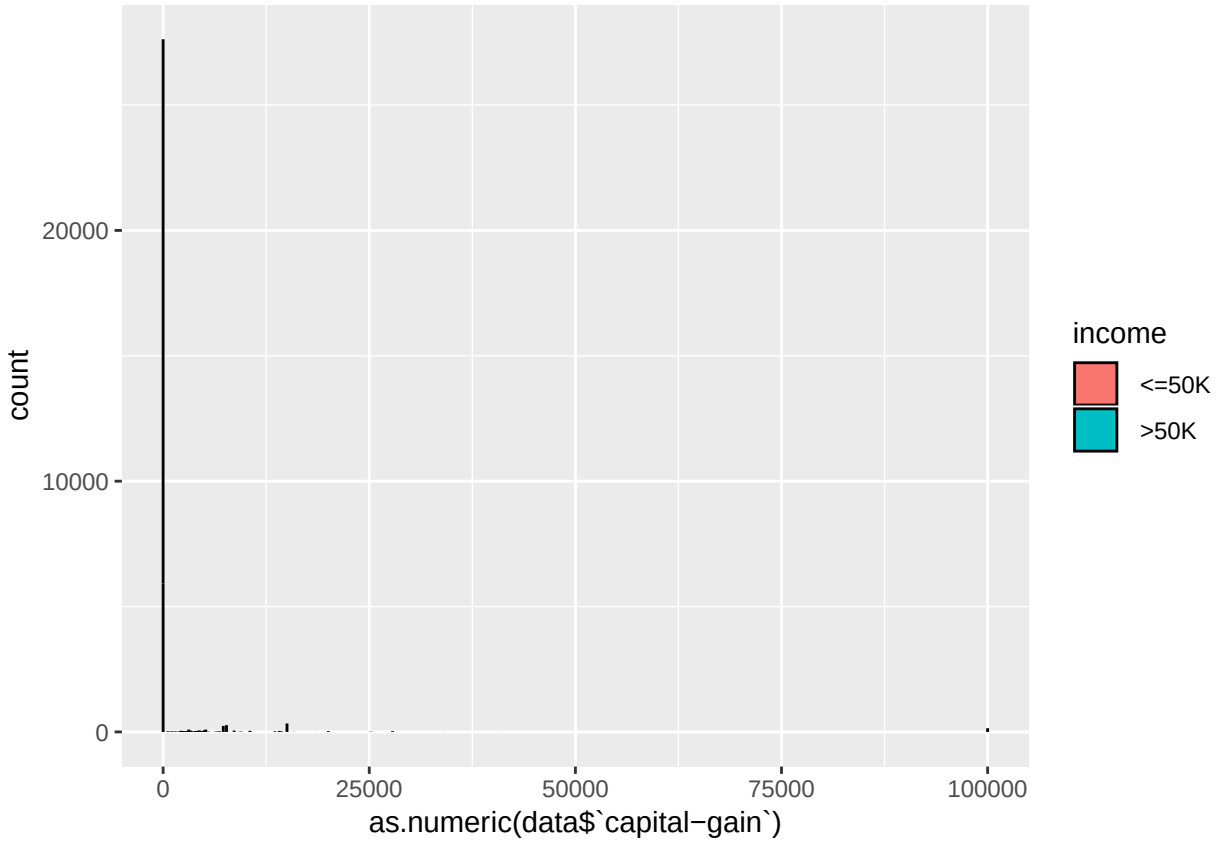


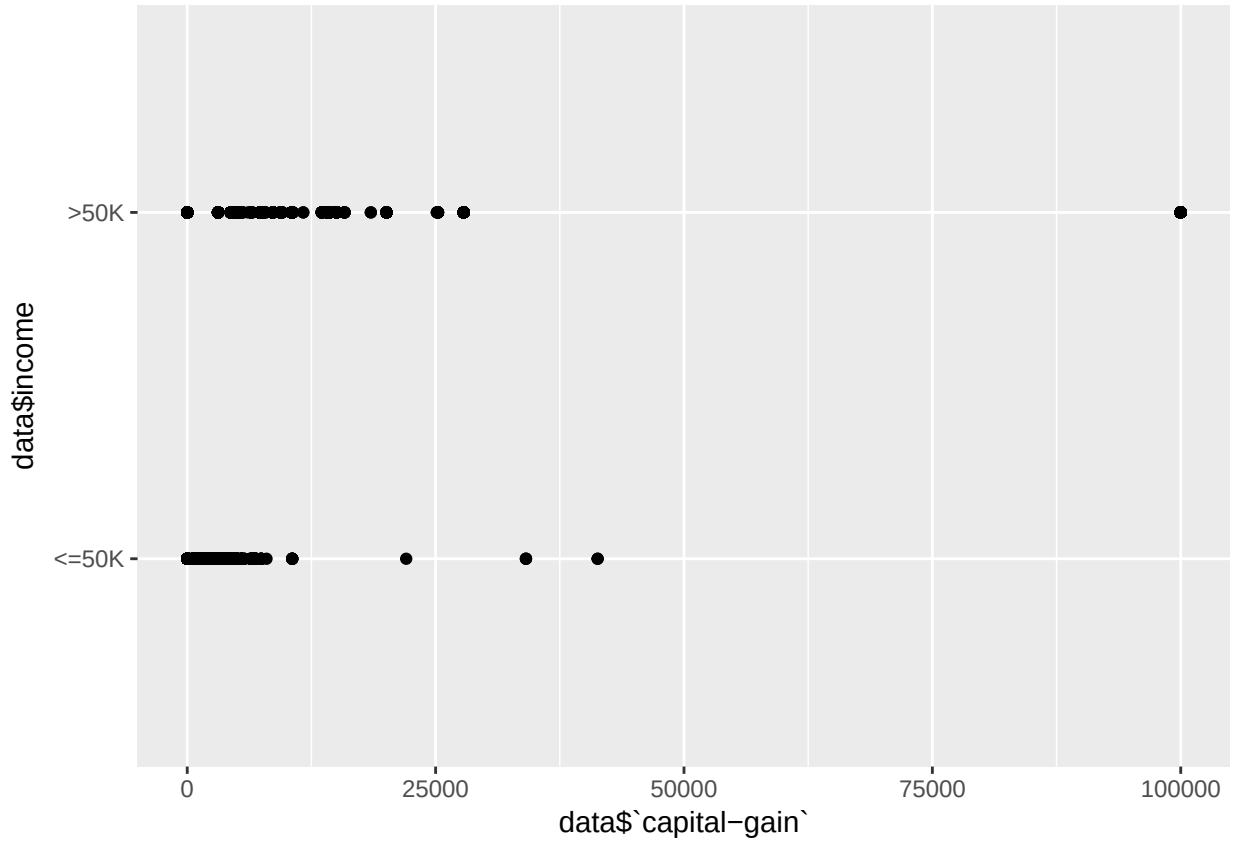
Seems like age is the only unbiased variable was age

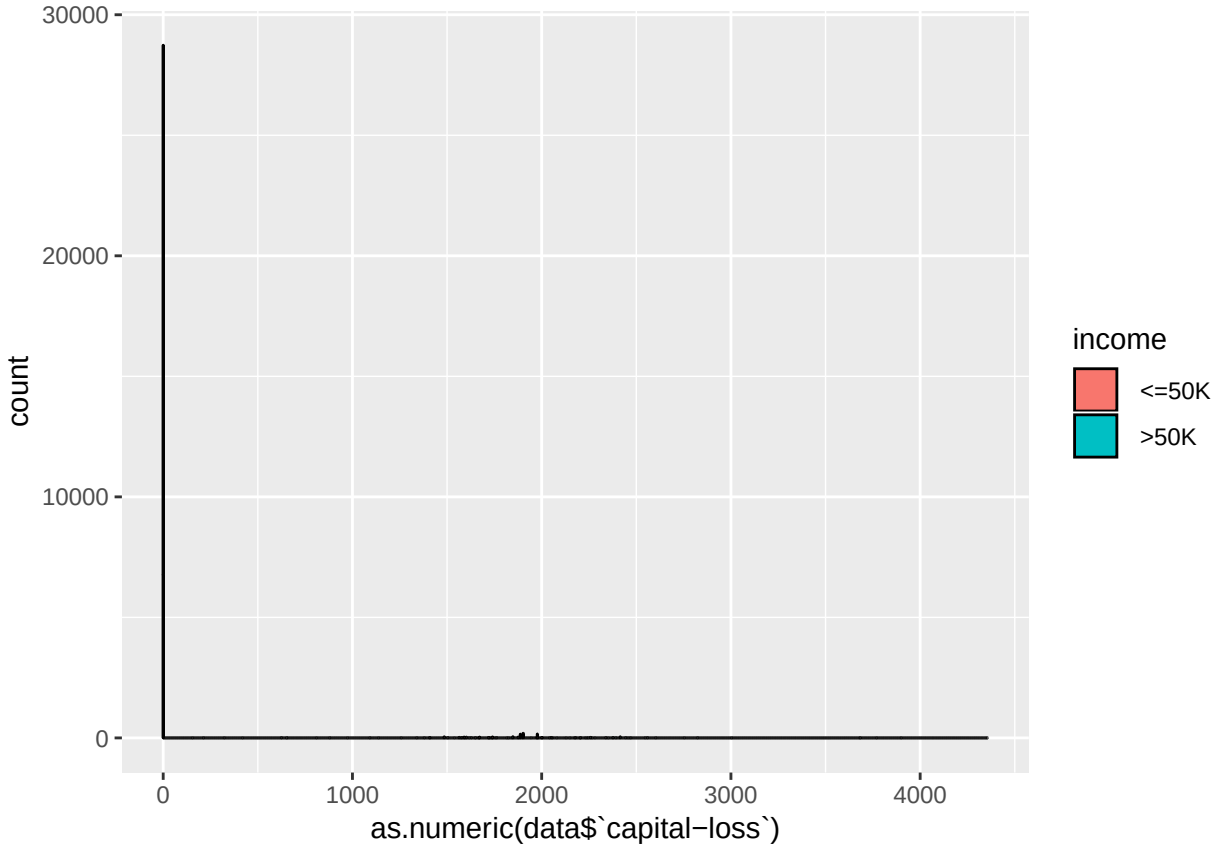

>50K
<=50K
data$income
25
50
75
data$age

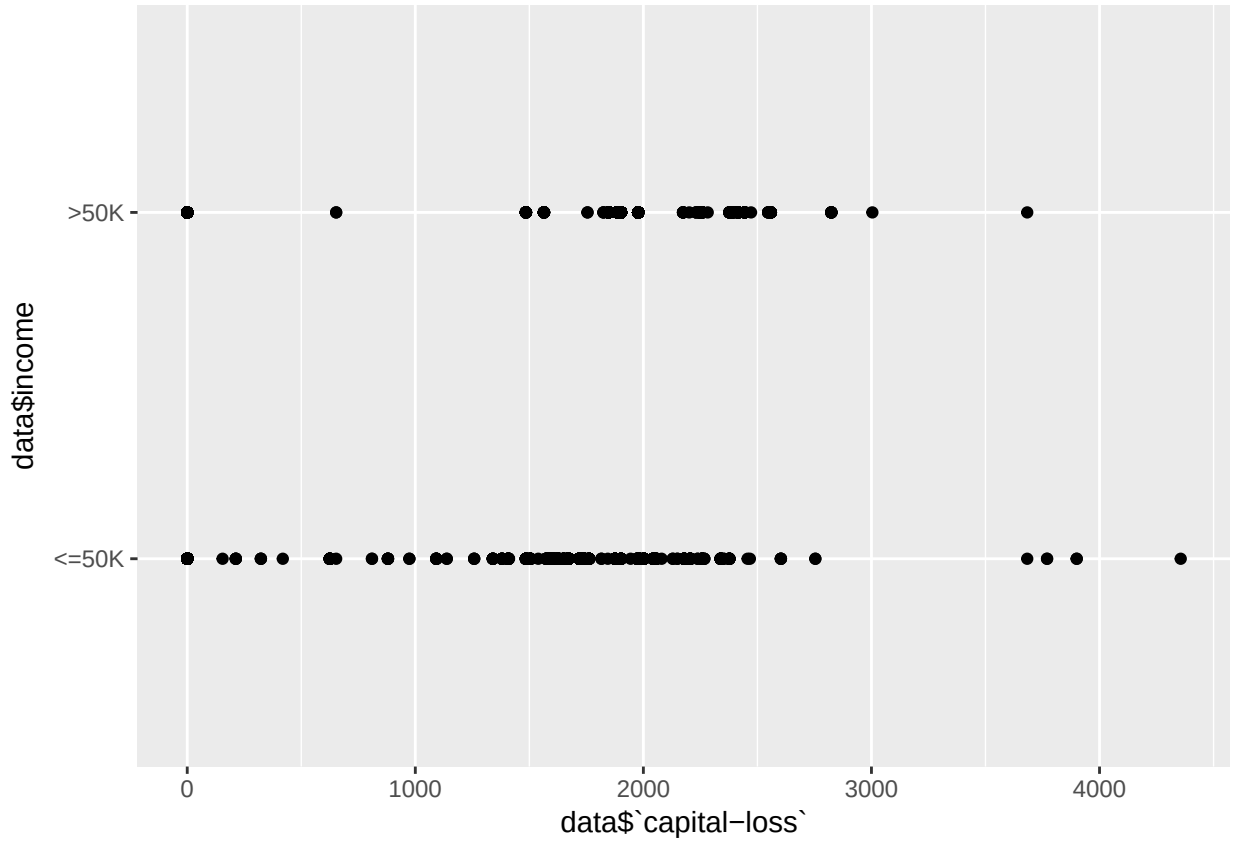

10000
7500
5000
2500
0
count
0
5
10
15
as.numeric(data$`education−num`)
income
<=50K
>50K

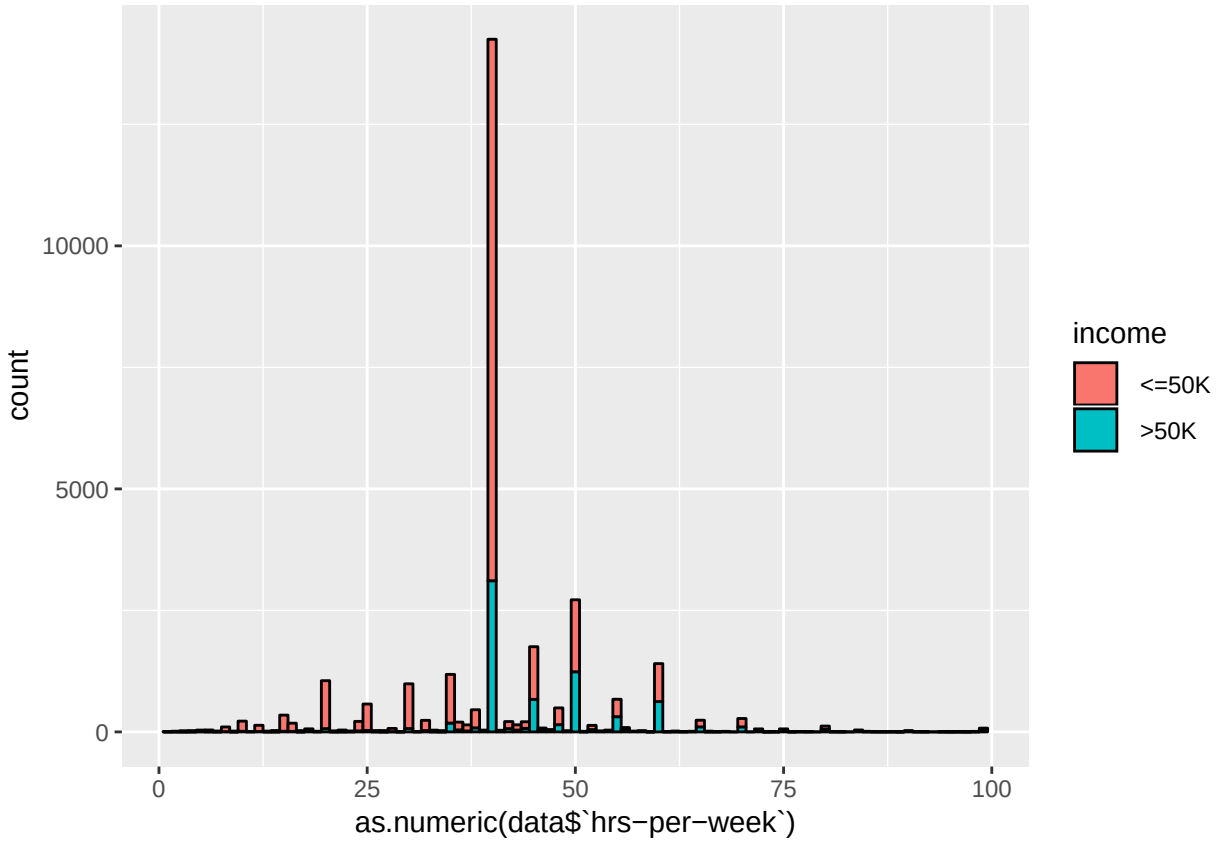

>50K
<=50K
data$income
4
8
12
16
data$`education−num`

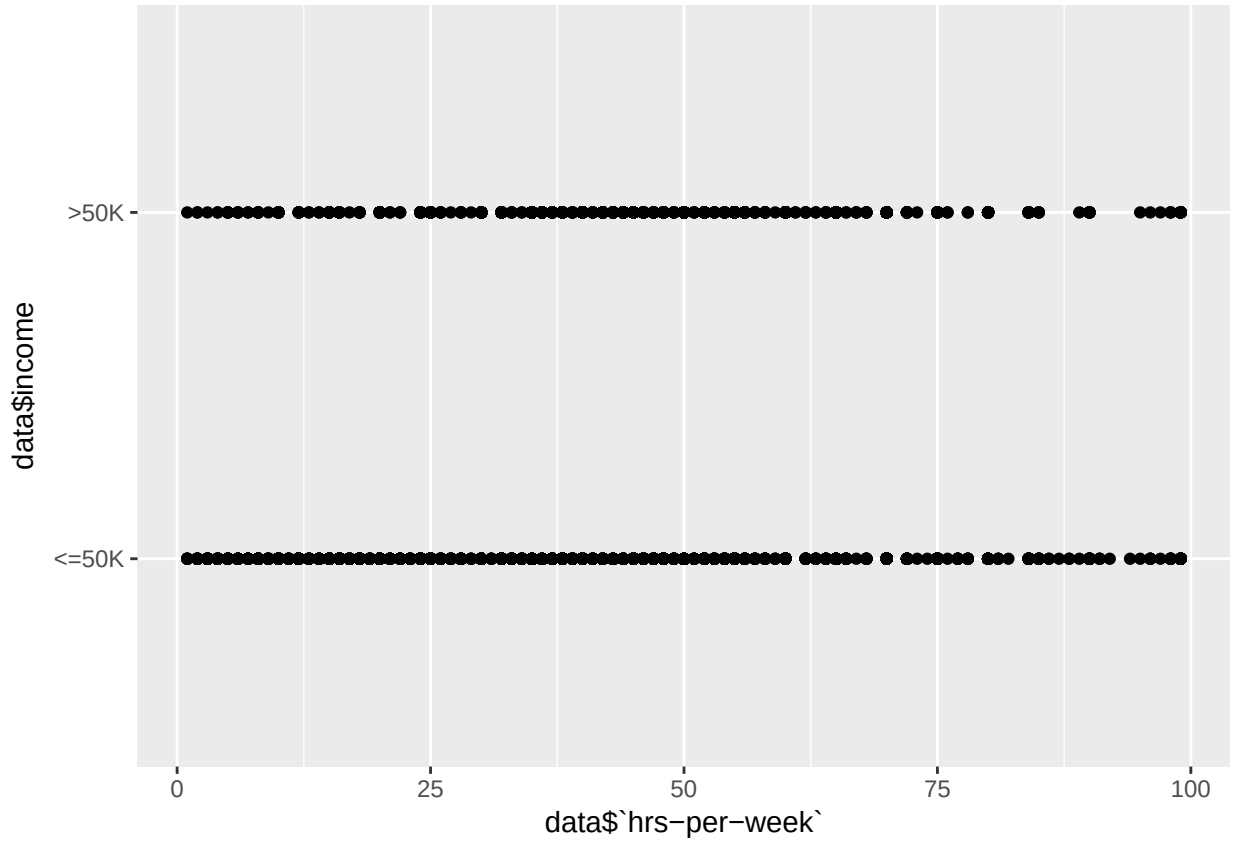

20000
10000
0
count
0
25000
50000
75000
100000
as.numeric(data$`capital−gain`)
income
<=50K
>50K


>50K
<=50K
data$income
0
25000
50000
75000
100000
data$`capital−gain`


30000
20000
10000
0
count
0
1000
2000
3000
4000
as.numeric(data$`capital−loss`)
income
<=50K
>50K


>50K
<=50K
data$income
0
1000
2000
3000
4000
data$`capital−loss`


10000
5000
0
count
0
25
50
75
100
as.numeric(data$`hrs−per−week`)
income
<=50K
>50K



Given the biases, we expect that an individual is most likely to be classified as earning less than $50K.

Lets build models for this dataset anyway and see which one is the best fit

```
## [1] 4262
```

```
## [1] 0.008726186
```

Importing the data again. We will remove the variables with the biggest outliers that are uncorrelated with other variables and remove any rows with missing data.

