Neural_Network_bank_note

Nabil Momin