All of the models we are using are supervised learning methods and are using k-fold cross-validation

For our first model lets use Logistic Regression

```
## + Fold01: iter= 1
## - Fold01: iter= 1
## + Fold01: iter=21
## - Fold01: iter=21
## + Fold01: iter=41
## - Fold01: iter=41
## + Fold02: iter= 1
## - Fold02: iter= 1
## + Fold02: iter=21
## - Fold02: iter=21
## + Fold02: iter=41
## - Fold02: iter=41
```

```
## + Fold03: iter= 1
## - Fold03: iter= 1
## + Fold03: iter=21
## - Fold03: iter=21
## + Fold03: iter=41
## - Fold03: iter=41
## + Fold04: iter= 1
## - Fold04: iter= 1
## + Fold04: iter=21
## - Fold04: iter=21
## + Fold04: iter=41
## - Fold04: iter=41
## + Fold05: iter= 1
## - Fold05: iter= 1
## + Fold05: iter=21
## - Fold05: iter=21
## + Fold05: iter=41
## - Fold05: iter=41
## + Fold06: iter= 1
## - Fold06: iter= 1
## + Fold06: iter=21
## - Fold06: iter=21
## + Fold06: iter=41
## - Fold06: iter=41
## + Fold07: iter= 1
## - Fold07: iter= 1
## + Fold07: iter=21
## - Fold07: iter=21
## + Fold07: iter=41
## - Fold07: iter=41
## + Fold08: iter= 1
## - Fold08: iter= 1
## + Fold08: iter=21
## - Fold08: iter=21
## + Fold08: iter=41
## - Fold08: iter=41
## + Fold09: iter= 1
## - Fold09: iter= 1
## + Fold09: iter=21
## - Fold09: iter=21
## + Fold09: iter=41
## - Fold09: iter=41
## + Fold10: iter= 1
## - Fold10: iter= 1
## + Fold10: iter=21
## - Fold10: iter=21
## + Fold10: iter=41
## - Fold10: iter=41
## Aggregating results
## Selecting tuning parameters
## Fitting iter = 41 on full training set

##
##           <=50K  >50K
```

```
##    <=50K  20792  3048
##    >50K    1862  4460
```

It's accuracy is 83% as the results show

Trying the C5 model

```
## + Fold01: model=tree, winnow=FALSE, trials=20
## - Fold01: model=tree, winnow=FALSE, trials=20
## + Fold01: model=tree, winnow= TRUE, trials=20
## - Fold01: model=tree, winnow= TRUE, trials=20
## + Fold01: model=rules, winnow=FALSE, trials=20
## - Fold01: model=rules, winnow=FALSE, trials=20
## + Fold01: model=rules, winnow= TRUE, trials=20
## - Fold01: model=rules, winnow= TRUE, trials=20
## + Fold02: model=tree, winnow=FALSE, trials=20
## - Fold02: model=tree, winnow=FALSE, trials=20
## + Fold02: model=tree, winnow= TRUE, trials=20
## - Fold02: model=tree, winnow= TRUE, trials=20
## + Fold02: model=rules, winnow=FALSE, trials=20
## - Fold02: model=rules, winnow=FALSE, trials=20
## + Fold02: model=rules, winnow= TRUE, trials=20
## - Fold02: model=rules, winnow= TRUE, trials=20
## + Fold03: model=tree, winnow=FALSE, trials=20
## - Fold03: model=tree, winnow=FALSE, trials=20
## + Fold03: model=tree, winnow= TRUE, trials=20
## - Fold03: model=tree, winnow= TRUE, trials=20
## + Fold03: model=rules, winnow=FALSE, trials=20
## - Fold03: model=rules, winnow=FALSE, trials=20
## + Fold03: model=rules, winnow= TRUE, trials=20
## - Fold03: model=rules, winnow= TRUE, trials=20
## + Fold04: model=tree, winnow=FALSE, trials=20
## - Fold04: model=tree, winnow=FALSE, trials=20
## + Fold04: model=tree, winnow= TRUE, trials=20
## - Fold04: model=tree, winnow= TRUE, trials=20
## + Fold04: model=rules, winnow=FALSE, trials=20
## - Fold04: model=rules, winnow=FALSE, trials=20
## + Fold04: model=rules, winnow= TRUE, trials=20
## - Fold04: model=rules, winnow= TRUE, trials=20
## + Fold05: model=tree, winnow=FALSE, trials=20
## - Fold05: model=tree, winnow=FALSE, trials=20
## + Fold05: model=tree, winnow= TRUE, trials=20
## - Fold05: model=tree, winnow= TRUE, trials=20
## + Fold05: model=rules, winnow=FALSE, trials=20
## - Fold05: model=rules, winnow=FALSE, trials=20
## + Fold05: model=rules, winnow= TRUE, trials=20
## - Fold05: model=rules, winnow= TRUE, trials=20
## + Fold06: model=tree, winnow=FALSE, trials=20
## - Fold06: model=tree, winnow=FALSE, trials=20
## + Fold06: model=tree, winnow= TRUE, trials=20
## - Fold06: model=tree, winnow= TRUE, trials=20
## + Fold06: model=rules, winnow=FALSE, trials=20
## - Fold06: model=rules, winnow=FALSE, trials=20
## + Fold06: model=rules, winnow= TRUE, trials=20
```

```
## - Fold06: model=rules, winnow= TRUE, trials=20
## + Fold07: model=tree, winnow=FALSE, trials=20
## - Fold07: model=tree, winnow=FALSE, trials=20
## + Fold07: model=tree, winnow= TRUE, trials=20
## - Fold07: model=tree, winnow= TRUE, trials=20
## + Fold07: model=rules, winnow=FALSE, trials=20
## - Fold07: model=rules, winnow=FALSE, trials=20
## + Fold07: model=rules, winnow= TRUE, trials=20
## - Fold07: model=rules, winnow= TRUE, trials=20
## + Fold08: model=tree, winnow=FALSE, trials=20
## - Fold08: model=tree, winnow=FALSE, trials=20
## + Fold08: model=tree, winnow= TRUE, trials=20
## - Fold08: model=tree, winnow= TRUE, trials=20
## + Fold08: model=rules, winnow=FALSE, trials=20
## - Fold08: model=rules, winnow=FALSE, trials=20
## + Fold08: model=rules, winnow= TRUE, trials=20
## - Fold08: model=rules, winnow= TRUE, trials=20
## + Fold09: model=tree, winnow=FALSE, trials=20
## - Fold09: model=tree, winnow=FALSE, trials=20
## + Fold09: model=tree, winnow= TRUE, trials=20
## - Fold09: model=tree, winnow= TRUE, trials=20
## + Fold09: model=rules, winnow=FALSE, trials=20
## - Fold09: model=rules, winnow=FALSE, trials=20
## + Fold09: model=rules, winnow= TRUE, trials=20
## - Fold09: model=rules, winnow= TRUE, trials=20
## + Fold10: model=tree, winnow=FALSE, trials=20
## - Fold10: model=tree, winnow=FALSE, trials=20
## + Fold10: model=tree, winnow= TRUE, trials=20
## - Fold10: model=tree, winnow= TRUE, trials=20
## + Fold10: model=rules, winnow=FALSE, trials=20
## - Fold10: model=rules, winnow=FALSE, trials=20
## + Fold10: model=rules, winnow= TRUE, trials=20
## - Fold10: model=rules, winnow= TRUE, trials=20
## Aggregating results
## Selecting tuning parameters
## Fitting trials = 20, model = tree, winnow = FALSE on full training set

##
##           <=50K  >50K
##    <=50K  20981  2974
##    >50K    1673  4534
```

It's accuracy comes out to 84%

Trying the Logit Boost model

```
## + Fold01: nIter=31
## - Fold01: nIter=31
## + Fold02: nIter=31
## - Fold02: nIter=31
## + Fold03: nIter=31
## - Fold03: nIter=31
## + Fold04: nIter=31
## - Fold04: nIter=31
```

```
## + Fold05: nIter=31
## - Fold05: nIter=31
## + Fold06: nIter=31
## - Fold06: nIter=31
## + Fold07: nIter=31
## - Fold07: nIter=31
## + Fold08: nIter=31
## - Fold08: nIter=31
## + Fold09: nIter=31
## - Fold09: nIter=31
## + Fold10: nIter=31
## - Fold10: nIter=31
## Aggregating results
## Selecting tuning parameters
## Fitting nIter = 11 on full training set
```

```
##
##            <=50K  >50K
##     <=50K  21533  4454
##     >50K    1121  3054
```

It's accuracy comes out to 81%

Trying the the SVM model

```
## + Fold01: cost=0.25, Loss=L1, weight=1
## - Fold01: cost=0.25, Loss=L1, weight=1
## + Fold01: cost=0.50, Loss=L1, weight=1
## - Fold01: cost=0.50, Loss=L1, weight=1
## + Fold01: cost=1.00, Loss=L1, weight=1
## - Fold01: cost=1.00, Loss=L1, weight=1
## + Fold01: cost=0.25, Loss=L2, weight=1
## - Fold01: cost=0.25, Loss=L2, weight=1
## + Fold01: cost=0.50, Loss=L2, weight=1
## - Fold01: cost=0.50, Loss=L2, weight=1
## + Fold01: cost=1.00, Loss=L2, weight=1
## - Fold01: cost=1.00, Loss=L2, weight=1
## + Fold01: cost=0.25, Loss=L1, weight=2
## - Fold01: cost=0.25, Loss=L1, weight=2
## + Fold01: cost=0.50, Loss=L1, weight=2
## - Fold01: cost=0.50, Loss=L1, weight=2
## + Fold01: cost=1.00, Loss=L1, weight=2
## - Fold01: cost=1.00, Loss=L1, weight=2
## + Fold01: cost=0.25, Loss=L2, weight=2
## - Fold01: cost=0.25, Loss=L2, weight=2
## + Fold01: cost=0.50, Loss=L2, weight=2
## - Fold01: cost=0.50, Loss=L2, weight=2
## + Fold01: cost=1.00, Loss=L2, weight=2
## - Fold01: cost=1.00, Loss=L2, weight=2
## + Fold01: cost=0.25, Loss=L1, weight=3
## - Fold01: cost=0.25, Loss=L1, weight=3
## + Fold01: cost=0.50, Loss=L1, weight=3
## - Fold01: cost=0.50, Loss=L1, weight=3
## + Fold01: cost=1.00, Loss=L1, weight=3
```

```
## - Fold01: cost=1.00, Loss=L1, weight=3
## + Fold01: cost=0.25, Loss=L2, weight=3
## - Fold01: cost=0.25, Loss=L2, weight=3
## + Fold01: cost=0.50, Loss=L2, weight=3
## - Fold01: cost=0.50, Loss=L2, weight=3
## + Fold01: cost=1.00, Loss=L2, weight=3
## - Fold01: cost=1.00, Loss=L2, weight=3
## + Fold02: cost=0.25, Loss=L1, weight=1
## - Fold02: cost=0.25, Loss=L1, weight=1
## + Fold02: cost=0.50, Loss=L1, weight=1
## - Fold02: cost=0.50, Loss=L1, weight=1
## + Fold02: cost=1.00, Loss=L1, weight=1
## - Fold02: cost=1.00, Loss=L1, weight=1
## + Fold02: cost=0.25, Loss=L2, weight=1
## - Fold02: cost=0.25, Loss=L2, weight=1
## + Fold02: cost=0.50, Loss=L2, weight=1
## - Fold02: cost=0.50, Loss=L2, weight=1
## + Fold02: cost=1.00, Loss=L2, weight=1
## - Fold02: cost=1.00, Loss=L2, weight=1
## + Fold02: cost=0.25, Loss=L1, weight=2
## - Fold02: cost=0.25, Loss=L1, weight=2
## + Fold02: cost=0.50, Loss=L1, weight=2
## - Fold02: cost=0.50, Loss=L1, weight=2
## + Fold02: cost=1.00, Loss=L1, weight=2
## - Fold02: cost=1.00, Loss=L1, weight=2
## + Fold02: cost=0.25, Loss=L2, weight=2
## - Fold02: cost=0.25, Loss=L2, weight=2
## + Fold02: cost=0.50, Loss=L2, weight=2
## - Fold02: cost=0.50, Loss=L2, weight=2
## + Fold02: cost=1.00, Loss=L2, weight=2
## - Fold02: cost=1.00, Loss=L2, weight=2
## + Fold02: cost=0.25, Loss=L1, weight=3
## - Fold02: cost=0.25, Loss=L1, weight=3
## + Fold02: cost=0.50, Loss=L1, weight=3
## - Fold02: cost=0.50, Loss=L1, weight=3
## + Fold02: cost=1.00, Loss=L1, weight=3
## - Fold02: cost=1.00, Loss=L1, weight=3
## + Fold02: cost=0.25, Loss=L2, weight=3
## - Fold02: cost=0.25, Loss=L2, weight=3
## + Fold02: cost=0.50, Loss=L2, weight=3
## - Fold02: cost=0.50, Loss=L2, weight=3
## + Fold02: cost=1.00, Loss=L2, weight=3
## - Fold02: cost=1.00, Loss=L2, weight=3
## + Fold03: cost=0.25, Loss=L1, weight=1
## - Fold03: cost=0.25, Loss=L1, weight=1
## + Fold03: cost=0.50, Loss=L1, weight=1
## - Fold03: cost=0.50, Loss=L1, weight=1
## + Fold03: cost=1.00, Loss=L1, weight=1
## - Fold03: cost=1.00, Loss=L1, weight=1
## + Fold03: cost=0.25, Loss=L2, weight=1
## - Fold03: cost=0.25, Loss=L2, weight=1
## + Fold03: cost=0.50, Loss=L2, weight=1
## - Fold03: cost=0.50, Loss=L2, weight=1
## + Fold03: cost=1.00, Loss=L2, weight=1
```

```
## - Fold03: cost=1.00, Loss=L2, weight=1
## + Fold03: cost=0.25, Loss=L1, weight=2
## - Fold03: cost=0.25, Loss=L1, weight=2
## + Fold03: cost=0.50, Loss=L1, weight=2
## - Fold03: cost=0.50, Loss=L1, weight=2
## + Fold03: cost=1.00, Loss=L1, weight=2
## - Fold03: cost=1.00, Loss=L1, weight=2
## + Fold03: cost=0.25, Loss=L2, weight=2
## - Fold03: cost=0.25, Loss=L2, weight=2
## + Fold03: cost=0.50, Loss=L2, weight=2
## - Fold03: cost=0.50, Loss=L2, weight=2
## + Fold03: cost=1.00, Loss=L2, weight=2
## - Fold03: cost=1.00, Loss=L2, weight=2
## + Fold03: cost=0.25, Loss=L1, weight=3
## - Fold03: cost=0.25, Loss=L1, weight=3
## + Fold03: cost=0.50, Loss=L1, weight=3
## - Fold03: cost=0.50, Loss=L1, weight=3
## + Fold03: cost=1.00, Loss=L1, weight=3
## - Fold03: cost=1.00, Loss=L1, weight=3
## + Fold03: cost=0.25, Loss=L2, weight=3
## - Fold03: cost=0.25, Loss=L2, weight=3
## + Fold03: cost=0.50, Loss=L2, weight=3
## - Fold03: cost=0.50, Loss=L2, weight=3
## + Fold03: cost=1.00, Loss=L2, weight=3
## - Fold03: cost=1.00, Loss=L2, weight=3
## + Fold04: cost=0.25, Loss=L1, weight=1
## - Fold04: cost=0.25, Loss=L1, weight=1
## + Fold04: cost=0.50, Loss=L1, weight=1
## - Fold04: cost=0.50, Loss=L1, weight=1
## + Fold04: cost=1.00, Loss=L1, weight=1
## - Fold04: cost=1.00, Loss=L1, weight=1
## + Fold04: cost=0.25, Loss=L2, weight=1
## - Fold04: cost=0.25, Loss=L2, weight=1
## + Fold04: cost=0.50, Loss=L2, weight=1
## - Fold04: cost=0.50, Loss=L2, weight=1
## + Fold04: cost=1.00, Loss=L2, weight=1
## - Fold04: cost=1.00, Loss=L2, weight=1
## + Fold04: cost=0.25, Loss=L1, weight=2
## - Fold04: cost=0.25, Loss=L1, weight=2
## + Fold04: cost=0.50, Loss=L1, weight=2
## - Fold04: cost=0.50, Loss=L1, weight=2
## + Fold04: cost=1.00, Loss=L1, weight=2
## - Fold04: cost=1.00, Loss=L1, weight=2
## + Fold04: cost=0.25, Loss=L2, weight=2
## - Fold04: cost=0.25, Loss=L2, weight=2
## + Fold04: cost=0.50, Loss=L2, weight=2
## - Fold04: cost=0.50, Loss=L2, weight=2
## + Fold04: cost=1.00, Loss=L2, weight=2
## - Fold04: cost=1.00, Loss=L2, weight=2
## + Fold04: cost=0.25, Loss=L1, weight=3
## - Fold04: cost=0.25, Loss=L1, weight=3
## + Fold04: cost=0.50, Loss=L1, weight=3
## - Fold04: cost=0.50, Loss=L1, weight=3
## + Fold04: cost=1.00, Loss=L1, weight=3
```

```
## - Fold04: cost=1.00, Loss=L1, weight=3
## + Fold04: cost=0.25, Loss=L2, weight=3
## - Fold04: cost=0.25, Loss=L2, weight=3
## + Fold04: cost=0.50, Loss=L2, weight=3
## - Fold04: cost=0.50, Loss=L2, weight=3
## + Fold04: cost=1.00, Loss=L2, weight=3
## - Fold04: cost=1.00, Loss=L2, weight=3
## + Fold05: cost=0.25, Loss=L1, weight=1
## - Fold05: cost=0.25, Loss=L1, weight=1
## + Fold05: cost=0.50, Loss=L1, weight=1
## - Fold05: cost=0.50, Loss=L1, weight=1
## + Fold05: cost=1.00, Loss=L1, weight=1
## - Fold05: cost=1.00, Loss=L1, weight=1
## + Fold05: cost=0.25, Loss=L2, weight=1
## - Fold05: cost=0.25, Loss=L2, weight=1
## + Fold05: cost=0.50, Loss=L2, weight=1
## - Fold05: cost=0.50, Loss=L2, weight=1
## + Fold05: cost=1.00, Loss=L2, weight=1
## - Fold05: cost=1.00, Loss=L2, weight=1
## + Fold05: cost=0.25, Loss=L1, weight=2
## - Fold05: cost=0.25, Loss=L1, weight=2
## + Fold05: cost=0.50, Loss=L1, weight=2
## - Fold05: cost=0.50, Loss=L1, weight=2
## + Fold05: cost=1.00, Loss=L1, weight=2
## - Fold05: cost=1.00, Loss=L1, weight=2
## + Fold05: cost=0.25, Loss=L2, weight=2
## - Fold05: cost=0.25, Loss=L2, weight=2
## + Fold05: cost=0.50, Loss=L2, weight=2
## - Fold05: cost=0.50, Loss=L2, weight=2
## + Fold05: cost=1.00, Loss=L2, weight=2
## - Fold05: cost=1.00, Loss=L2, weight=2
## + Fold05: cost=0.25, Loss=L1, weight=3
## - Fold05: cost=0.25, Loss=L1, weight=3
## + Fold05: cost=0.50, Loss=L1, weight=3
## - Fold05: cost=0.50, Loss=L1, weight=3
## + Fold05: cost=1.00, Loss=L1, weight=3
## - Fold05: cost=1.00, Loss=L1, weight=3
## + Fold05: cost=0.25, Loss=L2, weight=3
## - Fold05: cost=0.25, Loss=L2, weight=3
## + Fold05: cost=0.50, Loss=L2, weight=3
## - Fold05: cost=0.50, Loss=L2, weight=3
## + Fold05: cost=1.00, Loss=L2, weight=3
## - Fold05: cost=1.00, Loss=L2, weight=3
## + Fold06: cost=0.25, Loss=L1, weight=1
## - Fold06: cost=0.25, Loss=L1, weight=1
## + Fold06: cost=0.50, Loss=L1, weight=1
## - Fold06: cost=0.50, Loss=L1, weight=1
## + Fold06: cost=1.00, Loss=L1, weight=1
## - Fold06: cost=1.00, Loss=L1, weight=1
## + Fold06: cost=0.25, Loss=L2, weight=1
## - Fold06: cost=0.25, Loss=L2, weight=1
## + Fold06: cost=0.50, Loss=L2, weight=1
## - Fold06: cost=0.50, Loss=L2, weight=1
## + Fold06: cost=1.00, Loss=L2, weight=1
```

```
## - Fold06: cost=1.00, Loss=L2, weight=1
## + Fold06: cost=0.25, Loss=L1, weight=2
## - Fold06: cost=0.25, Loss=L1, weight=2
## + Fold06: cost=0.50, Loss=L1, weight=2
## - Fold06: cost=0.50, Loss=L1, weight=2
## + Fold06: cost=1.00, Loss=L1, weight=2
## - Fold06: cost=1.00, Loss=L1, weight=2
## + Fold06: cost=0.25, Loss=L2, weight=2
## - Fold06: cost=0.25, Loss=L2, weight=2
## + Fold06: cost=0.50, Loss=L2, weight=2
## - Fold06: cost=0.50, Loss=L2, weight=2
## + Fold06: cost=1.00, Loss=L2, weight=2
## - Fold06: cost=1.00, Loss=L2, weight=2
## + Fold06: cost=0.25, Loss=L1, weight=3
## - Fold06: cost=0.25, Loss=L1, weight=3
## + Fold06: cost=0.50, Loss=L1, weight=3
## - Fold06: cost=0.50, Loss=L1, weight=3
## + Fold06: cost=1.00, Loss=L1, weight=3
## - Fold06: cost=1.00, Loss=L1, weight=3
## + Fold06: cost=0.25, Loss=L2, weight=3
## - Fold06: cost=0.25, Loss=L2, weight=3
## + Fold06: cost=0.50, Loss=L2, weight=3
## - Fold06: cost=0.50, Loss=L2, weight=3
## + Fold06: cost=1.00, Loss=L2, weight=3
## - Fold06: cost=1.00, Loss=L2, weight=3
## + Fold07: cost=0.25, Loss=L1, weight=1
## - Fold07: cost=0.25, Loss=L1, weight=1
## + Fold07: cost=0.50, Loss=L1, weight=1
## - Fold07: cost=0.50, Loss=L1, weight=1
## + Fold07: cost=1.00, Loss=L1, weight=1
## - Fold07: cost=1.00, Loss=L1, weight=1
## + Fold07: cost=0.25, Loss=L2, weight=1
## - Fold07: cost=0.25, Loss=L2, weight=1
## + Fold07: cost=0.50, Loss=L2, weight=1
## - Fold07: cost=0.50, Loss=L2, weight=1
## + Fold07: cost=1.00, Loss=L2, weight=1
## - Fold07: cost=1.00, Loss=L2, weight=1
## + Fold07: cost=0.25, Loss=L1, weight=2
## - Fold07: cost=0.25, Loss=L1, weight=2
## + Fold07: cost=0.50, Loss=L1, weight=2
## - Fold07: cost=0.50, Loss=L1, weight=2
## + Fold07: cost=1.00, Loss=L1, weight=2
## - Fold07: cost=1.00, Loss=L1, weight=2
## + Fold07: cost=0.25, Loss=L2, weight=2
## - Fold07: cost=0.25, Loss=L2, weight=2
## + Fold07: cost=0.50, Loss=L2, weight=2
## - Fold07: cost=0.50, Loss=L2, weight=2
## + Fold07: cost=1.00, Loss=L2, weight=2
## - Fold07: cost=1.00, Loss=L2, weight=2
## + Fold07: cost=0.25, Loss=L1, weight=3
## - Fold07: cost=0.25, Loss=L1, weight=3
## + Fold07: cost=0.50, Loss=L1, weight=3
## - Fold07: cost=0.50, Loss=L1, weight=3
## + Fold07: cost=1.00, Loss=L1, weight=3
```

```
## - Fold07: cost=1.00, Loss=L1, weight=3
## + Fold07: cost=0.25, Loss=L2, weight=3
## - Fold07: cost=0.25, Loss=L2, weight=3
## + Fold07: cost=0.50, Loss=L2, weight=3
## - Fold07: cost=0.50, Loss=L2, weight=3
## + Fold07: cost=1.00, Loss=L2, weight=3
## - Fold07: cost=1.00, Loss=L2, weight=3
## + Fold08: cost=0.25, Loss=L1, weight=1
## - Fold08: cost=0.25, Loss=L1, weight=1
## + Fold08: cost=0.50, Loss=L1, weight=1
## - Fold08: cost=0.50, Loss=L1, weight=1
## + Fold08: cost=1.00, Loss=L1, weight=1
## - Fold08: cost=1.00, Loss=L1, weight=1
## + Fold08: cost=0.25, Loss=L2, weight=1
## - Fold08: cost=0.25, Loss=L2, weight=1
## + Fold08: cost=0.50, Loss=L2, weight=1
## - Fold08: cost=0.50, Loss=L2, weight=1
## + Fold08: cost=1.00, Loss=L2, weight=1
## - Fold08: cost=1.00, Loss=L2, weight=1
## + Fold08: cost=0.25, Loss=L1, weight=2
## - Fold08: cost=0.25, Loss=L1, weight=2
## + Fold08: cost=0.50, Loss=L1, weight=2
## - Fold08: cost=0.50, Loss=L1, weight=2
## + Fold08: cost=1.00, Loss=L1, weight=2
## - Fold08: cost=1.00, Loss=L1, weight=2
## + Fold08: cost=0.25, Loss=L2, weight=2
## - Fold08: cost=0.25, Loss=L2, weight=2
## + Fold08: cost=0.50, Loss=L2, weight=2
## - Fold08: cost=0.50, Loss=L2, weight=2
## + Fold08: cost=1.00, Loss=L2, weight=2
## - Fold08: cost=1.00, Loss=L2, weight=2
## + Fold08: cost=0.25, Loss=L1, weight=3
## - Fold08: cost=0.25, Loss=L1, weight=3
## + Fold08: cost=0.50, Loss=L1, weight=3
## - Fold08: cost=0.50, Loss=L1, weight=3
## + Fold08: cost=1.00, Loss=L1, weight=3
## - Fold08: cost=1.00, Loss=L1, weight=3
## + Fold08: cost=0.25, Loss=L2, weight=3
## - Fold08: cost=0.25, Loss=L2, weight=3
## + Fold08: cost=0.50, Loss=L2, weight=3
## - Fold08: cost=0.50, Loss=L2, weight=3
## + Fold08: cost=1.00, Loss=L2, weight=3
## - Fold08: cost=1.00, Loss=L2, weight=3
## + Fold09: cost=0.25, Loss=L1, weight=1
## - Fold09: cost=0.25, Loss=L1, weight=1
## + Fold09: cost=0.50, Loss=L1, weight=1
## - Fold09: cost=0.50, Loss=L1, weight=1
## + Fold09: cost=1.00, Loss=L1, weight=1
## - Fold09: cost=1.00, Loss=L1, weight=1
## + Fold09: cost=0.25, Loss=L2, weight=1
## - Fold09: cost=0.25, Loss=L2, weight=1
## + Fold09: cost=0.50, Loss=L2, weight=1
## - Fold09: cost=0.50, Loss=L2, weight=1
## + Fold09: cost=1.00, Loss=L2, weight=1
```

```
## - Fold09: cost=1.00, Loss=L2, weight=1
## + Fold09: cost=0.25, Loss=L1, weight=2
## - Fold09: cost=0.25, Loss=L1, weight=2
## + Fold09: cost=0.50, Loss=L1, weight=2
## - Fold09: cost=0.50, Loss=L1, weight=2
## + Fold09: cost=1.00, Loss=L1, weight=2
## - Fold09: cost=1.00, Loss=L1, weight=2
## + Fold09: cost=0.25, Loss=L2, weight=2
## - Fold09: cost=0.25, Loss=L2, weight=2
## + Fold09: cost=0.50, Loss=L2, weight=2
## - Fold09: cost=0.50, Loss=L2, weight=2
## + Fold09: cost=1.00, Loss=L2, weight=2
## - Fold09: cost=1.00, Loss=L2, weight=2
## + Fold09: cost=0.25, Loss=L1, weight=3
## - Fold09: cost=0.25, Loss=L1, weight=3
## + Fold09: cost=0.50, Loss=L1, weight=3
## - Fold09: cost=0.50, Loss=L1, weight=3
## + Fold09: cost=1.00, Loss=L1, weight=3
## - Fold09: cost=1.00, Loss=L1, weight=3
## + Fold09: cost=0.25, Loss=L2, weight=3
## - Fold09: cost=0.25, Loss=L2, weight=3
## + Fold09: cost=0.50, Loss=L2, weight=3
## - Fold09: cost=0.50, Loss=L2, weight=3
## + Fold09: cost=1.00, Loss=L2, weight=3
## - Fold09: cost=1.00, Loss=L2, weight=3
## + Fold10: cost=0.25, Loss=L1, weight=1
## - Fold10: cost=0.25, Loss=L1, weight=1
## + Fold10: cost=0.50, Loss=L1, weight=1
## - Fold10: cost=0.50, Loss=L1, weight=1
## + Fold10: cost=1.00, Loss=L1, weight=1
## - Fold10: cost=1.00, Loss=L1, weight=1
## + Fold10: cost=0.25, Loss=L2, weight=1
## - Fold10: cost=0.25, Loss=L2, weight=1
## + Fold10: cost=0.50, Loss=L2, weight=1
## - Fold10: cost=0.50, Loss=L2, weight=1
## + Fold10: cost=1.00, Loss=L2, weight=1
## - Fold10: cost=1.00, Loss=L2, weight=1
## + Fold10: cost=0.25, Loss=L1, weight=2
## - Fold10: cost=0.25, Loss=L1, weight=2
## + Fold10: cost=0.50, Loss=L1, weight=2
## - Fold10: cost=0.50, Loss=L1, weight=2
## + Fold10: cost=1.00, Loss=L1, weight=2
## - Fold10: cost=1.00, Loss=L1, weight=2
## + Fold10: cost=0.25, Loss=L2, weight=2
## - Fold10: cost=0.25, Loss=L2, weight=2
## + Fold10: cost=0.50, Loss=L2, weight=2
## - Fold10: cost=0.50, Loss=L2, weight=2
## + Fold10: cost=1.00, Loss=L2, weight=2
## - Fold10: cost=1.00, Loss=L2, weight=2
## + Fold10: cost=0.25, Loss=L1, weight=3
## - Fold10: cost=0.25, Loss=L1, weight=3
## + Fold10: cost=0.50, Loss=L1, weight=3
## - Fold10: cost=0.50, Loss=L1, weight=3
## + Fold10: cost=1.00, Loss=L1, weight=3
```

```
## - Fold10: cost=1.00, Loss=L1, weight=3
## + Fold10: cost=0.25, Loss=L2, weight=3
## - Fold10: cost=0.25, Loss=L2, weight=3
## + Fold10: cost=0.50, Loss=L2, weight=3
## - Fold10: cost=0.50, Loss=L2, weight=3
## + Fold10: cost=1.00, Loss=L2, weight=3
## - Fold10: cost=1.00, Loss=L2, weight=3
## Aggregating results
## Selecting tuning parameters
## Fitting cost = 0.25, Loss = L2, weight = 1 on full training set
```

```
##
##           <=50K  >50K
##    <=50K  21031  3603
##    >50K    1623  3905
```

It's accuracy comes out to 83%

Trying the Naive Bayes model

```
## + Fold01: usekernel= TRUE, laplace=0, adjust=1
## - Fold01: usekernel= TRUE, laplace=0, adjust=1
## + Fold01: usekernel=FALSE, laplace=0, adjust=1
## - Fold01: usekernel=FALSE, laplace=0, adjust=1
## + Fold02: usekernel= TRUE, laplace=0, adjust=1
## - Fold02: usekernel= TRUE, laplace=0, adjust=1
## + Fold02: usekernel=FALSE, laplace=0, adjust=1
## - Fold02: usekernel=FALSE, laplace=0, adjust=1
## + Fold03: usekernel= TRUE, laplace=0, adjust=1
## - Fold03: usekernel= TRUE, laplace=0, adjust=1
## + Fold03: usekernel=FALSE, laplace=0, adjust=1
## - Fold03: usekernel=FALSE, laplace=0, adjust=1
## + Fold04: usekernel= TRUE, laplace=0, adjust=1
## - Fold04: usekernel= TRUE, laplace=0, adjust=1
## + Fold04: usekernel=FALSE, laplace=0, adjust=1
## - Fold04: usekernel=FALSE, laplace=0, adjust=1
## + Fold05: usekernel= TRUE, laplace=0, adjust=1
## - Fold05: usekernel= TRUE, laplace=0, adjust=1
## + Fold05: usekernel=FALSE, laplace=0, adjust=1
## - Fold05: usekernel=FALSE, laplace=0, adjust=1
## + Fold06: usekernel= TRUE, laplace=0, adjust=1
## - Fold06: usekernel= TRUE, laplace=0, adjust=1
## + Fold06: usekernel=FALSE, laplace=0, adjust=1
## - Fold06: usekernel=FALSE, laplace=0, adjust=1
## + Fold07: usekernel= TRUE, laplace=0, adjust=1
## - Fold07: usekernel= TRUE, laplace=0, adjust=1
## + Fold07: usekernel=FALSE, laplace=0, adjust=1
## - Fold07: usekernel=FALSE, laplace=0, adjust=1
## + Fold08: usekernel= TRUE, laplace=0, adjust=1
## - Fold08: usekernel= TRUE, laplace=0, adjust=1
## + Fold08: usekernel=FALSE, laplace=0, adjust=1
## - Fold08: usekernel=FALSE, laplace=0, adjust=1
## + Fold09: usekernel= TRUE, laplace=0, adjust=1
## - Fold09: usekernel= TRUE, laplace=0, adjust=1
```

```
## + Fold09: usekernel=FALSE, laplace=0, adjust=1
## - Fold09: usekernel=FALSE, laplace=0, adjust=1
## + Fold10: usekernel= TRUE, laplace=0, adjust=1
## - Fold10: usekernel= TRUE, laplace=0, adjust=1
## + Fold10: usekernel=FALSE, laplace=0, adjust=1
## - Fold10: usekernel=FALSE, laplace=0, adjust=1
## Aggregating results
## Selecting tuning parameters
## Fitting laplace = 0, usekernel = TRUE, adjust = 1 on full training set
```

```
##
##            <=50K  >50K
##    <=50K  22647  7422
##    >50K       7    86
```

It's accuracy comes out to only 75%

For our last model, we try a neural net

```
## + Fold01: size=1, decay=0e+00
## # weights:  59
## initial  value 21707.541425
## iter  10 value 14120.427052
## iter  20 value 12672.888453
## iter  30 value 12549.309548
## iter  40 value 11966.074231
## iter  50 value 11831.656401
## iter  60 value 11784.259399
## iter  70 value 11724.009008
## iter  80 value 11558.483435
## iter  90 value 11359.050698
## iter 100 value 11297.594984
## final  value 11297.594984
## stopped after 100 iterations
## - Fold01: size=1, decay=0e+00
## + Fold01: size=3, decay=0e+00
## # weights:  175
## initial  value 15406.481999
## iter  10 value 14905.320463
## iter  20 value 13621.921817
## iter  30 value 11996.751712
## iter  40 value 11262.707758
## iter  50 value 10627.862585
## iter  60 value 10364.354534
## iter  70 value 10288.524694
## iter  80 value 10258.337330
## iter  90 value 10257.013298
## iter 100 value 10253.325556
## final  value 10253.325556
## stopped after 100 iterations
## - Fold01: size=3, decay=0e+00
## + Fold01: size=5, decay=0e+00
## # weights:  291
## initial  value 20485.045042
```

```
## iter  10 value 14603.295714
## iter  20 value 11459.730855
## iter  30 value 10645.198728
## iter  40 value 10350.067936
## iter  50 value 10192.826918
## iter  60 value 10130.205419
## iter  70 value 10094.071026
## iter  80 value 9923.550675
## iter  90 value 9739.738639
## iter 100 value 9639.473619
## final  value 9639.473619
## stopped after 100 iterations
## - Fold01: size=5, decay=0e+00
## + Fold01: size=1, decay=1e-01
## # weights:  59
## initial  value 16626.645712
## iter  10 value 15227.702962
## iter  20 value 15085.981548
## iter  30 value 14874.224981
## iter  40 value 14624.877112
## iter  50 value 12374.179435
## iter  60 value 11176.353840
## iter  70 value 10808.739000
## iter  80 value 10402.556512
## iter  90 value 10099.030261
## iter 100 value 9998.787663
## final  value 9998.787663
## stopped after 100 iterations
## - Fold01: size=1, decay=1e-01
## + Fold01: size=3, decay=1e-01
## # weights:  175
## initial  value 21678.968851
## iter  10 value 15046.031000
## iter  20 value 11325.261601
## iter  30 value 10476.085502
## iter  40 value 10098.491738
## iter  50 value 9898.103234
## iter  60 value 9800.998311
## iter  70 value 9737.832034
## iter  80 value 9703.885931
## iter  90 value 9655.142920
## iter 100 value 9591.328819
## final  value 9591.328819
## stopped after 100 iterations
## - Fold01: size=3, decay=1e-01
## + Fold01: size=5, decay=1e-01
## # weights:  291
## initial  value 15319.402312
## iter  10 value 13716.058635
## iter  20 value 11995.860564
## iter  30 value 10800.848940
## iter  40 value 10503.840252
## iter  50 value 10333.555700
## iter  60 value 10296.102536
```

```
## iter  70 value 10228.796783
## iter  80 value 10034.572795
## iter  90 value 9857.461871
## iter 100 value 9658.432189
## final  value 9658.432189
## stopped after 100 iterations
## - Fold01: size=5, decay=1e-01
## + Fold01: size=1, decay=1e-04
## # weights:  59
## initial  value 18588.565128
## final  value 15232.382712
## converged
## - Fold01: size=1, decay=1e-04
## + Fold01: size=3, decay=1e-04
## # weights:  175
## initial  value 16842.833041
## iter  10 value 15232.376328
## final  value 15232.372409
## converged
## - Fold01: size=3, decay=1e-04
## + Fold01: size=5, decay=1e-04
## # weights:  291
## initial  value 20388.713431
## iter  10 value 14863.922749
## iter  20 value 13440.570450
## iter  30 value 12363.623017
## iter  40 value 12337.380889
## iter  50 value 12271.515039
## iter  60 value 11561.319061
## iter  70 value 11040.898217
## iter  80 value 10198.436549
## iter  90 value 9842.268869
## iter 100 value 9774.716667
## final  value 9774.716667
## stopped after 100 iterations
## - Fold01: size=5, decay=1e-04
## + Fold02: size=1, decay=0e+00
## # weights:  59
## initial  value 18431.495416
## final  value 15232.655468
## converged
## - Fold02: size=1, decay=0e+00
## + Fold02: size=3, decay=0e+00
## # weights:  175
## initial  value 27642.036425
## final  value 15232.655353
## converged
## - Fold02: size=3, decay=0e+00
## + Fold02: size=5, decay=0e+00
## # weights:  291
## initial  value 16580.550971
## iter  10 value 14330.116632
## iter  20 value 12492.462840
## iter  30 value 11477.643074
```

```
## iter  40 value 10810.929991
## iter  50 value 10733.171419
## iter  60 value 10682.358238
## iter  70 value 10633.032167
## iter  80 value 10597.489079
## iter  90 value 10571.094092
## iter 100 value 10544.610415
## final  value 10544.610415
## stopped after 100 iterations
## - Fold02: size=5, decay=0e+00
## + Fold02: size=1, decay=1e-01
## # weights:  59
## initial  value 19109.993799
## iter  10 value 15222.963251
## iter  20 value 15045.975926
## iter  30 value 13991.782831
## iter  40 value 12112.715069
## iter  50 value 10859.285575
## iter  60 value 10446.317817
## iter  70 value 10061.014075
## iter  80 value 9884.986650
## iter  90 value 9789.066194
## iter 100 value 9719.191898
## final  value 9719.191898
## stopped after 100 iterations
## - Fold02: size=1, decay=1e-01
## + Fold02: size=3, decay=1e-01
## # weights:  175
## initial  value 18831.018416
## iter  10 value 13012.512789
## iter  20 value 10990.088613
## iter  30 value 10701.195910
## iter  40 value 10450.254871
## iter  50 value 10185.659456
## iter  60 value 9942.865473
## iter  70 value 9812.630393
## iter  80 value 9715.073502
## iter  90 value 9634.621548
## iter 100 value 9563.882106
## final  value 9563.882106
## stopped after 100 iterations
## - Fold02: size=3, decay=1e-01
## + Fold02: size=5, decay=1e-01
## # weights:  291
## initial  value 19353.263785
## iter  10 value 15235.483578
## iter  20 value 14504.688835
## iter  30 value 12803.508240
## iter  40 value 11337.293110
## iter  50 value 10946.719477
## iter  60 value 10657.442011
## iter  70 value 10331.861554
## iter  80 value 10035.215008
## iter  90 value 9761.781155
```

```
## iter 100 value 9652.928561
## final  value 9652.928561
## stopped after 100 iterations
## - Fold02: size=5, decay=1e-01
## + Fold02: size=1, decay=1e-04
## # weights:  59
## initial  value 20940.177188
## final  value 15232.656274
## converged
## - Fold02: size=1, decay=1e-04
## + Fold02: size=3, decay=1e-04
## # weights:  175
## initial  value 15502.213749
## iter  10 value 14913.969213
## iter  20 value 11921.296977
## iter  30 value 10735.772102
## iter  40 value 10361.732040
## iter  50 value 10234.549479
## iter  60 value 10202.256708
## iter  70 value 10187.566627
## iter  80 value 10186.605362
## iter  90 value 10186.121248
## iter 100 value 10184.152970
## final  value 10184.152970
## stopped after 100 iterations
## - Fold02: size=3, decay=1e-04
## + Fold02: size=5, decay=1e-04
## # weights:  291
## initial  value 21697.502257
## iter  10 value 15003.704902
## iter  20 value 14233.650677
## iter  30 value 13277.931056
## iter  40 value 13129.079508
## iter  50 value 13108.434752
## iter  60 value 13087.062717
## iter  70 value 13070.875880
## iter  80 value 13069.351413
## iter  90 value 13067.998323
## iter 100 value 13067.220647
## final  value 13067.220647
## stopped after 100 iterations
## - Fold02: size=5, decay=1e-04
## + Fold03: size=1, decay=0e+00
## # weights:  59
## initial  value 19703.443477
## final  value 15234.045797
## converged
## - Fold03: size=1, decay=0e+00
## + Fold03: size=3, decay=0e+00
## # weights:  175
## initial  value 15531.576852
## iter  10 value 13809.612327
## iter  20 value 12518.769751
## iter  30 value 10661.299256
```

```
## iter  40 value 10069.141971
## iter  50 value 9886.246700
## iter  60 value 9794.119570
## iter  70 value 9752.392448
## iter  80 value 9730.251982
## iter  90 value 9712.235139
## iter 100 value 9690.763423
## final  value 9690.763423
## stopped after 100 iterations
## - Fold03: size=3, decay=0e+00
## + Fold03: size=5, decay=0e+00
## # weights:  291
## initial  value 18909.007827
## iter  10 value 15014.514942
## iter  20 value 13662.232432
## iter  30 value 11848.845211
## iter  40 value 11178.661087
## iter  50 value 10888.876996
## iter  60 value 10717.274840
## iter  70 value 10509.014248
## iter  80 value 10323.493900
## iter  90 value 10279.149639
## iter 100 value 10230.731650
## final  value 10230.731650
## stopped after 100 iterations
## - Fold03: size=5, decay=0e+00
## + Fold03: size=1, decay=1e-01
## # weights:  59
## initial  value 15496.770017
## iter  10 value 15234.573524
## iter  20 value 15234.129351
## iter  20 value 15234.129332
## iter  20 value 15234.129332
## final  value 15234.129332
## converged
## - Fold03: size=1, decay=1e-01
## + Fold03: size=3, decay=1e-01
## # weights:  175
## initial  value 16073.761709
## iter  10 value 15193.561461
## iter  20 value 15043.198950
## iter  30 value 14486.744861
## iter  40 value 12843.211784
## iter  50 value 10835.488884
## iter  60 value 10496.817944
## iter  70 value 10045.237396
## iter  80 value 9851.886926
## iter  90 value 9680.044010
## iter 100 value 9637.773839
## final  value 9637.773839
## stopped after 100 iterations
## - Fold03: size=3, decay=1e-01
## + Fold03: size=5, decay=1e-01
## # weights:  291
```

```
## initial  value 15871.560369
## iter  10 value 14468.827344
## iter  20 value 11967.688980
## iter  30 value 10216.684756
## iter  40 value 9948.746571
## iter  50 value 9809.947865
## iter  60 value 9743.931387
## iter  70 value 9695.469006
## iter  80 value 9598.938902
## iter  90 value 9552.273850
## iter 100 value 9484.624453
## final  value 9484.624453
## stopped after 100 iterations
## - Fold03: size=5, decay=1e-01
## + Fold03: size=1, decay=1e-04
## # weights:  59
## initial  value 17417.455166
## iter  10 value 15226.162936
## iter  20 value 14898.322607
## iter  30 value 13347.103834
## iter  40 value 12261.607753
## iter  50 value 11909.049395
## iter  60 value 11639.646079
## iter  70 value 11549.808056
## iter  80 value 11415.458656
## iter  90 value 11274.997201
## iter 100 value 11020.188733
## final  value 11020.188733
## stopped after 100 iterations
## - Fold03: size=1, decay=1e-04
## + Fold03: size=3, decay=1e-04
## # weights:  175
## initial  value 21046.828690
## iter  10 value 14603.096985
## iter  20 value 11706.223564
## iter  30 value 11190.624430
## iter  40 value 11060.709850
## iter  50 value 10910.800080
## iter  60 value 10849.736025
## iter  70 value 10824.334423
## iter  80 value 10797.235394
## iter  90 value 10752.822112
## iter 100 value 10704.808622
## final  value 10704.808622
## stopped after 100 iterations
## - Fold03: size=3, decay=1e-04
## + Fold03: size=5, decay=1e-04
## # weights:  291
## initial  value 19354.481310
## iter  10 value 15047.010771
## iter  20 value 14694.605117
## iter  30 value 11996.036415
## iter  40 value 11079.251131
## iter  50 value 10206.400501
```

```
## iter  60 value 9945.978220
## iter  70 value 9750.333925
## iter  80 value 9661.261724
## iter  90 value 9586.352801
## iter 100 value 9555.942153
## final  value 9555.942153
## stopped after 100 iterations
## - Fold03: size=5, decay=1e-04
## + Fold04: size=1, decay=0e+00
## # weights:  59
## initial  value 23744.193134
## final  value 15232.368962
## converged
## - Fold04: size=1, decay=0e+00
## + Fold04: size=3, decay=0e+00
## # weights:  175
## initial  value 16305.172709
## final  value 15232.369018
## converged
## - Fold04: size=3, decay=0e+00
## + Fold04: size=5, decay=0e+00
## # weights:  291
## initial  value 15147.295287
## iter  10 value 12605.189887
## iter  20 value 11515.455925
## iter  30 value 10769.353855
## iter  40 value 10377.568225
## iter  50 value 10177.839177
## iter  60 value 9932.754241
## iter  70 value 9841.230357
## iter  80 value 9808.867136
## iter  90 value 9757.495807
## iter 100 value 9731.506239
## final  value 9731.506239
## stopped after 100 iterations
## - Fold04: size=5, decay=0e+00
## + Fold04: size=1, decay=1e-01
## # weights:  59
## initial  value 25220.962405
## iter  10 value 15233.728484
## final  value 15232.497600
## converged
## - Fold04: size=1, decay=1e-01
## + Fold04: size=3, decay=1e-01
## # weights:  175
## initial  value 20029.417061
## iter  10 value 15081.542151
## iter  20 value 14721.092322
## iter  30 value 12716.937704
## iter  40 value 11903.720171
## iter  50 value 11634.747825
## iter  60 value 11453.038457
## iter  70 value 11181.878962
## iter  80 value 10667.326717
```

```
## iter  90 value 10203.642144
## iter 100 value 9957.986620
## final  value 9957.986620
## stopped after 100 iterations
## - Fold04: size=3, decay=1e-01
## + Fold04: size=5, decay=1e-01
## # weights:  291
## initial  value 15483.179196
## iter  10 value 14479.107766
## iter  20 value 13412.830210
## iter  30 value 11424.310884
## iter  40 value 10487.165885
## iter  50 value 10085.860052
## iter  60 value 9906.761357
## iter  70 value 9719.693234
## iter  80 value 9612.312356
## iter  90 value 9560.546829
## iter 100 value 9516.679523
## final  value 9516.679523
## stopped after 100 iterations
## - Fold04: size=5, decay=1e-01
## + Fold04: size=1, decay=1e-04
## # weights:  59
## initial  value 20543.306909
## final  value 15232.372294
## converged
## - Fold04: size=1, decay=1e-04
## + Fold04: size=3, decay=1e-04
## # weights:  175
## initial  value 22881.560084
## iter  10 value 13226.015200
## iter  20 value 11174.926234
## iter  30 value 10588.789517
## iter  40 value 10306.956190
## iter  50 value 10192.135129
## iter  60 value 10123.241941
## iter  70 value 9998.129525
## iter  80 value 9846.532506
## iter  90 value 9729.125042
## iter 100 value 9647.414959
## final  value 9647.414959
## stopped after 100 iterations
## - Fold04: size=3, decay=1e-04
## + Fold04: size=5, decay=1e-04
## # weights:  291
## initial  value 15963.119244
## iter  10 value 14801.942867
## iter  20 value 12115.827423
## iter  30 value 10607.451378
## iter  40 value 10068.208172
## iter  50 value 9914.828038
## iter  60 value 9827.487866
## iter  70 value 9708.878491
## iter  80 value 9616.740181
```

```
## iter  90 value 9574.891072
## iter 100 value 9559.808900
## final  value 9559.808900
## stopped after 100 iterations
## - Fold04: size=5, decay=1e-04
## + Fold05: size=1, decay=0e+00
## # weights:  59
## initial  value 19620.605666
## final  value 15234.045800
## converged
## - Fold05: size=1, decay=0e+00
## + Fold05: size=3, decay=0e+00
## # weights:  175
## initial  value 20205.005563
## iter  10 value 14177.686391
## iter  20 value 11501.239047
## iter  30 value 10907.590669
## iter  40 value 10756.508508
## iter  50 value 10677.944519
## iter  60 value 10642.979585
## iter  70 value 10635.258819
## iter  80 value 10604.385335
## iter  90 value 10576.193875
## iter 100 value 10573.645605
## final  value 10573.645605
## stopped after 100 iterations
## - Fold05: size=3, decay=0e+00
## + Fold05: size=5, decay=0e+00
## # weights:  291
## initial  value 15440.587549
## iter  10 value 15234.325170
## iter  20 value 14930.503707
## iter  30 value 14056.784480
## iter  40 value 12470.528134
## iter  50 value 12180.442941
## iter  60 value 11824.041984
## iter  70 value 11228.960246
## iter  80 value 10286.603965
## iter  90 value 9957.962838
## iter 100 value 9839.207826
## final  value 9839.207826
## stopped after 100 iterations
## - Fold05: size=5, decay=0e+00
## + Fold05: size=1, decay=1e-01
## # weights:  59
## initial  value 20229.205674
## iter  10 value 15245.337124
## iter  20 value 15162.954336
## iter  30 value 14311.894562
## iter  40 value 11413.087376
## iter  50 value 10959.399205
## iter  60 value 10687.069223
## iter  70 value 10473.677464
## iter  80 value 10339.588682
```

```
## iter  90 value 10286.758611
## iter 100 value 10110.573338
## final  value 10110.573338
## stopped after 100 iterations
## - Fold05: size=1, decay=1e-01
## + Fold05: size=3, decay=1e-01
## # weights:  175
## initial  value 24757.242742
## iter  10 value 14989.216483
## iter  20 value 14359.308370
## iter  30 value 11603.622012
## iter  40 value 10758.073218
## iter  50 value 10338.880235
## iter  60 value 10119.192237
## iter  70 value 10005.687815
## iter  80 value 9908.403588
## iter  90 value 9839.627235
## iter 100 value 9706.527703
## final  value 9706.527703
## stopped after 100 iterations
## - Fold05: size=3, decay=1e-01
## + Fold05: size=5, decay=1e-01
## # weights:  291
## initial  value 17500.920813
## iter  10 value 14994.278530
## iter  20 value 13465.041407
## iter  30 value 12253.315553
## iter  40 value 11539.469213
## iter  50 value 10948.115128
## iter  60 value 10276.723565
## iter  70 value 10020.614611
## iter  80 value 9915.970889
## iter  90 value 9783.945570
## iter 100 value 9623.046097
## final  value 9623.046097
## stopped after 100 iterations
## - Fold05: size=5, decay=1e-01
## + Fold05: size=1, decay=1e-04
## # weights:  59
## initial  value 30282.875510
## final  value 15234.084113
## converged
## - Fold05: size=1, decay=1e-04
## + Fold05: size=3, decay=1e-04
## # weights:  175
## initial  value 26831.288176
## iter  10 value 15144.517124
## iter  20 value 14639.091370
## iter  30 value 14187.346039
## iter  40 value 12454.376995
## iter  50 value 11506.293016
## iter  60 value 11286.217017
## iter  70 value 11155.024855
## iter  80 value 11067.114060
```

```
## iter  90 value 10941.668735
## iter 100 value 10827.497318
## final  value 10827.497318
## stopped after 100 iterations
## - Fold05: size=3, decay=1e-04
## + Fold05: size=5, decay=1e-04
## # weights:  291
## initial  value 19509.465018
## iter  10 value 15174.861352
## iter  20 value 14767.991864
## iter  30 value 13805.983824
## iter  40 value 12516.442099
## iter  50 value 11705.109144
## iter  60 value 10767.932688
## iter  70 value 10069.878510
## iter  80 value 9911.238374
## iter  90 value 9787.927098
## iter 100 value 9750.906882
## final  value 9750.906882
## stopped after 100 iterations
## - Fold05: size=5, decay=1e-04
## + Fold06: size=1, decay=0e+00
## # weights:  59
## initial  value 17366.399068
## final  value 15232.368962
## converged
## - Fold06: size=1, decay=0e+00
## + Fold06: size=3, decay=0e+00
## # weights:  175
## initial  value 18160.163539
## iter  10 value 15133.821136
## iter  20 value 12281.105026
## iter  30 value 11240.270976
## iter  40 value 10915.187094
## iter  50 value 10781.344236
## iter  60 value 10682.302987
## iter  70 value 10659.481754
## iter  80 value 10655.227448
## iter  90 value 10648.325121
## iter 100 value 10641.661549
## final  value 10641.661549
## stopped after 100 iterations
## - Fold06: size=3, decay=0e+00
## + Fold06: size=5, decay=0e+00
## # weights:  291
## initial  value 17661.334566
## iter  10 value 14994.760566
## iter  20 value 12087.111193
## iter  30 value 10742.376354
## iter  40 value 10661.723595
## iter  50 value 10536.206758
## iter  60 value 10474.699834
## iter  70 value 10464.707546
## iter  80 value 10453.577610
```

```
## iter  90 value 10386.520160
## iter 100 value 10301.115502
## final  value 10301.115502
## stopped after 100 iterations
## - Fold06: size=5, decay=0e+00
## + Fold06: size=1, decay=1e-01
## # weights:  59
## initial  value 17374.033419
## iter  10 value 15165.364126
## iter  20 value 15053.074996
## iter  30 value 14198.707677
## iter  40 value 13100.262982
## iter  50 value 12280.071985
## iter  60 value 10931.806200
## iter  70 value 10321.097027
## iter  80 value 10121.155211
## iter  90 value 9995.237175
## iter 100 value 9957.335230
## final  value 9957.335230
## stopped after 100 iterations
## - Fold06: size=1, decay=1e-01
## + Fold06: size=3, decay=1e-01
## # weights:  175
## initial  value 22529.612530
## iter  10 value 15067.352916
## iter  20 value 13796.414852
## iter  30 value 11760.652749
## iter  40 value 10825.949054
## iter  50 value 10517.420567
## iter  60 value 10331.332367
## iter  70 value 10163.618098
## iter  80 value 9988.268103
## iter  90 value 9807.133845
## iter 100 value 9707.189309
## final  value 9707.189309
## stopped after 100 iterations
## - Fold06: size=3, decay=1e-01
## + Fold06: size=5, decay=1e-01
## # weights:  291
## initial  value 25531.053038
## iter  10 value 15234.395629
## iter  20 value 15191.494663
## iter  30 value 14490.249435
## iter  40 value 13004.577464
## iter  50 value 12204.625211
## iter  60 value 11339.288443
## iter  70 value 10872.293631
## iter  80 value 10408.004196
## iter  90 value 10144.214977
## iter 100 value 9998.617552
## final  value 9998.617552
## stopped after 100 iterations
## - Fold06: size=5, decay=1e-01
## + Fold06: size=1, decay=1e-04
```

```
## # weights:  59
## initial  value 17580.917054
## final  value 15232.369887
## converged
## - Fold06: size=1, decay=1e-04
## + Fold06: size=3, decay=1e-04
## # weights:  175
## initial  value 35067.768750
## iter  10 value 14555.688595
## iter  20 value 13574.389334
## iter  30 value 12861.456715
## iter  40 value 11198.912672
## iter  50 value 10603.359690
## iter  60 value 10114.714196
## iter  70 value 9909.907219
## iter  80 value 9748.061454
## iter  90 value 9653.516407
## iter 100 value 9605.059066
## final  value 9605.059066
## stopped after 100 iterations
## - Fold06: size=3, decay=1e-04
## + Fold06: size=5, decay=1e-04
## # weights:  291
## initial  value 20960.195876
## iter  10 value 15093.580918
## iter  20 value 13749.112104
## iter  30 value 11599.598137
## iter  40 value 10850.456178
## iter  50 value 10686.901864
## iter  60 value 10499.830578
## iter  70 value 10440.967154
## iter  80 value 10420.535827
## iter  90 value 10419.150623
## iter 100 value 10418.687822
## final  value 10418.687822
## stopped after 100 iterations
## - Fold06: size=5, decay=1e-04
## + Fold07: size=1, decay=0e+00
## # weights:  59
## initial  value 17920.387267
## final  value 15232.655218
## converged
## - Fold07: size=1, decay=0e+00
## + Fold07: size=3, decay=0e+00
## # weights:  175
## initial  value 15248.657643
## iter  10 value 14987.486831
## iter  20 value 14056.614904
## iter  30 value 13380.477378
## iter  40 value 13129.009229
## iter  50 value 13081.352276
## iter  60 value 13069.297452
## iter  70 value 13061.919077
## iter  80 value 13049.142602
```

```
## iter  90 value 12940.929542
## iter 100 value 12018.011255
## final  value 12018.011255
## stopped after 100 iterations
## - Fold07: size=3, decay=0e+00
## + Fold07: size=5, decay=0e+00
## # weights:  291
## initial  value 15850.487068
## iter  10 value 14264.315825
## iter  20 value 13072.631444
## iter  30 value 11109.866980
## iter  40 value 10219.072986
## iter  50 value 9766.313056
## iter  60 value 9623.656006
## iter  70 value 9535.263322
## iter  80 value 9484.643241
## iter  90 value 9454.653699
## iter 100 value 9438.076147
## final  value 9438.076147
## stopped after 100 iterations
## - Fold07: size=5, decay=0e+00
## + Fold07: size=1, decay=1e-01
## # weights:  59
## initial  value 20871.620165
## iter  10 value 15199.000585
## iter  20 value 14815.810108
## iter  30 value 12557.516144
## iter  40 value 11337.545563
## iter  50 value 10622.560481
## iter  60 value 10442.462062
## iter  70 value 10112.293877
## iter  80 value 9966.298179
## iter  90 value 9897.357225
## iter 100 value 9870.602904
## final  value 9870.602904
## stopped after 100 iterations
## - Fold07: size=1, decay=1e-01
## + Fold07: size=3, decay=1e-01
## # weights:  175
## initial  value 16167.307510
## iter  10 value 14974.272245
## iter  20 value 12142.196410
## iter  30 value 10975.826626
## iter  40 value 10696.776383
## iter  50 value 10482.200404
## iter  60 value 10157.857969
## iter  70 value 9932.845222
## iter  80 value 9796.995766
## iter  90 value 9685.261511
## iter 100 value 9569.245630
## final  value 9569.245630
## stopped after 100 iterations
## - Fold07: size=3, decay=1e-01
## + Fold07: size=5, decay=1e-01
```

```
## # weights:  291
## initial  value 25425.840603
## iter  10 value 15210.800072
## iter  20 value 14648.006195
## iter  30 value 13627.135258
## iter  40 value 12585.570790
## iter  50 value 10948.242185
## iter  60 value 10469.414644
## iter  70 value 10237.080170
## iter  80 value 10106.252591
## iter  90 value 9993.416754
## iter 100 value 9815.008899
## final  value 9815.008899
## stopped after 100 iterations
## - Fold07: size=5, decay=1e-01
## + Fold07: size=1, decay=1e-04
## # weights:  59
## initial  value 18665.681606
## final  value 15232.656346
## converged
## - Fold07: size=1, decay=1e-04
## + Fold07: size=3, decay=1e-04
## # weights:  175
## initial  value 23464.126917
## final  value 15232.724270
## converged
## - Fold07: size=3, decay=1e-04
## + Fold07: size=5, decay=1e-04
## # weights:  291
## initial  value 18583.594993
## iter  10 value 15213.753955
## iter  20 value 15025.375277
## iter  30 value 12568.802241
## iter  40 value 10833.982053
## iter  50 value 10142.701860
## iter  60 value 9934.802430
## iter  70 value 9792.298736
## iter  80 value 9721.188839
## iter  90 value 9702.793636
## iter 100 value 9696.986272
## final  value 9696.986272
## stopped after 100 iterations
## - Fold07: size=5, decay=1e-04
## + Fold08: size=1, decay=0e+00
## # weights:  59
## initial  value 20943.008963
## final  value 15232.368962
## converged
## - Fold08: size=1, decay=0e+00
## + Fold08: size=3, decay=0e+00
## # weights:  175
## initial  value 20091.632481
## iter  10 value 15101.874469
## iter  20 value 14890.031978
```

```
## iter  30 value 13344.283071
## iter  40 value 11900.398946
## iter  50 value 11212.051633
## iter  60 value 11058.581852
## iter  70 value 10998.458927
## iter  80 value 10977.308655
## iter  90 value 10956.570482
## iter 100 value 10952.861277
## final  value 10952.861277
## stopped after 100 iterations
## - Fold08: size=3, decay=0e+00
## + Fold08: size=5, decay=0e+00
## # weights:  291
## initial  value 27594.992452
## iter  10 value 14722.205070
## iter  20 value 11986.853433
## iter  30 value 11112.987079
## iter  40 value 10295.819044
## iter  50 value 10047.267752
## iter  60 value 9897.806474
## iter  70 value 9806.260768
## iter  80 value 9754.102257
## iter  90 value 9725.256905
## iter 100 value 9711.521389
## final  value 9711.521389
## stopped after 100 iterations
## - Fold08: size=5, decay=0e+00
## + Fold08: size=1, decay=1e-01
## # weights:  59
## initial  value 19870.436482
## iter  10 value 15232.383981
## iter  20 value 15137.521608
## iter  30 value 14399.999519
## iter  40 value 13354.619903
## iter  50 value 12077.737425
## iter  60 value 11536.659580
## iter  70 value 11195.040387
## iter  80 value 11101.209742
## iter  90 value 10253.054577
## iter 100 value 10085.756680
## final  value 10085.756680
## stopped after 100 iterations
## - Fold08: size=1, decay=1e-01
## + Fold08: size=3, decay=1e-01
## # weights:  175
## initial  value 24038.689685
## iter  10 value 15231.224149
## iter  20 value 14910.127157
## iter  30 value 13919.895246
## iter  40 value 12371.445122
## iter  50 value 10890.675590
## iter  60 value 10318.801102
## iter  70 value 9933.266372
## iter  80 value 9806.856377
```

```
## iter  90 value 9676.777443
## iter 100 value 9614.133370
## final  value 9614.133370
## stopped after 100 iterations
## - Fold08: size=3, decay=1e-01
## + Fold08: size=5, decay=1e-01
## # weights:  291
## initial  value 17157.272220
## iter  10 value 15106.385832
## iter  20 value 12704.780657
## iter  30 value 11060.933846
## iter  40 value 10902.249837
## iter  50 value 10349.127310
## iter  60 value 10026.796457
## iter  70 value 9750.431828
## iter  80 value 9583.475978
## iter  90 value 9487.688568
## iter 100 value 9437.482075
## final  value 9437.482075
## stopped after 100 iterations
## - Fold08: size=5, decay=1e-01
## + Fold08: size=1, decay=1e-04
## # weights:  59
## initial  value 23399.590584
## final  value 15232.370496
## converged
## - Fold08: size=1, decay=1e-04
## + Fold08: size=3, decay=1e-04
## # weights:  175
## initial  value 19351.007154
## iter  10 value 14890.169535
## iter  20 value 11503.412456
## iter  30 value 10756.070220
## iter  40 value 10608.612300
## iter  50 value 10438.636573
## iter  60 value 10151.423325
## iter  70 value 9831.462719
## iter  80 value 9684.877372
## iter  90 value 9624.241992
## iter 100 value 9582.814549
## final  value 9582.814549
## stopped after 100 iterations
## - Fold08: size=3, decay=1e-04
## + Fold08: size=5, decay=1e-04
## # weights:  291
## initial  value 16723.118152
## iter  10 value 14973.383007
## iter  20 value 12485.065489
## iter  30 value 11028.358343
## iter  40 value 10814.875641
## iter  50 value 10723.886319
## iter  60 value 10635.567704
## iter  70 value 10584.161453
## iter  80 value 10565.335598
```

```
## iter  90 value 10560.652683
## iter 100 value 10555.510960
## final  value 10555.510960
## stopped after 100 iterations
## - Fold08: size=5, decay=1e-04
## + Fold09: size=1, decay=0e+00
## # weights:  59
## initial  value 19741.879159
## iter  10 value 15232.664197
## final  value 15232.655317
## converged
## - Fold09: size=1, decay=0e+00
## + Fold09: size=3, decay=0e+00
## # weights:  175
## initial  value 22407.559313
## iter  10 value 15064.788835
## iter  20 value 14288.099799
## iter  30 value 13472.362523
## iter  40 value 12004.393660
## iter  50 value 10913.236497
## iter  60 value 10247.003974
## iter  70 value 9906.361448
## iter  80 value 9767.491269
## iter  90 value 9685.056779
## iter 100 value 9619.038276
## final  value 9619.038276
## stopped after 100 iterations
## - Fold09: size=3, decay=0e+00
## + Fold09: size=5, decay=0e+00
## # weights:  291
## initial  value 16188.716617
## iter  10 value 14390.132664
## iter  20 value 10847.574532
## iter  30 value 10357.462446
## iter  40 value 9995.629955
## iter  50 value 9847.631556
## iter  60 value 9754.364634
## iter  70 value 9607.844565
## iter  80 value 9569.390243
## iter  90 value 9543.823958
## iter 100 value 9525.097916
## final  value 9525.097916
## stopped after 100 iterations
## - Fold09: size=5, decay=0e+00
## + Fold09: size=1, decay=1e-01
## # weights:  59
## initial  value 18316.226512
## iter  10 value 15234.160084
## iter  20 value 15233.044894
## iter  30 value 15172.661777
## iter  40 value 14783.483966
## iter  50 value 13380.102488
## iter  60 value 12279.704248
## iter  70 value 11653.158145
```

```
## iter  80 value 11357.447428
## iter  90 value 10721.808762
## iter 100 value 10463.658831
## final  value 10463.658831
## stopped after 100 iterations
## - Fold09: size=1, decay=1e-01
## + Fold09: size=3, decay=1e-01
## # weights:  175
## initial  value 20521.574011
## iter  10 value 14980.359705
## iter  20 value 13233.608132
## iter  30 value 11853.289055
## iter  40 value 10979.722232
## iter  50 value 10676.627065
## iter  60 value 10440.132680
## iter  70 value 9998.451920
## iter  80 value 9763.952117
## iter  90 value 9603.408467
## iter 100 value 9512.471775
## final  value 9512.471775
## stopped after 100 iterations
## - Fold09: size=3, decay=1e-01
## + Fold09: size=5, decay=1e-01
## # weights:  291
## initial  value 16274.217509
## iter  10 value 14957.400009
## iter  20 value 14057.489728
## iter  30 value 13219.349370
## iter  40 value 10952.220913
## iter  50 value 10459.783515
## iter  60 value 9986.118500
## iter  70 value 9750.920908
## iter  80 value 9610.608633
## iter  90 value 9574.038662
## iter 100 value 9541.444632
## final  value 9541.444632
## stopped after 100 iterations
## - Fold09: size=5, decay=1e-01
## + Fold09: size=1, decay=1e-04
## # weights:  59
## initial  value 15708.670819
## iter  10 value 15140.259130
## iter  20 value 15084.857653
## iter  30 value 12727.585750
## iter  40 value 11578.890673
## iter  50 value 11349.091982
## iter  60 value 11272.187893
## iter  70 value 11234.782794
## iter  80 value 11192.683616
## iter  90 value 11026.631882
## iter 100 value 10969.302388
## final  value 10969.302388
## stopped after 100 iterations
## - Fold09: size=1, decay=1e-04
```

```
## + Fold09: size=3, decay=1e-04
## # weights:  175
## initial  value 16090.631453
## iter  10 value 15103.455128
## iter  20 value 14849.998846
## iter  30 value 13191.692024
## iter  40 value 10510.989060
## iter  50 value 10161.350456
## iter  60 value 9970.153784
## iter  70 value 9840.805286
## iter  80 value 9693.897730
## iter  90 value 9602.088538
## iter 100 value 9565.706284
## final  value 9565.706284
## stopped after 100 iterations
## - Fold09: size=3, decay=1e-04
## + Fold09: size=5, decay=1e-04
## # weights:  291
## initial  value 37364.247385
## iter  10 value 15144.511022
## iter  20 value 14314.609103
## iter  30 value 11577.342137
## iter  40 value 10556.399267
## iter  50 value 10358.882069
## iter  60 value 10055.401817
## iter  70 value 9878.057913
## iter  80 value 9770.128392
## iter  90 value 9716.388914
## iter 100 value 9693.263250
## final  value 9693.263250
## stopped after 100 iterations
## - Fold09: size=5, decay=1e-04
## + Fold10: size=1, decay=0e+00
## # weights:  59
## initial  value 25636.722213
## final  value 15232.655340
## converged
## - Fold10: size=1, decay=0e+00
## + Fold10: size=3, decay=0e+00
## # weights:  175
## initial  value 19027.696137
## final  value 15232.655380
## converged
## - Fold10: size=3, decay=0e+00
## + Fold10: size=5, decay=0e+00
## # weights:  291
## initial  value 24168.485280
## iter  10 value 14026.820187
## iter  20 value 12606.494311
## iter  30 value 11147.363752
## iter  40 value 10864.085089
## iter  50 value 10780.432549
## iter  60 value 10626.635262
## iter  70 value 10595.923853
```

```
## iter  80 value 10588.680327
## iter  90 value 10579.577743
## iter 100 value 10573.564760
## final  value 10573.564760
## stopped after 100 iterations
## - Fold10: size=5, decay=0e+00
## + Fold10: size=1, decay=1e-01
## # weights:  59
## initial  value 16351.916459
## iter  10 value 15234.035081
## iter  20 value 15232.778093
## iter  30 value 15039.963055
## iter  40 value 13933.308030
## iter  50 value 13284.557449
## iter  60 value 12958.329219
## iter  70 value 12930.744707
## iter  80 value 12910.232948
## iter  90 value 12903.373151
## iter 100 value 11344.789432
## final  value 11344.789432
## stopped after 100 iterations
## - Fold10: size=1, decay=1e-01
## + Fold10: size=3, decay=1e-01
## # weights:  175
## initial  value 26190.761554
## iter  10 value 14963.847510
## iter  20 value 13210.179823
## iter  30 value 11938.794507
## iter  40 value 11257.893815
## iter  50 value 10997.867268
## iter  60 value 10889.881064
## iter  70 value 10575.955854
## iter  80 value 10279.283037
## iter  90 value 10127.815775
## iter 100 value 9837.000676
## final  value 9837.000676
## stopped after 100 iterations
## - Fold10: size=3, decay=1e-01
## + Fold10: size=5, decay=1e-01
## # weights:  291
## initial  value 19766.128552
## iter  10 value 14801.757527
## iter  20 value 13513.566852
## iter  30 value 12318.816660
## iter  40 value 10508.576457
## iter  50 value 10151.129940
## iter  60 value 9976.542107
## iter  70 value 9770.694151
## iter  80 value 9660.624247
## iter  90 value 9559.498840
## iter 100 value 9509.806976
## final  value 9509.806976
## stopped after 100 iterations
## - Fold10: size=5, decay=1e-01
```

```
## + Fold10: size=1, decay=1e-04
## # weights:  59
## initial  value 30332.487217
## final  value 15232.668761
## converged
## - Fold10: size=1, decay=1e-04
## + Fold10: size=3, decay=1e-04
## # weights:  175
## initial  value 15855.495055
## final  value 15232.658027
## converged
## - Fold10: size=3, decay=1e-04
## + Fold10: size=5, decay=1e-04
## # weights:  291
## initial  value 15586.015577
## iter  10 value 15098.903069
## iter  20 value 11968.758558
## iter  30 value 10752.176506
## iter  40 value 10395.462139
## iter  50 value 10263.507958
## iter  60 value 10201.499552
## iter  70 value 10176.446113
## iter  80 value 10146.081975
## iter  90 value 10048.701651
## iter 100 value 9908.556146
## final  value 9908.556146
## stopped after 100 iterations
## - Fold10: size=5, decay=1e-04
## Aggregating results
## Selecting tuning parameters
## Fitting size = 5, decay = 0.1 on full training set
## # weights:  291
## initial  value 20934.406120
## iter  10 value 16981.848356
## iter  20 value 16896.644565
## iter  30 value 16721.840833
## iter  40 value 16318.798202
## iter  50 value 14998.757189
## iter  60 value 13152.898471
## iter  70 value 11988.221191
## iter  80 value 11314.745469
## iter  90 value 10865.728546
## iter 100 value 10714.013883
## final  value 10714.013883
## stopped after 100 iterations

##
##           <=50K  >50K
##    <=50K  20531  2811
##    >50K    2123  4697
```

it's accuracy comes to 83%

All the models are quite similar in their accuracy, except for the Naive Bayes model which shows a much lower accuracy of 75%. C5 appears to be the best model, but only by a slim margin.

Lets see how this model works

```
##
## Call:
## (function (x, y, trials = 1, rules = FALSE, weights = NULL, control
##  0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
##  0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0,
##
##
## C5.0 [Release 2.07 GPL Edition]      Tue Feb 19 01:30:00 2019
## -------------------------------
##
## Class specified by attribute `outcome'
##
## Read 30162 cases (57 attributes) from undefined.data
##
## -----  Trial 0:  -----
##
## Decision tree:
##
## marStat Married-civ-spouse <= 0:
## :...education Doctorate > 0:
## :   :...age <= 32: <=50K (23/4)
## :   :   age > 32: >50K (94/34)
## :   education Doctorate <= 0:
## :   :...education Prof-school > 0:
## :       :...age <= 32: <=50K (51/9)
## :       :   age > 32: >50K (105/39)
## :       education Prof-school <= 0:
## :       :...education Masters <= 0: <=50K (15139/790)
## :           education Masters > 0:
## :           :...occupation Exec-managerial <= 0: <=50K (523/102)
## :               occupation Exec-managerial > 0:
## :               :...age <= 30: <=50K (20)
## :                   age > 30:
## :                   :...hrs.per.week <= 39: <=50K (14)
## :                       hrs.per.week > 39: >50K (128/50)
## marStat Married-civ-spouse > 0:
## :...education.num > 12:
##     :...occupation Other-service > 0: <=50K (54/18)
##     :   occupation Other-service <= 0:
##     :   :...occupation Farming-fishing > 0:
##     :       :...workclass Self-emp-inc <= 0: <=50K (56/17)
##     :       :   workclass Self-emp-inc > 0: >50K (7)
##     :       occupation Farming-fishing <= 0:
##     :       :...hrs.per.week <= 31:
##     :           :...relationship Wife > 0: >50K (70/16)
##     :           :   relationship Wife <= 0:
##     :           :   :...education Prof-school <= 0: <=50K (153/48)
##     :           :       education Prof-school > 0: >50K (26/9)
##     :           hrs.per.week > 31:
##     :           :...occupation Machine-op-inspct > 0:
##     :               :...race White <= 0: <=50K (7)
##     :               :   race White > 0: >50K (29/12)
```

```
##     :                occupation Machine-op-inspct <= 0:
##     :                :...age <= 28:
##     :                    :...age <= 25: <=50K (63/19)
##     :                    :   age > 25: >50K (152/66)
##     :                    age > 28:
##     :                    :...occupation Craft-repair <= 0: >50K (3422/731)
##     :                        occupation Craft-repair > 0:
##     :                        :...workclass Private <= 0: <=50K (52/21)
##     :                            workclass Private > 0: >50K (94/32)
##     education.num <= 12:
##     :...education.num <= 8: <=50K (1529/186)
##         education.num > 8:
##         :...age <= 35: <=50K (2756/668)
##             age > 35:
##             :...occupation Other-service > 0: <=50K (291/54)
##                 occupation Other-service <= 0:
##                 :...occupation Farming-fishing > 0: <=50K (289/57)
##                     occupation Farming-fishing <= 0:
##                     :...hrs.per.week <= 34: <=50K (386/97)
##                         hrs.per.week > 34:
##                         :...occupation Handlers-cleaners > 0: <=50K (133/38)
##                             occupation Handlers-cleaners <= 0:
##                             :...occupation Exec-managerial > 0: [S1]
##                                 occupation Exec-managerial <= 0:
##                                 :...occupation Tech-support > 0: >50K (169/55)
##                                     occupation Tech-support <= 0:
##                                     :...workclass Federal-gov > 0: >50K (168/64)
##                                         workclass Federal-gov <= 0:
##                                         :...education HS-grad > 0: [S2]
##                                             education HS-grad <= 0: [S3]
##
## SubTree [S1]
##
## workclass Self-emp-not-inc <= 0: >50K (661/216)
## workclass Self-emp-not-inc > 0: <=50K (107/40)
##
## SubTree [S2]
##
## occupation Prof-specialty > 0: >50K (61/28)
## occupation Prof-specialty <= 0:
## :...workclass Self-emp-inc <= 0: <=50K (1794/693)
##     workclass Self-emp-inc > 0: >50K (67/31)
##
## SubTree [S3]
##
## workclass Self-emp-not-inc > 0: <=50K (128/48)
## workclass Self-emp-not-inc <= 0:
## :...occupation Machine-op-inspct > 0: <=50K (104/40)
##     occupation Machine-op-inspct <= 0:
##     :...occupation Transport-moving > 0:
##         :...workclass Self-emp-inc <= 0: <=50K (111/41)
##         :   workclass Self-emp-inc > 0: >50K (5)
##         occupation Transport-moving <= 0:
##         :...occupation Adm-clerical > 0:
```

```
##             :...sex Male <= 0: >50K (60/22)
##             :   sex Male > 0:
##             :   :...hrs.per.week <= 41: <=50K (74/25)
##             :       hrs.per.week > 41: >50K (19/5)
##             occupation Adm-clerical <= 0:
##             :...workclass Local-gov > 0: >50K (90/28)
##                 workclass Local-gov <= 0:
##                 :...occupation Craft-repair <= 0:
##                     :...occupation Protective-serv <= 0: >50K (437/161)
##                     :   occupation Protective-serv > 0: <=50K (38/16)
##                     occupation Craft-repair > 0:
##                     :...hrs.per.week > 47: >50K (99/34)
##                         hrs.per.week <= 47:
##                         :...age <= 47: <=50K (194/81)
##                             age > 47: >50K (110/44)
##
## -----  Trial 1:  -----
##
## Decision tree:
##
## marStat Married-civ-spouse <= 0:
## :...marStat Married-AF-spouse > 0: >50K (29.5/8.8)
## :   marStat Married-AF-spouse <= 0:
## :   :...education.num <= 12: <=50K (10655.2/892.1)
## :       education.num > 12:
## :       :...age <= 27: <=50K (806.3/60.2)
## :           age > 27:
## :           :...hrs.per.week <= 43: <=50K (1497.6/424.6)
## :               hrs.per.week > 43:
## :               :...workclass State-gov > 0: <=50K (45.3/13.7)
## :                   workclass State-gov <= 0:
## :                   :...workclass Local-gov <= 0: >50K (977.9/403.5)
## :                       workclass Local-gov > 0: <=50K (133.7/54.4)
## marStat Married-civ-spouse > 0:
## :...relationship Other-relative > 0: <=50K (119.6/19.9)
##     relationship Other-relative <= 0:
##     :...education.num <= 7: <=50K (1311.4/334)
##         education.num > 7:
##         :...age <= 29: <=50K (1600.8/565.6)
##             age > 29:
##             :...education Prof-school > 0: >50K (353.6/93.2)
##                 education Prof-school <= 0:
##                 :...race Other > 0: <=50K (51.7/16.4)
##                     race Other <= 0:
##                     :...education Doctorate > 0: >50K (257.4/78.7)
##                         education Doctorate <= 0:
##                         :...occupation Other-service > 0: <=50K (452.6/178.4)
##                             occupation Other-service <= 0:
##                             :...occupation Farming-fishing > 0: <=50K (417.9/170.7)
##                                 occupation Farming-fishing <= 0: [S1]
##
## SubTree [S1]
##
## occupation Handlers-cleaners > 0: <=50K (281/114.3)
```

```
## occupation Handlers-cleaners <= 0:
## :...education Masters > 0: >50K (904.5/320.9)
##     education Masters <= 0:
##     :...age > 60: <=50K (707.8/311.4)
##         age <= 60:
##         :...workclass Federal-gov > 0: <=50K (400.7/189)
##             workclass Federal-gov <= 0:
##             :...hrs.per.week > 40:
##                 :...workclass Local-gov > 0: <=50K (226.5/106.4)
##                 :   workclass Local-gov <= 0:
##                 :   :...occupation Exec-managerial > 0: >50K (933.3/346.9)
##                 :       occupation Exec-managerial <= 0:
##                 :       :...education HS-grad > 0: >50K (1186.8/435)
##                 :           education HS-grad <= 0:
##                 :           :...occupation Transport-moving > 0: >50K (142/49)
##                 :               occupation Transport-moving <= 0:
##                 :               :...hrs.per.week <= 50: >50K (908.4/397.9)
##                 :                   hrs.per.week > 50: <=50K (552.4/251)
##                 hrs.per.week <= 40:
##                 :...occupation Protective-serv > 0: >50K (202.9/75.8)
##                     occupation Protective-serv <= 0:
##                     :...relationship Wife > 0: >50K (741.6/309.5)
##                         relationship Wife <= 0:
##                         :...workclass State-gov > 0: <=50K (203.1/83.9)
##                             workclass State-gov <= 0:
##                             :...workclass Local-gov > 0: <=50K (292.7/125.9)
##                                 workclass Local-gov <= 0:
##                                 :...age > 44: [S2]
##                                     age <= 44: [S3]
##
## SubTree [S2]
##
## workclass Self-emp-inc > 0: <=50K (86.9/36.5)
## workclass Self-emp-inc <= 0:
## :...hrs.per.week <= 34: <=50K (104.9/41.5)
##     hrs.per.week > 34: >50K (1447.2/621.6)
##
## SubTree [S3]
##
## occupation Transport-moving > 0: <=50K (145.5/51.4)
## occupation Transport-moving <= 0:
## :...workclass Self-emp-not-inc > 0: <=50K (158.1/64)
##     workclass Self-emp-not-inc <= 0:
##     :...education HS-grad <= 0: >50K (1111/532.5)
##         education HS-grad > 0: <=50K (714.3/332.2)
##
## -----  Trial 2:  -----
##
## Decision tree:
##
## age <= 24: <=50K (3384.4/152.8)
## age > 24:
## :...relationship Own-child > 0: <=50K (1272.9/127)
##     relationship Own-child <= 0:
```

```
##     :...occupation Priv-house-serv > 0: <=50K (75.5/2.7)
##         occupation Priv-house-serv <= 0:
##         :...marStat Married-civ-spouse <= 0:
##             :...occupation Other-service > 0: <=50K (934.3/54.6)
##             :   occupation Other-service <= 0:
##             :   :...occupation Machine-op-inspct > 0: <=50K (444.9/25.4)
##             :       occupation Machine-op-inspct <= 0:
##             :       :...occupation Adm-clerical > 0: <=50K (1288.9/158)
##             :           occupation Adm-clerical <= 0:
##             :           :...education.num <= 10: <=50K (2843.4/710.2)
##             :               education.num > 10:
##             :               :...hrs.per.week <= 31: <=50K (166.1/24.3)
##             :                   hrs.per.week > 31: [S1]
##             marStat Married-civ-spouse > 0:
##             :...education.num <= 5: <=50K (616.3/170.7)
##                 education.num > 5:
##                 :...workclass Federal-gov > 0: >50K (638.1/225.3)
##                     workclass Federal-gov <= 0:
##                     :...education Prof-school > 0: >50K (345.8/127.7)
##                         education Prof-school <= 0:
##                         :...education 11th > 0: <=50K (276.5/106.7)
##                             education 11th <= 0:
##                             :...hrs.per.week > 51: >50K (2532.5/1107.6)
##                                 hrs.per.week <= 51:
##                                 :...workclass Self-emp-inc > 0: >50K (615.8/269.8)
##                                     workclass Self-emp-inc <= 0:
##                                     :...workclass Local-gov > 0:
##                                         :...age > 60: <=50K (59.4/16.6)
##                                         :   age <= 60:
##                                         :   :...age <= 36: <=50K (268.8/125.7)
##                                         :       age > 36: >50K (697.3/279)
##                                         workclass Local-gov <= 0: [S2]
##
## SubTree [S1]
##
## occupation Transport-moving > 0: <=50K (28.2/4.4)
## occupation Transport-moving <= 0:
## :...sex Male <= 0: <=50K (1403.5/493.4)
##     sex Male > 0:
##     :...occupation Craft-repair > 0: <=50K (111.4/34.3)
##         occupation Craft-repair <= 0:
##         :...marStat Never-married <= 0: >50K (599.8/232.6)
##             marStat Never-married > 0: <=50K (800.4/347.4)
##
## SubTree [S2]
##
## occupation Farming-fishing > 0: <=50K (224.9/85.3)
## occupation Farming-fishing <= 0:
## :...occupation Protective-serv > 0: <=50K (182.3/68.9)
##     occupation Protective-serv <= 0:
##     :...occupation Exec-managerial > 0:
##         :...education.num > 11: >50K (847/347.1)
##         :   education.num <= 11:
##         :   :...age <= 35: >50K (219.9/96.6)
```

```
##         :       age > 35: <=50K (645/266.2)
##         occupation Exec-managerial <= 0:
##         :...workclass State-gov > 0: >50K (370.8/175)
##             workclass State-gov <= 0:
##             :...race White <= 0: <=50K (793.8/329.2)
##                 race White > 0:
##                 :...education HS-grad <= 0:
##                     :...hrs.per.week <= 26: >50K (293.1/121.5)
##                     :   hrs.per.week > 26:
##                     :   :...age <= 29: >50K (433.9/190.8)
##                     :       age > 29:
##                     :       :...education.num <= 7: >50K (162.5/77.2)
##                     :           education.num > 7:
##                     :           :...age <= 60: <=50K (3254.7/1334.6)
##                     :               age > 60: >50K (206.2/85.8)
##                     education HS-grad > 0:
##                     :...hrs.per.week <= 39: <=50K (303.8/81.9)
##                         hrs.per.week > 39:
##                         :...age <= 35: <=50K (801.8/348.9)
##                             age > 35:
##                             :...occupation Tech-support > 0: <=50K (40/14.3)
##                                 occupation Tech-support <= 0:
##                                 :...workclass Private <= 0: <=50K (162.3/71.1)
##                                     workclass Private > 0: [S3]
##
## SubTree [S3]
##
## occupation Machine-op-inspct <= 0: >50K (1480.9/658.5)
## occupation Machine-op-inspct > 0: <=50K (334.9/157.9)
##
## -----  Trial 3:  -----
##
## Decision tree:
##
## age <= 24: <=50K (2962.3/178.1)
## age > 24:
## :...relationship Own-child > 0: <=50K (1139.1/151.8)
##     relationship Own-child <= 0:
##     :...relationship Other-relative > 0: <=50K (438.3/78)
##         relationship Other-relative <= 0:
##         :...relationship Unmarried > 0: <=50K (2212.3/514.2)
##             relationship Unmarried <= 0:
##             :...occupation Other-service > 0: <=50K (1135.4/308.4)
##                 occupation Other-service <= 0:
##                 :...relationship Not-in-family > 0:
##                     :...occupation Machine-op-inspct > 0: <=50K (246/23.5)
##                     :   occupation Machine-op-inspct <= 0:
##                     :   :...occupation Handlers-cleaners > 0: <=50K (139.1/10.8)
##                     :       occupation Handlers-cleaners <= 0:
##                     :       :...occupation Adm-clerical > 0: <=50K (666.8/131)
##                     :           occupation Adm-clerical <= 0:
##                     :           :...age <= 29: <=50K (697/184.6)
##                     :               age > 29: [S1]
##                     relationship Not-in-family <= 0:
```

```
##                     :...education 7th-8th > 0: <=50K (236.3/90)
##                         education 7th-8th <= 0:
##                         :...occupation Tech-support > 0: >50K (568.4/247.5)
##                             occupation Tech-support <= 0:
##                             :...hrs.per.week <= 31: <=50K (921.8/371)
##                                 hrs.per.week > 31:
##                                 :...education Prof-school > 0: >50K (300.5/116)
##                                     education Prof-school <= 0: [S2]
##
## SubTree [S1]
##
## occupation Transport-moving > 0: <=50K (180.1/54.9)
## occupation Transport-moving <= 0:
## :...occupation Farming-fishing > 0: <=50K (100/29.4)
##     occupation Farming-fishing <= 0:
##     :...education.num <= 9: <=50K (691.1/248.2)
##         education.num > 9:
##         :...workclass State-gov > 0: <=50K (143.6/48.5)
##             workclass State-gov <= 0:
##             :...hrs.per.week <= 31: <=50K (130.1/41.4)
##                 hrs.per.week > 31:
##                 :...workclass Self-emp-not-inc > 0: <=50K (196.2/75)
##                     workclass Self-emp-not-inc <= 0:
##                     :...occupation Craft-repair <= 0: >50K (1881.1/865.4)
##                         occupation Craft-repair > 0: <=50K (158/65.9)
##
## SubTree [S2]
##
## occupation Protective-serv > 0: >50K (477.5/205.1)
## occupation Protective-serv <= 0:
## :...education.num <= 10:
##     :...race Black <= 0: <=50K (8639.3/3949.7)
##     :   race Black > 0: >50K (551/260.1)
##     education.num > 10:
##     :...occupation Handlers-cleaners > 0: <=50K (58.7/22)
##         occupation Handlers-cleaners <= 0:
##         :...occupation Transport-moving > 0: <=50K (102/38.5)
##             occupation Transport-moving <= 0:
##             :...workclass Self-emp-not-inc > 0: <=50K (528.1/237.2)
##                 workclass Self-emp-not-inc <= 0:
##                 :...occupation Farming-fishing > 0: >50K (55.2/15.8)
##                     occupation Farming-fishing <= 0:
##                     :...occupation Adm-clerical > 0: <=50K (378.1/172.6)
##                         occupation Adm-clerical <= 0:
##                         :...age > 36: >50K (2825/1174.4)
##                             age <= 36:
##                             :...relationship Wife <= 0: <=50K (1218.6/571.9)
##                                 relationship Wife > 0: >50K (184.9/68.4)
##
## -----  Trial 4:  -----
##
## Decision tree:
##
## age <= 23: <=50K (2188.3/95.8)
```

```
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (64.5/3.5)
##     occupation Priv-house-serv <= 0:
##     :...relationship Own-child > 0: <=50K (1167.9/172)
##         relationship Own-child <= 0:
##         :...marStat Married-civ-spouse > 0:
##             :...education.num <= 6:
##             :   :...occupation Exec-managerial <= 0: <=50K (882.3/311.8)
##             :   :   occupation Exec-managerial > 0: >50K (67/18.6)
##             :   education.num > 6:
##             :   :...race Black > 0: <=50K (925.1/414.3)
##             :       race Black <= 0:
##             :       :...workclass State-gov > 0: <=50K (659.4/293.8)
##             :           workclass State-gov <= 0:
##             :           :...occupation Craft-repair > 0:
##             :               :...hrs.per.week <= 31: <=50K (58.4/14.7)
##             :               :   hrs.per.week > 31: >50K (2962.6/1452.6)
##             :               occupation Craft-repair <= 0:
##             :               :...workclass Local-gov > 0:
##             :                   :...age <= 37: >50K (344/143.5)
##             :                   :   age > 37: <=50K (708.6/320.7)
##             :                   workclass Local-gov <= 0: [S1]
##             marStat Married-civ-spouse <= 0:
##             :...education 5th-6th > 0: <=50K (51.1)
##                 education 5th-6th <= 0:
##                 :...education 1st-4th > 0: <=50K (27.1)
##                     education 1st-4th <= 0:
##                     :...occupation Other-service > 0: <=50K (749.8/80.5)
##                         occupation Other-service <= 0:
##                         :...occupation Machine-op-inspct > 0: <=50K (355/33.3)
##                             occupation Machine-op-inspct <= 0:
##                             :...occupation Handlers-cleaners > 0: <=50K (200.6/15.7)
##                                 occupation Handlers-cleaners <= 0:
##                                 :...occupation Adm-clerical > 0: <=50K (1096.7/210.4)
##                                     occupation Adm-clerical <= 0:
##                                     :...education Doctorate > 0: >50K (173.9/74.7)
##                                         education Doctorate <= 0:
##                                         :...hrs.per.week <= 42: <=50K (3171.7/1044.8)
##                                             hrs.per.week > 42: [S2]
##
## SubTree [S1]
##
## occupation Protective-serv > 0: <=50K (122.3/51.1)
## occupation Protective-serv <= 0:
## :...occupation Prof-specialty > 0:
##     :...age <= 56: >50K (1772.9/694.5)
##     :   age > 56: <=50K (254.8/117.5)
##     occupation Prof-specialty <= 0:
##     :...education Prof-school > 0: <=50K (71.6/21.1)
##         education Prof-school <= 0:
##         :...occupation Transport-moving <= 0:
##             :...age <= 27: <=50K (461.1/202.7)
##             :   age > 27: >50K (8179.2/3668.4)
##             occupation Transport-moving > 0:
```

```
##             :...education Some-college <= 0: <=50K (761.7/366.7)
##                 education Some-college > 0: >50K (222.6/78.5)
##
## SubTree [S2]
##
## marStat Widowed > 0: >50K (113.7/39.8)
## marStat Widowed <= 0:
## :...workclass State-gov > 0: <=50K (47.5/13.4)
##     workclass State-gov <= 0:
##     :...sex Male <= 0: <=50K (747.1/285.8)
##         sex Male > 0:
##         :...marStat Married-spouse-absent > 0: <=50K (32.7/5.8)
##             marStat Married-spouse-absent <= 0:
##             :...age > 39: >50K (653.8/253.8)
##                 age <= 39:
##                 :...workclass Self-emp-not-inc <= 0: <=50K (748.9/312.2)
##                     workclass Self-emp-not-inc > 0: >50K (118.1/48.3)
##
## -----  Trial 5:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1967.5/103.8)
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (58.1/3.7)
##     occupation Priv-house-serv <= 0:
##     :...relationship Own-child > 0: <=50K (1075.2/188.2)
##         relationship Own-child <= 0:
##         :...relationship Other-relative > 0: <=50K (395.8/88.5)
##             relationship Other-relative <= 0:
##             :...marStat Married-AF-spouse > 0: >50K (28.6/7.4)
##                 marStat Married-AF-spouse <= 0:
##                 :...occupation Other-service > 0: <=50K (1375.2/375.9)
##                     occupation Other-service <= 0:
##                     :...relationship Unmarried > 0:
##                         :...occupation Machine-op-inspct > 0: <=50K (104.1/7.5)
##                         :   occupation Machine-op-inspct <= 0:
##                         :   :...occupation Adm-clerical > 0: <=50K (374.8/62.7)
##                         :       occupation Adm-clerical <= 0: [S1]
##                         relationship Unmarried <= 0:
##                         :...marStat Married-civ-spouse <= 0:
##                             :...age <= 27: <=50K (555/125.7)
##                             :   age > 27:
##                             :   :...education Prof-school <= 0: <=50K (4565.9/1830.7)
##                             :       education Prof-school > 0: >50K (147/61.2)
##                             marStat Married-civ-spouse > 0:
##                             :...occupation Farming-fishing > 0: <=50K (661.8/258.3)
##                                 occupation Farming-fishing <= 0:
##                                 :...occupation Craft-repair > 0:
##                                     :...race Black <= 0: <=50K (3473.6/1472.7)
##                                     :   race Black > 0: >50K (145.3/60.3)
##                                     occupation Craft-repair <= 0: [S2]
##
## SubTree [S1]
```

```
##
## occupation Handlers-cleaners > 0: <=50K (44.2/3.7)
## occupation Handlers-cleaners <= 0:
## :...occupation Farming-fishing > 0: <=50K (37.1/3.7)
##     occupation Farming-fishing <= 0:
##     :...hrs.per.week <= 31: <=50K (82.2/9.4)
##         hrs.per.week > 31:
##         :...workclass Federal-gov > 0: >50K (58.2/17.3)
##             workclass Federal-gov <= 0:
##             :...age <= 41: <=50K (433.1/134.3)
##                 age > 41: >50K (611.8/287.8)
##
## SubTree [S2]
##
## occupation Handlers-cleaners > 0: <=50K (490.3/203.6)
## occupation Handlers-cleaners <= 0:
## :...occupation Machine-op-inspct > 0: <=50K (1231.9/552.8)
##     occupation Machine-op-inspct <= 0:
##     :...occupation Tech-support > 0: <=50K (592.6/267.9)
##         occupation Tech-support <= 0:
##         :...workclass Federal-gov > 0: >50K (512.9/217.8)
##             workclass Federal-gov <= 0:
##             :...education Prof-school > 0: >50K (325.7/138.4)
##                 education Prof-school <= 0:
##                 :...occupation Sales > 0:
##                     :...sex Male <= 0: <=50K (179.1/71.6)
##                     :   sex Male > 0:
##                     :   :...education.num <= 5: >50K (40.1/10.9)
##                     :       education.num > 5:
##                     :       :...education Bachelors <= 0: <=50K (1572.3/735.5)
##                     :           education Bachelors > 0: >50K (612.7/279.3)
##                     occupation Sales <= 0:
##                     :...race Asian-Pac-Islander > 0: <=50K (297.8/134)
##                         race Asian-Pac-Islander <= 0:
##                         :...education Masters > 0: >50K (827.1/362.5)
##                             education Masters <= 0:
##                             :...age > 44: >50K (3019.1/1364.7)
##                                 age <= 44:
##                                 :...workclass Self-emp-inc > 0: <=50K (215.7/90.4)
##                                     workclass Self-emp-inc <= 0:
##                                     :...relationship Wife > 0: >50K (730.1/328.6)
##                                         relationship Wife <= 0: [S3]
##
## SubTree [S3]
##
## occupation Prof-specialty > 0: >50K (884.1/413.2)
## occupation Prof-specialty <= 0:
## :...age <= 24: >50K (32/7.9)
##     age > 24: <=50K (2404/1133.8)
##
## -----  Trial 6:  -----
##
## Decision tree:
##
```

```
## occupation Priv-house-serv > 0: <=50K (66.2/4)
## occupation Priv-house-serv <= 0:
## :...relationship Own-child > 0: <=50K (2054.5/232.8)
##     relationship Own-child <= 0:
##     :...relationship Unmarried > 0: <=50K (2112/610.8)
##         relationship Unmarried <= 0:
##         :...occupation Other-service > 0: <=50K (1254/389.3)
##             occupation Other-service <= 0:
##             :...education Doctorate > 0: >50K (446.4/183.4)
##                 education Doctorate <= 0:
##                 :...marStat Never-married > 0:
##                     :...occupation Handlers-cleaners > 0: <=50K (113.8/4)
##                     :   occupation Handlers-cleaners <= 0:
##                     :   :...occupation Machine-op-inspct > 0: <=50K (124.3/12.1)
##                     :       occupation Machine-op-inspct <= 0:
##                     :       :...occupation Farming-fishing > 0: <=50K (71.3/14.8)
##                     :           occupation Farming-fishing <= 0:
##                     :           :...age <= 34: <=50K (1607.2/477.6)
##                     :               age > 34: [S1]
##                     marStat Never-married <= 0:
##                     :...education 9th > 0: <=50K (165.4/64.1)
##                         education 9th <= 0:
##                         :...education.num <= 7:
##                             :...workclass Self-emp-inc <= 0: <=50K (1111.1/444.8)
##                             :   workclass Self-emp-inc > 0: >50K (48.8/16.6)
##                             education.num > 7:
##                             :...hrs.per.week <= 38:
##                                 :...workclass Self-emp-inc <= 0: <=50K (1979.8/823.2)
##                                 :   workclass Self-emp-inc > 0: >50K (128/51.1)
##                                 hrs.per.week > 38:
##                                 :...sex Male <= 0: [S2]
##                                     sex Male > 0:
##                                     :...marStat Widowed > 0: >50K (54.6/15.4)
##                                         marStat Widowed <= 0: [S3]
##
## SubTree [S1]
##
## occupation Protective-serv > 0: >50K (36/8.8)
## occupation Protective-serv <= 0:
## :...education HS-grad <= 0: >50K (977.6/453)
##     education HS-grad > 0: <=50K (163/61.8)
##
## SubTree [S2]
##
## workclass Self-emp-not-inc > 0: >50K (98.1/41.2)
## workclass Self-emp-not-inc <= 0:
## :...hrs.per.week > 52: <=50K (157.7/55.3)
##     hrs.per.week <= 52:
##     :...hrs.per.week <= 44: <=50K (1368.1/581.6)
##         hrs.per.week > 44: >50K (384.2/158.3)
##
## SubTree [S3]
##
## education Assoc-voc > 0: <=50K (902.8/419)
```

```
## education Assoc-voc <= 0:
## :...workclass Self-emp-not-inc > 0:
##     :...hrs.per.week <= 59: >50K (1128.3/536.7)
##     :   hrs.per.week > 59: <=50K (545.9/224.4)
##     workclass Self-emp-not-inc <= 0:
##     :...education Assoc-acdm > 0: <=50K (534.3/251)
##         education Assoc-acdm <= 0:
##         :...occupation Exec-managerial > 0: >50K (2339.3/1046.4)
##             occupation Exec-managerial <= 0:
##             :...age <= 32:
##                 :...relationship Not-in-family > 0: <=50K (95.8/31)
##                 :   relationship Not-in-family <= 0:
##                 :   :...occupation Transport-moving <= 0: <=50K (1725.4/764.1)
##                 :       occupation Transport-moving > 0: >50K (189.8/74.6)
##                 age > 32:
##                 :...education Prof-school > 0: >50K (143.3/51.2)
##                     education Prof-school <= 0:
##                     :...workclass Self-emp-inc > 0: <=50K (430.2/200)
##                         workclass Self-emp-inc <= 0:
##                         :...race Asian-Pac-Islander > 0: >50K (182.5/74.1)
##                             race Asian-Pac-Islander <= 0:
##                             :...education Some-college > 0: >50K (1988.9/891)
##                                 education Some-college <= 0:
##                                 :...hrs.per.week <= 41: <=50K (3168.6/1541.1)
##                                     hrs.per.week > 41: [S4]
##
## SubTree [S4]
##
## occupation Protective-serv > 0: >50K (77.4/26.1)
## occupation Protective-serv <= 0:
## :...workclass Local-gov <= 0: >50K (2065.7/930.6)
##     workclass Local-gov > 0: <=50K (121.8/44.7)
##
## -----  Trial 7:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1652.3/116.1)
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (48.9/4.3)
##     occupation Priv-house-serv <= 0:
##     :...relationship Own-child > 0: <=50K (947/218)
##         relationship Own-child <= 0:
##         :...relationship Other-relative > 0: <=50K (368.7/99.4)
##             relationship Other-relative <= 0:
##             :...relationship Unmarried > 0:
##                 :...education.num <= 11: <=50K (1303.1/316.8)
##                 :   education.num > 11: >50K (654.8/315.3)
##                 relationship Unmarried <= 0:
##                 :...relationship Not-in-family <= 0:
##                     :...age > 74: <=50K (116.1/36.3)
##                     :   age <= 74:
##                     :   :...occupation Farming-fishing > 0: <=50K (645.5/286.8)
##                     :       occupation Farming-fishing <= 0:
```

```
##                     :       :...occupation Tech-support > 0: >50K (645.8/280.4)
##                     :           occupation Tech-support <= 0:
##                     :           :...hrs.per.week <= 27: <=50K (774.2/336.3)
##                     :               hrs.per.week > 27:
##                     :               :...education.num > 10: >50K (6462/2991.5)
##                     :                   education.num <= 10:
##                     :                   :...occupation Sales > 0: >50K (1426.6/651.8)
##                     :                       occupation Sales <= 0:
##                     :                       :...relationship Wife > 0: [S1]
##                     :                           relationship Wife <= 0: [S2]
##                     relationship Not-in-family > 0:
##                     :...occupation Handlers-cleaners > 0: <=50K (107.5/14.4)
##                         occupation Handlers-cleaners <= 0:
##                         :...occupation Other-service > 0: <=50K (344.2/59.2)
##                             occupation Other-service <= 0:
##                             :...occupation Machine-op-inspct > 0: <=50K (192.1/31.2)
##                                 occupation Machine-op-inspct <= 0:
##                                 :...occupation Adm-clerical > 0: <=50K (580.2/173.6)
##                                     occupation Adm-clerical <= 0:
##                                     :...age <= 26: <=50K (266.9/83.3)
##                                         age > 26: [S3]
##
## SubTree [S1]
##
## hrs.per.week <= 52: >50K (839.2/381.7)
## hrs.per.week > 52: <=50K (43.8/9.7)
##
## SubTree [S2]
##
## hrs.per.week <= 34: <=50K (96/24.6)
## hrs.per.week > 34:
## :...age <= 38: <=50K (3327.7/1541.3)
##     age > 38:
##     :...occupation Prof-specialty <= 0: >50K (4956.1/2428.7)
##         occupation Prof-specialty > 0: <=50K (232.4/98.5)
##
## SubTree [S3]
##
## occupation Transport-moving > 0: <=50K (192.6/68.2)
## occupation Transport-moving <= 0:
## :...occupation Protective-serv > 0: >50K (139.3/58.2)
##     occupation Protective-serv <= 0:
##     :...marStat Widowed > 0: >50K (206.3/92.2)
##         marStat Widowed <= 0:
##         :...age > 64: <=50K (64.1/14.1)
##             age <= 64:
##             :...education Some-college > 0: <=50K (568/224.1)
##                 education Some-college <= 0:
##                 :...hrs.per.week <= 24: <=50K (31.5)
##                     hrs.per.week > 24:
##                     :...education.num <= 6: <=50K (58.9/16.5)
##                         education.num > 6:
##                         :...occupation Exec-managerial <= 0: <=50K (2113.2/1003.8)
##                             occupation Exec-managerial > 0: >50K (756.8/350.6)
```

```
##
## -----  Trial 8:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1539.1/121.4)
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (45.7/4.5)
##     occupation Priv-house-serv <= 0:
##     :...relationship Own-child > 0:
##         :...marStat Married-civ-spouse <= 0: <=50K (830.3/180.6)
##         :   marStat Married-civ-spouse > 0: >50K (71.3/23)
##         relationship Own-child <= 0:
##         :...relationship Unmarried > 0:
##             :...hrs.per.week <= 46: <=50K (1525.6/413.7)
##             :   hrs.per.week > 46: >50K (441.4/208.7)
##             relationship Unmarried <= 0:
##             :...occupation Other-service > 0: <=50K (1101.2/390.8)
##                 occupation Other-service <= 0:
##                 :...relationship Not-in-family > 0:
##                     :...occupation Machine-op-inspct > 0: <=50K (181.2/32.7)
##                     :   occupation Machine-op-inspct <= 0:
##                     :   :...occupation Adm-clerical > 0: <=50K (557.4/182.2)
##                     :       occupation Adm-clerical <= 0:
##                     :       :...age <= 24: <=50K (70/12.8)
##                     :           age > 24:
##                     :           :...hrs.per.week > 45: >50K (1631.6/780.9)
##                     :               hrs.per.week <= 45: [S1]
##                     relationship Not-in-family <= 0:
##                     :...education.num <= 8: <=50K (1356.6/570.4)
##                         education.num > 8:
##                         :...workclass Self-emp-not-inc > 0:
##                             :...occupation Machine-op-inspct > 0: >50K (32.4/9.9)
##                             :   occupation Machine-op-inspct <= 0:
##                             :   :...relationship Wife <= 0: <=50K (1992.6/886.8)
##                             :       relationship Wife > 0: >50K (143.8/58.6)
##                             workclass Self-emp-not-inc <= 0:
##                             :...education Doctorate > 0: >50K (235/101.4)
##                                 education Doctorate <= 0:
##                                 :...age > 56: <=50K (1696.7/761.1)
##                                     age <= 56: [S2]
##
## SubTree [S1]
##
## occupation Transport-moving > 0: <=50K (100.3/30)
## occupation Transport-moving <= 0:
## :...hrs.per.week <= 34: <=50K (248/79.8)
##     hrs.per.week > 34:
##     :...age <= 46: <=50K (1759.2/720.1)
##         age > 46: >50K (716.6/334.7)
##
## SubTree [S2]
##
## occupation Protective-serv > 0: >50K (505.4/228.8)
```

```
## occupation Protective-serv <= 0:
## :...workclass State-gov > 0: >50K (504.8/237.9)
##     workclass State-gov <= 0:
##     :...race White <= 0: <=50K (1237.8/557.1)
##         race White > 0:
##         :...relationship Wife <= 0: <=50K (10427.1/5119)
##             relationship Wife > 0: >50K (1210.7/579.7)
##
## -----  Trial 9:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1444/125.6)
## age > 23:
## :...relationship Own-child > 0: <=50K (869/231.9)
##     relationship Own-child <= 0:
##     :...relationship Unmarried > 0: <=50K (1955/653.2)
##         relationship Unmarried <= 0:
##         :...relationship Other-relative > 0: <=50K (351.1/110.1)
##             relationship Other-relative <= 0:
##             :...relationship Not-in-family <= 0:
##                 :...education.num > 12: >50K (5758.4/2631.9)
##                 :   education.num <= 12:
##                 :   :...education.num <= 8: <=50K (1402.1/622.6)
##                 :       education.num > 8:
##                 :       :...workclass State-gov > 0: <=50K (399.5/180.4)
##                 :           workclass State-gov <= 0:
##                 :           :...workclass Self-emp-not-inc <= 0:
##                 :               :...sex Male <= 0:
##                 :               :   :...workclass Federal-gov <= 0: <=50K (1139.6/533)
##                 :               :   :   workclass Federal-gov > 0: >50K (53.4/18.6)
##                 :               :   sex Male > 0:
##                 :               :   :...hrs.per.week <= 17: <=50K (61.7/15.2)
##                 :               :       hrs.per.week > 17: [S1]
##                 :               workclass Self-emp-not-inc > 0:
##                 :               :...occupation Adm-clerical > 0: >50K (25.1/6.7)
##                 :                   occupation Adm-clerical <= 0: [S2]
##                 relationship Not-in-family > 0:
##                 :...occupation Handlers-cleaners > 0: <=50K (105.5/14.6)
##                     occupation Handlers-cleaners <= 0:
##                     :...occupation Other-service > 0: <=50K (308.9/64.3)
##                         occupation Other-service <= 0:
##                         :...occupation Machine-op-inspct > 0: <=50K (172/33.9)
##                             occupation Machine-op-inspct <= 0:
##                             :...education.num <= 12:
##                                 :...sex Male <= 0: <=50K (945.7/279.2)
##                                 :   sex Male > 0: [S3]
##                                 education.num > 12:
##                                 :...age <= 24: <=50K (30.1)
##                                     age > 24:
##                                     :...workclass State-gov > 0: <=50K (144/52.1)
##                                         workclass State-gov <= 0:
##                                         :...marStat Separated > 0: >50K (84.5/29.5)
##                                             marStat Separated <= 0:
```

```
##                                                :...sex Male <= 0: <=50K (946.1/431.5)
##                                                    sex Male > 0: [S4]
##
## SubTree [S1]
##
## occupation Other-service <= 0: >50K (9310.6/4462.2)
## occupation Other-service > 0: <=50K (308.7/145.1)
##
## SubTree [S2]
##
## occupation Machine-op-inspct > 0: >50K (28.4/9.2)
## occupation Machine-op-inspct <= 0:
## :...hrs.per.week <= 15: >50K (59.6/18.1)
##     hrs.per.week > 15: <=50K (1368.2/628.5)
##
## SubTree [S3]
##
## occupation Prof-specialty <= 0: <=50K (1482/620.1)
## occupation Prof-specialty > 0: >50K (147.7/49.9)
##
## SubTree [S4]
##
## marStat Widowed > 0: >50K (27/2.8)
## marStat Widowed <= 0:
## :...age > 54: <=50K (119.9/38.6)
##     age <= 54:
##     :...marStat Never-married <= 0: <=50K (342.1/160.4)
##         marStat Never-married > 0: >50K (772.2/328)
##
## -----  Trial 10:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1352.9/130.9)
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (40.5/4.8)
##     occupation Priv-house-serv <= 0:
##     :...race Other > 0: <=50K (144.3/49)
##         race Other <= 0:
##         :...relationship Unmarried > 0:
##             :...occupation Machine-op-inspct > 0: <=50K (74.4/9.1)
##             :   occupation Machine-op-inspct <= 0:
##             :   :...sex Male <= 0: <=50K (1245.1/387.8)
##             :       sex Male > 0: >50K (556.1/264.4)
##             relationship Unmarried <= 0:
##             :...occupation Handlers-cleaners > 0: <=50K (676.9/243.8)
##                 occupation Handlers-cleaners <= 0:
##                 :...age <= 28:
##                     :...workclass Self-emp-inc <= 0: <=50K (2357.9/853.5)
##                     :   workclass Self-emp-inc > 0: >50K (62.5/20.5)
##                     age > 28:
##                     :...education Prof-school > 0: >50K (528.1/235.4)
##                         education Prof-school <= 0:
##                         :...marStat Widowed > 0: <=50K (335.6/134.4)
```

```
##                               marStat Widowed <= 0:
##                               :...education Masters > 0:
##                                   :...workclass State-gov > 0: <=50K (140.9/59.4)
##                                   :   workclass State-gov <= 0: [S1]
##                                   education Masters <= 0:
##                                   :...relationship Not-in-family > 0: [S2]
##                                       relationship Not-in-family <= 0:
##                                       :...education Bachelors <= 0:
##                                           :...relationship Wife > 0:
##                                           :   :...hrs.per.week <= 42: >50K (1132.9/520.8)
##                                           :   :   hrs.per.week > 42: <=50K (172.9/63.2)
##                                           :   relationship Wife <= 0:
##                                           :   :...hrs.per.week <= 34: <=50K (562.4/217.4)
##                                           :       hrs.per.week > 34: [S3]
##                                           education Bachelors > 0: [S4]
##
## SubTree [S1]
##
## workclass Self-emp-not-inc <= 0: >50K (1436.9/651.1)
## workclass Self-emp-not-inc > 0: <=50K (150.8/66.2)
##
## SubTree [S2]
##
## occupation Machine-op-inspct > 0: <=50K (125.5/30.6)
## occupation Machine-op-inspct <= 0:
## :...occupation Other-service > 0: <=50K (204.1/50)
##     occupation Other-service <= 0:
##     :...education 11th <= 0: <=50K (3338.8/1505.5)
##         education 11th > 0: >50K (55.5/21.9)
##
## SubTree [S3]
##
## workclass Self-emp-not-inc <= 0: <=50K (10387.4/4895.1)
## workclass Self-emp-not-inc > 0: >50K (1433.1/689)
##
## SubTree [S4]
##
## occupation Other-service > 0: >50K (76/27.8)
## occupation Other-service <= 0:
## :...sex Male <= 0: <=50K (372.7/169.2)
##     sex Male > 0:
##     :...workclass Self-emp-not-inc <= 0: >50K (2786.7/1346.1)
##         workclass Self-emp-not-inc > 0: <=50K (411.3/188.4)
##
## -----  Trial 11:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1167.3/21.6)
## age > 23:
## :...occupation Priv-house-serv > 0: <=50K (33.5)
##     occupation Priv-house-serv <= 0:
##     :...relationship Own-child > 0: <=50K (731/151.5)
##         relationship Own-child <= 0:
```

```
##         :...relationship Unmarried > 0: <=50K (1915/686.5)
##             relationship Unmarried <= 0:
##             :...race Other > 0: <=50K (123.8/48.4)
##                 race Other <= 0:
##                 :...marStat Never-married > 0: <=50K (2924.5/1236.6)
##                     marStat Never-married <= 0:
##                     :...marStat Widowed > 0: <=50K (338.2/143.2)
##                         marStat Widowed <= 0:
##                         :...occupation Tech-support > 0: >50K (770.7/348.7)
##                             occupation Tech-support <= 0:
##                             :...occupation Other-service > 0: <=50K (845.2/374.2)
##                                 occupation Other-service <= 0:
##                                 :...workclass Self-emp-inc > 0: [S1]
##                                     workclass Self-emp-inc <= 0:
##                                     :...occupation Exec-managerial > 0: [S2]
##                                         occupation Exec-managerial <= 0:
##                                         :...hrs.per.week <= 35: [S3]
##                                             hrs.per.week > 35: [S4]
##
## SubTree [S1]
##
## marStat Married-civ-spouse <= 0: <=50K (100.3/41)
## marStat Married-civ-spouse > 0: >50K (1173/535.1)
##
## SubTree [S2]
##
## workclass Self-emp-not-inc > 0: <=50K (544.2/244.8)
## workclass Self-emp-not-inc <= 0:
## :...hrs.per.week <= 48:
##     :...race Black <= 0: <=50K (1841.2/887.5)
##     :   race Black > 0: >50K (108.6/44.5)
##     hrs.per.week > 48:
##     :...education HS-grad <= 0: >50K (824.9/300.2)
##         education HS-grad > 0: <=50K (187.3/86.5)
##
## SubTree [S3]
##
## marStat Married-spouse-absent > 0: >50K (30/7.3)
## marStat Married-spouse-absent <= 0:
## :...age <= 27: <=50K (37.5/5.1)
##     age > 27:
##     :...occupation Prof-specialty <= 0: <=50K (910.3/366.9)
##         occupation Prof-specialty > 0: >50K (414.8/197.5)
##
## SubTree [S4]
##
## education 7th-8th > 0: <=50K (184.4/76)
## education 7th-8th <= 0:
## :...sex Male <= 0:
##     :...occupation Machine-op-inspct > 0: <=50K (117.1/40.5)
##     :   occupation Machine-op-inspct <= 0:
##     :   :...education.num <= 10: <=50K (732.2/308.6)
##     :       education.num > 10: >50K (656/305.9)
##     sex Male > 0:
```

```
##     :...education 5th-6th > 0: <=50K (66.4/25.7)
##         education 5th-6th <= 0:
##         :...education 12th > 0: >50K (124.3/51.9)
##             education 12th <= 0:
##             :...workclass Self-emp-not-inc > 0: <=50K (1577.4/745)
##                 workclass Self-emp-not-inc <= 0:
##                 :...hrs.per.week > 53:
##                     :...race Black > 0: >50K (56.3/20.1)
##                     :   race Black <= 0:
##                     :   :...race White <= 0: <=50K (47.1/11.8)
##                     :       race White > 0:
##                     :       :...hrs.per.week <= 72: <=50K (1388.2/612.8)
##                     :           hrs.per.week > 72: >50K (158.2/59.3)
##                     hrs.per.week <= 53:
##                     :...education 9th > 0: <=50K (84.4/33.1)
##                         education 9th <= 0:
##                         :...age <= 25: <=50K (196.7/75.7)
##                             age > 25:
##                             :...occupation Handlers-cleaners > 0: <=50K (398.3/186.1)
##                                 occupation Handlers-cleaners <= 0:
##                                 :...occupation Prof-specialty <= 0:
##                                     :...age <= 61: >50K (7336.7/3587.3)
##                                     :   age > 61: <=50K (236.9/88.3)
##                                     occupation Prof-specialty > 0:
##                                     :...age > 51: >50K (305.4/107.5)
##                                         age <= 51: [S5]
##
## SubTree [S5]
##
## workclass Local-gov > 0: <=50K (219.3/94.6)
## workclass Local-gov <= 0:
## :...hrs.per.week <= 39: >50K (47.8/12.3)
##     hrs.per.week > 39:
##     :...education Bachelors <= 0: >50K (733.2/326.4)
##         education Bachelors > 0: <=50K (426.8/197.8)
##
## -----  Trial 12:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1073.9)
## age > 23:
## :...relationship Own-child > 0: <=50K (613.5/68.4)
##     relationship Own-child <= 0:
##     :...relationship Unmarried > 0:
##         :...occupation Machine-op-inspct > 0: <=50K (59.9)
##         :   occupation Machine-op-inspct <= 0:
##         :   :...occupation Handlers-cleaners > 0: <=50K (33.5)
##         :       occupation Handlers-cleaners <= 0:
##         :       :...occupation Farming-fishing > 0: <=50K (30.3)
##         :           occupation Farming-fishing <= 0:
##         :           :...occupation Adm-clerical > 0: <=50K (227.7/20.9)
##         :               occupation Adm-clerical <= 0:
##         :               :...hrs.per.week <= 31: <=50K (100.7/7.2)
```

```
##         :                   hrs.per.week > 31:
##         :                   :...workclass Federal-gov > 0: >50K (69.9/24.1)
##         :                       workclass Federal-gov <= 0:
##         :                       :...education.num <= 12: <=50K (716.7/229)
##         :                           education.num > 12: >50K (515.6/223.6)
##         relationship Unmarried <= 0:
##         :...relationship Other-relative > 0: <=50K (323.8/106)
##             relationship Other-relative <= 0:
##             :...education Doctorate > 0: >50K (472.8/204.1)
##                 education Doctorate <= 0:
##                 :...relationship Not-in-family <= 0:
##                     :...occupation Exec-managerial > 0: >50K (3470.2/1610.8)
##                     :   occupation Exec-managerial <= 0:
##                     :   :...workclass Self-emp-not-inc > 0:
##                     :       :...occupation Craft-repair <= 0: >50K (1502/689.4)
##                     :       :   occupation Craft-repair > 0: <=50K (476.4/221.3)
##                     :       workclass Self-emp-not-inc <= 0:
##                     :       :...occupation Other-service > 0: >50K (645.9/305.3)
##                     :           occupation Other-service <= 0:
##                     :           :...occupation Prof-specialty <= 0:
##                     :               :...hrs.per.week <= 55: <=50K (10849.6/5026.5)
##                     :               :   hrs.per.week > 55: >50K (1146.8/531.5)
##                     :               occupation Prof-specialty > 0:
##                     :               :...hrs.per.week > 51: <=50K (379.1/155.2)
##                     :                   hrs.per.week <= 51:
##                     :                   :...hrs.per.week <= 28: <=50K (150/56.2)
##                     :                       hrs.per.week > 28: >50K (1944.1/918.8)
##                     relationship Not-in-family > 0:
##                     :...occupation Machine-op-inspct > 0: <=50K (132/4.1)
##                         occupation Machine-op-inspct <= 0:
##                         :...occupation Other-service > 0: <=50K (216/15.7)
##                             occupation Other-service <= 0:
##                             :...occupation Handlers-cleaners > 0: <=50K (81.5/7)
##                                 occupation Handlers-cleaners <= 0:
##                                 :...age <= 26: <=50K (268.7/75.1)
##                                     age > 26: [S1]
##
## SubTree [S1]
##
## occupation Transport-moving > 0: <=50K (175.1/55.7)
## occupation Transport-moving <= 0:
## :...occupation Farming-fishing > 0: <=50K (95.4/35.1)
##     occupation Farming-fishing <= 0:
##     :...hrs.per.week <= 38: <=50K (441.3/151)
##         hrs.per.week > 38:
##         :...education Bachelors > 0: >50K (1317.6/602)
##             education Bachelors <= 0:
##             :...sex Male <= 0: <=50K (935.6/363.7)
##                 sex Male > 0:
##                 :...education.num <= 6: <=50K (35.6/8)
##                     education.num > 6:
##                     :...race Black > 0: <=50K (117.3/46.6)
##                         race Black <= 0:
##                         :...workclass Private <= 0: >50K (476.1/201.5)
```

```
##                             workclass Private > 0:
##                             :...education Some-college <= 0: >50K (675.7/324.1)
##                                 education Some-college > 0: <=50K (244/100.3)
##
## -----  Trial 13:  -----
##
## Decision tree:
##
## age <= 23: <=50K (1000.9)
## age > 23:
## :...relationship Own-child > 0: <=50K (529.7/21.6)
##     relationship Own-child <= 0:
##     :...occupation Priv-house-serv > 0: <=50K (27.8)
##         occupation Priv-house-serv <= 0:
##         :...relationship Unmarried > 0: <=50K (1572.8/417.1)
##             relationship Unmarried <= 0:
##             :...education 5th-6th > 0: <=50K (100.8/27.4)
##                 education 5th-6th <= 0:
##                 :...relationship Other-relative > 0: <=50K (281.7/89.7)
##                     relationship Other-relative <= 0:
##                     :...relationship Not-in-family > 0:
##                         :...occupation Other-service > 0: <=50K (187.6/3.1)
##                         :   occupation Other-service <= 0:
##                         :   :...occupation Machine-op-inspct > 0: <=50K (119.9/3.2)
##                         :       occupation Machine-op-inspct <= 0: [S1]
##                         relationship Not-in-family <= 0:
##                         :...education 9th > 0: <=50K (141.5/55.9)
##                             education 9th <= 0:
##                             :...education 7th-8th > 0: <=50K (236.2/95.9)
##                                 education 7th-8th <= 0: [S2]
##
## SubTree [S1]
##
## occupation Handlers-cleaners > 0: <=50K (70.3/3.1)
## occupation Handlers-cleaners <= 0:
## :...age <= 27: <=50K (350.6/71.9)
##     age > 27:
##     :...occupation Adm-clerical > 0: <=50K (393.7/109)
##         occupation Adm-clerical <= 0:
##         :...hrs.per.week <= 31: <=50K (136.9/27.1)
##             hrs.per.week > 31:
##             :...occupation Farming-fishing > 0: <=50K (71.7/22.6)
##                 occupation Farming-fishing <= 0:
##                 :...occupation Transport-moving > 0: <=50K (150.6/49.5)
##                     occupation Transport-moving <= 0:
##                     :...marStat Widowed > 0: >50K (181.6/79.6)
##                         marStat Widowed <= 0:
##                         :...age > 64: <=50K (48.1/10.1)
##                             age <= 64:
##                             :...education Doctorate > 0: >50K (134.6/55.9)
##                                 education Doctorate <= 0:
##                                 :...education Prof-school > 0: >50K (155.8/66.7)
##                                     education Prof-school <= 0:
##                                     :...education Masters <= 0: <=50K (2703.3/1172.7)
```

```
##                                         education Masters > 0: >50K (548.4/263.2)
##
## SubTree [S2]
##
## occupation Farming-fishing > 0: <=50K (670.9/289.9)
## occupation Farming-fishing <= 0:
## :...occupation Other-service > 0: <=50K (750.9/333.8)
##     occupation Other-service <= 0:
##     :...race White <= 0: <=50K (1788.5/852.3)
##         race White > 0:
##         :...workclass Federal-gov > 0: >50K (600/263.5)
##             workclass Federal-gov <= 0:
##             :...education Prof-school > 0: >50K (335.9/146.1)
##                 education Prof-school <= 0:
##                 :...occupation Sales > 0: >50K (2546.8/1226.2)
##                     occupation Sales <= 0:
##                     :...workclass Self-emp-inc > 0: <=50K (702.5/316.4)
##                         workclass Self-emp-inc <= 0:
##                         :...relationship Wife > 0:
##                             :...hrs.per.week <= 52: >50K (1297.2/590.2)
##                             :   hrs.per.week > 52: <=50K (68.7/20.6)
##                             relationship Wife <= 0:
##                             :...hrs.per.week <= 34: <=50K (447.2/190.4)
##                                 hrs.per.week > 34: [S3]
##
## SubTree [S3]
##
## workclass Self-emp-not-inc > 0: <=50K (1094.9/514.1)
## workclass Self-emp-not-inc <= 0:
## :...education Doctorate > 0: >50K (154.6/64.5)
##     education Doctorate <= 0:
##     :...age <= 30: <=50K (1364.9/616.3)
##         age > 30:
##         :...occupation Adm-clerical > 0: <=50K (543.4/255.9)
##             occupation Adm-clerical <= 0:
##             :...occupation Prof-specialty <= 0: >50K (7052.8/3420)
##                 occupation Prof-specialty > 0:
##                 :...workclass State-gov > 0: <=50K (127.8/51.6)
##                     workclass State-gov <= 0:
##                     :...hrs.per.week <= 44: >50K (634.9/283.1)
##                         hrs.per.week > 44: <=50K (565.5/246)
##
## -----  Trial 14:  -----
##
## Decision tree:
##
## relationship Own-child > 0: <=50K (1049.9/3.1)
## relationship Own-child <= 0:
## :...age <= 23: <=50K (366.3)
##     age > 23:
##     :...occupation Priv-house-serv > 0: <=50K (26.1)
##         occupation Priv-house-serv <= 0:
##         :...education 5th-6th > 0: <=50K (89.7/10.8)
##             education 5th-6th <= 0:
```

```
##             :...relationship Unmarried > 0: <=50K (1357.5/285.6)
##                 relationship Unmarried <= 0:
##                 :...relationship Other-relative > 0: <=50K (224.5/44.6)
##                     relationship Other-relative <= 0:
##                     :...education 9th > 0: <=50K (134.7/31.9)
##                         education 9th <= 0:
##                         :...marStat Married-AF-spouse > 0: >50K (32.1/10.2)
##                             marStat Married-AF-spouse <= 0:
##                             :...marStat Married-civ-spouse <= 0:
##                                 :...age <= 27: <=50K (312.4)
##                                 :   age > 27: [S1]
##                                 marStat Married-civ-spouse > 0:
##                                 :...education Prof-school > 0: >50K (355.7/140.8)
##                                     education Prof-school <= 0:
##                                     :...education Doctorate > 0: >50K (281.8/111.6)
##                                         education Doctorate <= 0: [S2]
##
## SubTree [S1]
##
## occupation Other-service > 0: <=50K (141.3)
## occupation Other-service <= 0:
## :...occupation Machine-op-inspct > 0: <=50K (91.4)
##     occupation Machine-op-inspct <= 0:
##     :...occupation Adm-clerical > 0: <=50K (275.9/10.8)
##         occupation Adm-clerical <= 0:
##         :...occupation Handlers-cleaners > 0: <=50K (52.5/3.4)
##             occupation Handlers-cleaners <= 0:
##             :...occupation Farming-fishing > 0: <=50K (64.8/15.2)
##                 occupation Farming-fishing <= 0:
##                 :...hrs.per.week <= 42: <=50K (1792.1/624.8)
##                     hrs.per.week > 42:
##                     :...workclass State-gov > 0: <=50K (53.5/16.5)
##                         workclass State-gov <= 0:
##                         :...education Assoc-acdm > 0: <=50K (69.3/25.1)
##                             education Assoc-acdm <= 0:
##                             :...education HS-grad <= 0: >50K (1648.4/788.3)
##                                 education HS-grad > 0: <=50K (315.4/132.4)
##
## SubTree [S2]
##
## race Asian-Pac-Islander > 0: >50K (617.7/283.4)
## race Asian-Pac-Islander <= 0:
## :...education Masters > 0:
##     :...age <= 35: <=50K (256/110.5)
##     :   age > 35: >50K (918.9/399.1)
##     education Masters <= 0:
##     :...race Black > 0:
##         :...hrs.per.week <= 33: <=50K (34.3/5.1)
##         :   hrs.per.week > 33:
##         :   :...occupation Transport-moving <= 0: >50K (915.8/400.9)
##         :       occupation Transport-moving > 0: <=50K (116.8/48.1)
##         race Black <= 0:
##         :...workclass Self-emp-inc > 0: >50K (1095.6/509.5)
##             workclass Self-emp-inc <= 0:
```

```
##             :...occupation Tech-support > 0: >50K (634.4/299.7)
##                 occupation Tech-support <= 0:
##                 :...occupation Adm-clerical > 0:
##                     :...education Assoc-voc <= 0: >50K (1283.5/614.5)
##                     :   education Assoc-voc > 0: <=50K (71.4/26.2)
##                     occupation Adm-clerical <= 0:
##                     :...age > 71: <=50K (123/33.9)
##                         age <= 71:
##                         :...education Bachelors <= 0: <=50K (11729.8/5289.4)
##                             education Bachelors > 0:
##                             :...hrs.per.week > 41: >50K (1486.9/694.6)
##                                 hrs.per.week <= 41:
##                                 :...age <= 65: <=50K (1579.8/702.2)
##                                     age > 65: >50K (50.8/13.4)
##
## -----  Trial 15:  -----
##
## Decision tree:
##
## relationship Own-child > 0: <=50K (977.5)
## relationship Own-child <= 0:
## :...relationship Other-relative > 0: <=50K (239.7/5.5)
##     relationship Other-relative <= 0:
##     :...age <= 24: <=50K (497.5/34)
##         age > 24:
##         :...relationship Unmarried > 0: <=50K (1201.4/201.2)
##             relationship Unmarried <= 0:
##             :...education 9th > 0: <=50K (108.8/12.7)
##                 education 9th <= 0:
##                 :...education 5th-6th > 0: <=50K (67.4/8.1)
##                     education 5th-6th <= 0:
##                     :...relationship Not-in-family > 0: <=50K (4513.1/1308.3)
##                         relationship Not-in-family <= 0:
##                         :...education 1st-4th > 0: <=50K (48.5/10.4)
##                             education 1st-4th <= 0:
##                             :...education 11th > 0: <=50K (268/69.4)
##                                 education 11th <= 0:
##                                 :...education 7th-8th > 0: <=50K (185.1/52.5)
##                                     education 7th-8th <= 0:
##                                     :...education Doctorate > 0: >50K (236.9/78)
##                                         education Doctorate <= 0: [S1]
##
## SubTree [S1]
##
## education Prof-school > 0: >50K (310.3/109.7)
## education Prof-school <= 0:
## :...occupation Other-service > 0: <=50K (619.2/250.7)
##     occupation Other-service <= 0:
##     :...occupation Exec-managerial > 0: >50K (3455.4/1474.6)
##         occupation Exec-managerial <= 0:
##         :...hrs.per.week <= 31: <=50K (800.2/312.7)
##             hrs.per.week > 31:
##             :...age > 35:
##                 :...workclass Self-emp-inc > 0: <=50K (544.5/252.5)
```

```
##                 :   workclass Self-emp-inc <= 0:
##                 :   :...occupation Adm-clerical > 0: <=50K (1140.7/533)
##                 :       occupation Adm-clerical <= 0:
##                 :       :...age > 71: <=50K (44.2/11.5)
##                 :           age <= 71:
##                 :           :...occupation Sales <= 0: >50K (8024.1/3822.4)
##                 :               occupation Sales > 0:
##                 :               :...hrs.per.week > 70: >50K (38.8/6.9)
##                 :                   hrs.per.week <= 70:
##                 :                   :...age <= 53: >50K (1135.4/482.3)
##                 :                       age > 53: <=50K (453.8/203.4)
##                 age <= 35:
##                 :...education.num <= 8: <=50K (78.6/12.2)
##                     education.num > 8:
##                     :...occupation Handlers-cleaners > 0: <=50K (121.1/35.6)
##                         occupation Handlers-cleaners <= 0:
##                         :...occupation Prof-specialty > 0: >50K (763.1/343)
##                             occupation Prof-specialty <= 0:
##                             :...occupation Protective-serv > 0: >50K (244.9/112.1)
##                                 occupation Protective-serv <= 0:
##                                 :...hrs.per.week > 72: >50K (58.3/18.3)
##                                     hrs.per.week <= 72: [S2]
##
## SubTree [S2]
##
## workclass Self-emp-not-inc > 0: <=50K (216/77.7)
## workclass Self-emp-not-inc <= 0:
## :...hrs.per.week <= 39: <=50K (108.2/29.8)
##     hrs.per.week > 39:
##     :...education HS-grad > 0: <=50K (1146.5/469.7)
##         education HS-grad <= 0:
##         :...age <= 30: >50K (683.8/319.6)
##             age > 30: <=50K (902/395.1)
##
## -----  Trial 16:  -----
##
## Decision tree:
##
## relationship Own-child > 0: <=50K (903.5)
## relationship Own-child <= 0:
## :...relationship Other-relative > 0: <=50K (219.4/3)
##     relationship Other-relative <= 0:
##     :...occupation Other-service > 0: <=50K (760/38.3)
##         occupation Other-service <= 0:
##         :...relationship Unmarried > 0: <=50K (990.2/133.7)
##             relationship Unmarried <= 0:
##             :...relationship Not-in-family > 0:
##                 :...education.num <= 12: <=50K (1720.8/107)
##                 :   education.num > 12:
##                 :   :...occupation Adm-clerical > 0: <=50K (83.3)
##                 :       occupation Adm-clerical <= 0:
##                 :       :...age <= 29: <=50K (273.2/31.3)
##                 :           age > 29:
##                 :           :...education.num > 14: >50K (358.4/132.6)
```

```
##                 :               education.num <= 14:
##                 :               :...workclass State-gov > 0: <=50K (56.4)
##                 :                   workclass State-gov <= 0:
##                 :                   :...hrs.per.week <= 44: <=50K (507.1/120.7)
##                 :                       hrs.per.week > 44: [S1]
##                 relationship Not-in-family <= 0:
##                 :...education Doctorate > 0: >50K (192.4/45.6)
##                     education Doctorate <= 0:
##                     :...education Prof-school > 0: >50K (258.5/73.1)
##                         education Prof-school <= 0:
##                         :...education Masters > 0: >50K (1072.1/398)
##                             education Masters <= 0:
##                             :...education Bachelors > 0: [S2]
##                                 education Bachelors <= 0:
##                                 :...education.num <= 7: <=50K (772/73.6)
##                                     education.num > 7:
##                                     :...age <= 29: <=50K (1264/391.8)
##                                         age > 29: [S3]
##
## SubTree [S1]
##
## occupation Prof-specialty <= 0: >50K (672.7/299)
## occupation Prof-specialty > 0: <=50K (338.4/117.2)
##
## SubTree [S2]
##
## occupation Transport-moving > 0: <=50K (71.9/24.9)
## occupation Transport-moving <= 0:
## :...occupation Exec-managerial > 0: >50K (877.3/294.6)
##     occupation Exec-managerial <= 0:
##     :...workclass Self-emp-not-inc > 0: <=50K (384.2/171.4)
##         workclass Self-emp-not-inc <= 0:
##         :...age <= 33: <=50K (803.3/370.9)
##             age > 33:
##             :...occupation Sales > 0: >50K (405.1/122)
##                 occupation Sales <= 0:
##                 :...occupation Protective-serv > 0: >50K (53/14.9)
##                     occupation Protective-serv <= 0:
##                     :...workclass Local-gov <= 0: >50K (1215.5/531)
##                         workclass Local-gov > 0: <=50K (259.3/109.1)
##
## SubTree [S3]
##
## occupation Handlers-cleaners > 0: <=50K (353.2/123.3)
## occupation Handlers-cleaners <= 0:
## :...occupation Adm-clerical > 0:
##     :...age <= 50: >50K (985.6/429.8)
##     :   age > 50: <=50K (341.3/149.9)
##     occupation Adm-clerical <= 0:
##     :...occupation Sales > 0:
##         :...hrs.per.week <= 31: <=50K (82.1/21.3)
##         :   hrs.per.week > 31:
##         :   :...workclass Self-emp-not-inc > 0: <=50K (284.9/131.1)
##         :       workclass Self-emp-not-inc <= 0:
```

```
##         :       :...sex Male <= 0: <=50K (97.7/40.4)
##         :           sex Male > 0: >50K (1481.4/683.6)
##         occupation Sales <= 0:
##         :...race White <= 0: <=50K (864.7/322.6)
##             race White > 0:
##             :...relationship Wife > 0: >50K (532.2/256.2)
##                 relationship Wife <= 0:
##                 :...workclass State-gov > 0: <=50K (296.9/107.3)
##                     workclass State-gov <= 0:
##                     :...hrs.per.week <= 47: <=50K (5962/2479.2)
##                         hrs.per.week > 47:
##                         :...workclass Self-emp-not-inc > 0: <=50K (647.3/261.3)
##                             workclass Self-emp-not-inc <= 0:
##                             :...education HS-grad <= 0: >50K (1102.7/505)
##                                 education HS-grad > 0: <=50K (1179.9/539.3)
##
## -----  Trial 17:  -----
##
## Decision tree:
##
## education.num <= 7: <=50K (1141.1/4.4)
## education.num > 7:
## :...relationship Other-relative > 0: <=50K (155.7)
##     relationship Other-relative <= 0:
##     :...relationship Own-child > 0: <=50K (694)
##         relationship Own-child <= 0:
##         :...occupation Other-service > 0: <=50K (547.1/26.5)
##             occupation Other-service <= 0:
##             :...occupation Farming-fishing > 0: <=50K (575.4/58.8)
##                 occupation Farming-fishing <= 0:
##                 :...marStat Married-civ-spouse <= 0:
##                     :...education.num <= 12: <=50K (1775.1/27)
##                     :   education.num > 12:
##                     :   :...hrs.per.week <= 44: <=50K (952.4/179.4)
##                     :       hrs.per.week > 44:
##                     :       :...age <= 31: <=50K (319.4/75)
##                     :           age > 31:
##                     :           :...education Prof-school > 0: >50K (86.3/21.7)
##                     :               education Prof-school <= 0: [S1]
##                     marStat Married-civ-spouse > 0:
##                     :...occupation Handlers-cleaners > 0: <=50K (336.9/53.9)
##                         occupation Handlers-cleaners <= 0:
##                         :...race Other > 0: <=50K (60.3/14.8)
##                             race Other <= 0:
##                             :...education.num > 12: [S2]
##                                 education.num <= 12:
##                                 :...age <= 32: <=50K (2019.1/562.7)
##                                     age > 32:
##                                     :...education 12th > 0: <=50K (119.9/34.9)
##                                         education 12th <= 0:
##                                         :...hrs.per.week <= 37: <=50K (805.4/313.3)
##                                             hrs.per.week > 37: [S3]
##
## SubTree [S1]
```

```
##
## occupation Exec-managerial <= 0: <=50K (813.8/310.3)
## occupation Exec-managerial > 0: >50K (458.7/221.4)
##
## SubTree [S2]
##
## occupation Machine-op-inspct > 0: <=50K (91/28.1)
## occupation Machine-op-inspct <= 0:
## :...age <= 28: <=50K (518/231.4)
##     age > 28:
##     :...occupation Craft-repair <= 0: >50K (3936.3/1055.9)
##         occupation Craft-repair > 0: <=50K (312.4/139.1)
##
## SubTree [S3]
##
## occupation Exec-managerial > 0: >50K (2019.1/837.4)
## occupation Exec-managerial <= 0:
## :...occupation Tech-support > 0: >50K (463.6/195.8)
##     occupation Tech-support <= 0:
##     :...age > 43:
##         :...age > 62: <=50K (217.7/78.8)
##         :   age <= 62:
##         :   :...occupation Sales > 0:
##         :       :...hrs.per.week > 70: >50K (32.2/4.1)
##         :       :   hrs.per.week <= 70:
##         :       :   :...workclass Private <= 0: >50K (307.2/145.5)
##         :       :       workclass Private > 0: <=50K (644.9/266.7)
##         :       occupation Sales <= 0:
##         :       :...hrs.per.week > 54: <=50K (488.8/223.8)
##         :           hrs.per.week <= 54:
##         :           :...education HS-grad <= 0: >50K (1444.7/595.1)
##         :               education HS-grad > 0:
##         :               :...relationship Wife <= 0: >50K (2223.6/998.1)
##         :                   relationship Wife > 0: <=50K (150.9/58.8)
##         age <= 43:
##         :...workclass State-gov > 0: <=50K (107.4/35.2)
##             workclass State-gov <= 0:
##             :...occupation Protective-serv > 0: >50K (174.4/80.7)
##                 occupation Protective-serv <= 0:
##                 :...race White <= 0: <=50K (358.4/162.9)
##                     race White > 0:
##                     :...occupation Prof-specialty > 0: >50K (293.5/131.7)
##                         occupation Prof-specialty <= 0:
##                         :...hrs.per.week > 70: >50K (68.8/24.4)
##                             hrs.per.week <= 70:
##                             :...age <= 35: <=50K (618.7/203.1)
##                                 age > 35:
##                                 :...occupation Craft-repair <= 0: [S4]
##                                     occupation Craft-repair > 0: [S5]
##
## SubTree [S4]
##
## workclass Self-emp-not-inc > 0: >50K (81.2/33.2)
## workclass Self-emp-not-inc <= 0:
```

```
## :...workclass Self-emp-inc <= 0: <=50K (1476.4/615.7)
##     workclass Self-emp-inc > 0: >50K (72.2/31.2)
##
## SubTree [S5]
##
## workclass Self-emp-not-inc > 0: <=50K (58.6/4.5)
## workclass Self-emp-not-inc <= 0:
## :...education Assoc-acdm > 0: <=50K (28.8/10.1)
##     education Assoc-acdm <= 0:
##     :...hrs.per.week <= 53: >50K (927.6/433.1)
##         hrs.per.week > 53: <=50K (94.1/33)
##
## -----  Trial 18:  -----
##
## Decision tree:
##
## education.num <= 7: <=50K (1030.4)
## education.num > 7:
## :...occupation Other-service > 0: <=50K (601.3)
##     occupation Other-service <= 0:
##     :...relationship Other-relative > 0: <=50K (119.7)
##         relationship Other-relative <= 0:
##         :...relationship Own-child > 0: <=50K (521.3)
##             relationship Own-child <= 0:
##             :...relationship Unmarried > 0: <=50K (725/47.1)
##                 relationship Unmarried <= 0:
##                 :...occupation Handlers-cleaners > 0: <=50K (321/20.9)
##                     occupation Handlers-cleaners <= 0:
##                     :...occupation Farming-fishing > 0: <=50K (525.9/68.8)
##                         occupation Farming-fishing <= 0:
##                         :...relationship Not-in-family > 0:
##                             :...education.num <= 12: <=50K (1126/5)
##                             :   education.num > 12:
##                             :   :...occupation Adm-clerical > 0: <=50K (68.3)
##                             :       occupation Adm-clerical <= 0:
##                             :       :...education.num <= 14: <=50K (1660.7/421.5)
##                             :           education.num > 14: >50K (431.3/175.7)
##                             relationship Not-in-family <= 0:
##                             :...education Prof-school > 0: >50K (172.5/4.2)
##                                 education Prof-school <= 0:
##                                 :...education Doctorate > 0: >50K (125/3.7)
##                                     education Doctorate <= 0:
##                                     :...education.num > 12:
##                                         :...hrs.per.week <= 31: <=50K (519/181.6)
##                                         :   hrs.per.week > 31: >50K (3609.8/790)
##                                         education.num <= 12: [S1]
##
## SubTree [S1]
##
## workclass Self-emp-inc > 0: >50K (812.2/283.1)
## workclass Self-emp-inc <= 0:
## :...workclass Federal-gov > 0: >50K (701.7/244.6)
##     workclass Federal-gov <= 0:
##     :...age <= 35: <=50K (2723/703)
```

```
##         age > 35:
##         :...occupation Tech-support > 0: >50K (292.1/81.4)
##             occupation Tech-support <= 0:
##             :...occupation Prof-specialty > 0: >50K (528.1/185.2)
##                 occupation Prof-specialty <= 0:
##                 :...workclass Self-emp-not-inc > 0:
##                     :...occupation Machine-op-inspct <= 0: <=50K (1041.9/287.5)
##                     :   occupation Machine-op-inspct > 0: >50K (41/7.6)
##                     workclass Self-emp-not-inc <= 0:
##                     :...occupation Exec-managerial > 0:
##                         :...education Assoc-acdm > 0: >50K (59.3/2.3)
##                         :   education Assoc-acdm <= 0:
##                         :   :...age > 62: <=50K (89.1/26.4)
##                         :       age <= 62:
##                         :       :...workclass Private <= 0: <=50K (210.6/85.9)
##                         :           workclass Private > 0: >50K (751.8/229.5)
##                         occupation Exec-managerial <= 0:
##                         :...hrs.per.week <= 41:
##                             :...age > 61: <=50K (158.4/17.3)
##                             :   age <= 61:
##                             :   :...relationship Wife > 0: >50K (627.8/273.8)
##                             :       relationship Wife <= 0:
##                             :       :...hrs.per.week <= 34: <=50K (39.8)
##                             :           hrs.per.week > 34:
##                             :           :...occupation Sales <= 0: <=50K (4014.8/1354.4)
##                             :               occupation Sales > 0: >50K (593.6/262.2)
##                             hrs.per.week > 41:
##                             :...occupation Protective-serv > 0: >50K (110.4/33)
##                                 occupation Protective-serv <= 0:
##                                 :...workclass Local-gov > 0: <=50K (43.8/3.1)
##                                     workclass Local-gov <= 0:
##                                     :...age <= 38: <=50K (564.6/222.4)
##                                         age > 38: [S2]
##
## SubTree [S2]
##
## occupation Adm-clerical > 0: >50K (134.7/43)
## occupation Adm-clerical <= 0:
## :...hrs.per.week > 59: >50K (508.6/166.2)
##     hrs.per.week <= 59:
##     :...age <= 42: >50K (415.5/158.1)
##         age > 42:
##         :...education Some-college <= 0: <=50K (876.2/403.2)
##             education Some-college > 0: >50K (333.1/152.2)
##
## -----  Trial 19:  -----
##
## Decision tree:
##
## relationship Unmarried > 0: <=50K (732.7)
## relationship Unmarried <= 0:
## :...occupation Other-service > 0: <=50K (587.2)
##     occupation Other-service <= 0:
##     :...occupation Handlers-cleaners > 0: <=50K (390/5.8)
```

```
##         occupation Handlers-cleaners <= 0:
##         :...relationship Other-relative > 0: <=50K (114.8)
##             relationship Other-relative <= 0:
##             :...relationship Own-child > 0: <=50K (464.4)
##                 relationship Own-child <= 0:
##                 :...occupation Farming-fishing > 0: <=50K (502.7/54.5)
##                     occupation Farming-fishing <= 0:
##                     :...marStat Never-married > 0: <=50K (1691.9/267.4)
##                         marStat Never-married <= 0:
##                         :...marStat Widowed > 0: <=50K (129.4/14.2)
##                             marStat Widowed <= 0:
##                             :...education Prof-school > 0: >50K (229.1/37.2)
##                                 education Prof-school <= 0:
##                                 :...race Other > 0: <=50K (70.4/8.3)
##                                     race Other <= 0: [S1]
##
## SubTree [S1]
##
## occupation Machine-op-inspct > 0: <=50K (1470.9/360.2)
## occupation Machine-op-inspct <= 0:
## :...education.num > 12:
##     :...age <= 28: <=50K (746.6/311.3)
##     :   age > 28:
##     :   :...relationship Not-in-family > 0: <=50K (750.4/321.8)
##     :       relationship Not-in-family <= 0:
##     :       :...occupation Transport-moving <= 0: >50K (2974.6/453.4)
##     :           occupation Transport-moving > 0: <=50K (97.8/30.8)
##     education.num <= 12:
##     :...relationship Not-in-family > 0: <=50K (499)
##         relationship Not-in-family <= 0:
##         :...age <= 31: <=50K (1144/161.3)
##             age > 31:
##             :...workclass Self-emp-not-inc > 0:
##                 :...occupation Adm-clerical > 0: >50K (27.2/2.2)
##                 :   occupation Adm-clerical <= 0:
##                 :   :...relationship Wife <= 0: <=50K (1145.9/294.1)
##                 :       relationship Wife > 0: >50K (114.9/30.3)
##                 workclass Self-emp-not-inc <= 0:
##                 :...hrs.per.week <= 34: <=50K (606.8/158.9)
##                     hrs.per.week > 34:
##                     :...education.num <= 9:
##                         :...education HS-grad <= 0: <=50K (321.9/10.5)
##                         :   education HS-grad > 0:
##                         :   :...occupation Tech-support > 0: >50K (83.8/19.5)
##                         :       occupation Tech-support <= 0:
##                         :       :...age <= 44:
##                         :           :...hrs.per.week <= 41:
##                         :           :   :...relationship Wife <= 0: <=50K (1109.9/161.6)
##                         :           :   :   relationship Wife > 0: >50K (203.6/78.6)
##                         :           :   hrs.per.week > 41: [S2]
##                         :           age > 44: [S3]
##                         education.num > 9:
##                         :...workclass State-gov > 0: <=50K (216.8/91.2)
##                             workclass State-gov <= 0:
```

```
##                             :...occupation Protective-serv > 0: >50K (308.5/54.1)
##                                 occupation Protective-serv <= 0:
##                                 :...hrs.per.week > 70: >50K (47.9)
##                                     hrs.per.week <= 70: [S4]
##
## SubTree [S2]
##
## occupation Exec-managerial <= 0: <=50K (938.6/397.4)
## occupation Exec-managerial > 0: >50K (186.1/56.3)
##
## SubTree [S3]
##
## occupation Exec-managerial > 0: >50K (286.4/45.8)
## occupation Exec-managerial <= 0:
## :...age > 60: <=50K (216.8/40.4)
##     age <= 60:
##     :...workclass State-gov > 0: <=50K (95.3/25.8)
##         workclass State-gov <= 0:
##         :...occupation Prof-specialty > 0: >50K (39.9/6.1)
##             occupation Prof-specialty <= 0:
##             :...workclass Federal-gov > 0: >50K (111.5/27.9)
##                 workclass Federal-gov <= 0:
##                 :...race White <= 0: <=50K (198.9/65.2)
##                     race White > 0:
##                     :...hrs.per.week > 44: >50K (908.9/312.3)
##                         hrs.per.week <= 44:
##                         :...hrs.per.week <= 39: <=50K (60.4/10.2)
##                             hrs.per.week > 39:
##                             :...occupation Sales > 0: <=50K (232.6/79.3)
##                                 occupation Sales <= 0:
##                                 :...workclass Local-gov <= 0: >50K (1394.6/619.9)
##                                     workclass Local-gov > 0: <=50K (97.6/31.8)
##
## SubTree [S4]
##
## occupation Exec-managerial > 0: >50K (811/176.6)
## occupation Exec-managerial <= 0:
## :...age <= 36: <=50K (609/228.1)
##     age > 36:
##     :...occupation Tech-support > 0: >50K (144.5/23.6)
##         occupation Tech-support <= 0:
##         :...occupation Prof-specialty > 0: >50K (251.9/52.8)
##             occupation Prof-specialty <= 0:
##             :...hrs.per.week > 57: >50K (199.3/34.5)
##                 hrs.per.week <= 57:
##                 :...hrs.per.week > 53: <=50K (157.7/58.5)
##                     hrs.per.week <= 53:
##                     :...hrs.per.week > 47: >50K (392.9/106.9)
##                         hrs.per.week <= 47:
##                         :...age > 61: <=50K (77.9/24.5)
##                             age <= 61:
##                             :...workclass Federal-gov > 0: >50K (101.9/26.4)
##                                 workclass Federal-gov <= 0:
##                                 :...occupation Sales > 0: >50K (397.3/117.1)
```

```
##                                       occupation Sales <= 0:
##                                       :...age > 48: >50K (678.3/220)
##                                           age <= 48:
##                                           :...relationship Wife > 0: >50K (76.2/13.1)
##                                               relationship Wife <= 0: [S5]
##
## SubTree [S5]
##
## workclass Local-gov <= 0: <=50K (952.9/433.6)
## workclass Local-gov > 0: >50K (90.5/22.9)
##
##
## Evaluation on training data (30162 cases):
##
## Trial        Decision Tree
## -----      ----------------
##    Size      Errors
##
##    0     48 4789(15.9%)
##    1     36 5886(19.5%)
##    2     40 6629(22.0%)
##    3     32 6408(21.2%)
##    4     34 7424(24.6%)
##    5     37 6372(21.1%)
##    6     38 6963(23.1%)
##    7     32 7152(23.7%)
##    8     26 8331(27.6%)
##    9     30 6793(22.5%)
##   10     27 7011(23.2%)
##   11     41 7712(25.6%)
##   12     35 7707(25.6%)
##   13     40 6690(22.2%)
##   14     36 6272(20.8%)
##   15     32 6158(20.4%)
##   16     39 5364(17.8%)
##   17     43 5249(17.4%)
##   18     39 5023(16.7%)
##   19     55 4915(16.3%)
## boost           4646(15.4%)   <<
##
##
##     (a)   (b)    <-classified as
##    ----  ----
##   20981  1673    (a): class <=50K
##    2973  4535    (b): class >50K
##
##
##  Attribute usage:
##
##  100.00% age
##  100.00% education.num
##  100.00% marStat Married-civ-spouse
##  100.00% occupation Other-service
##  100.00% occupation Priv-house-serv
```

```
##  100.00% relationship Own-child
##  100.00% relationship Unmarried
##   99.65% education Doctorate
##   99.57% education Prof-school
##   98.98% relationship Other-relative
##   98.53% marStat Married-AF-spouse
##   97.65% education Masters
##   95.66% occupation Handlers-cleaners
##   86.72% race Other
##   80.50% hrs.per.week
##   79.68% education 5th-6th
##   79.58% occupation Farming-fishing
##   78.74% occupation Machine-op-inspct
##   77.27% education 1st-4th
##   75.82% relationship Not-in-family
##   73.95% marStat Never-married
##   71.77% marStat Widowed
##   70.86% occupation Adm-clerical
##   70.84% sex Male
##   69.36% education 9th
##   62.01% workclass Self-emp-not-inc
##   61.94% workclass Self-emp-inc
##   60.29% occupation Exec-managerial
##   58.31% education Bachelors
##   57.61% occupation Protective-serv
##   56.66% workclass State-gov
##   56.22% occupation Transport-moving
##   55.26% occupation Tech-support
##   55.04% education 11th
##   53.49% occupation Prof-specialty
##   52.09% occupation Craft-repair
##   51.00% education 7th-8th
##   50.49% race Black
##   49.86% workclass Federal-gov
##   47.95% relationship Wife
##   45.53% workclass Local-gov
##   44.95% race Asian-Pac-Islander
##   43.54% race White
##   42.40% occupation Sales
##   38.44% education HS-grad
##   37.09% education Assoc-voc
##   35.87% education 12th
##   34.38% education Assoc-acdm
##   27.17% education Some-college
##   11.39% workclass Private
##    8.50% marStat Married-spouse-absent
##    5.89% marStat Separated
##
##
## Time: 14.1 secs
```

In this model we can see the five attributes used the most were: age workclass education occupation marital status

```
   (a)   (b)    <-classified as
  ----  ----
 20981  1673    (a): class <=50K
  2973  4535    (b): class >50K
```

We see from the table above that, as expcected, the model predicts that an individual belongs to class a (earning less than 50K) significantly more than class b(earning more than 50K).

The Shiny App can be found at the link below, where you can provide inputs for an in individual and determine if they are likely to earn less than or more than 50K: https://www.shinyapps.io/admin/#/application/722712

The shiny app was exported to shiny.io by saving the model object in a file and read on the server side of the app.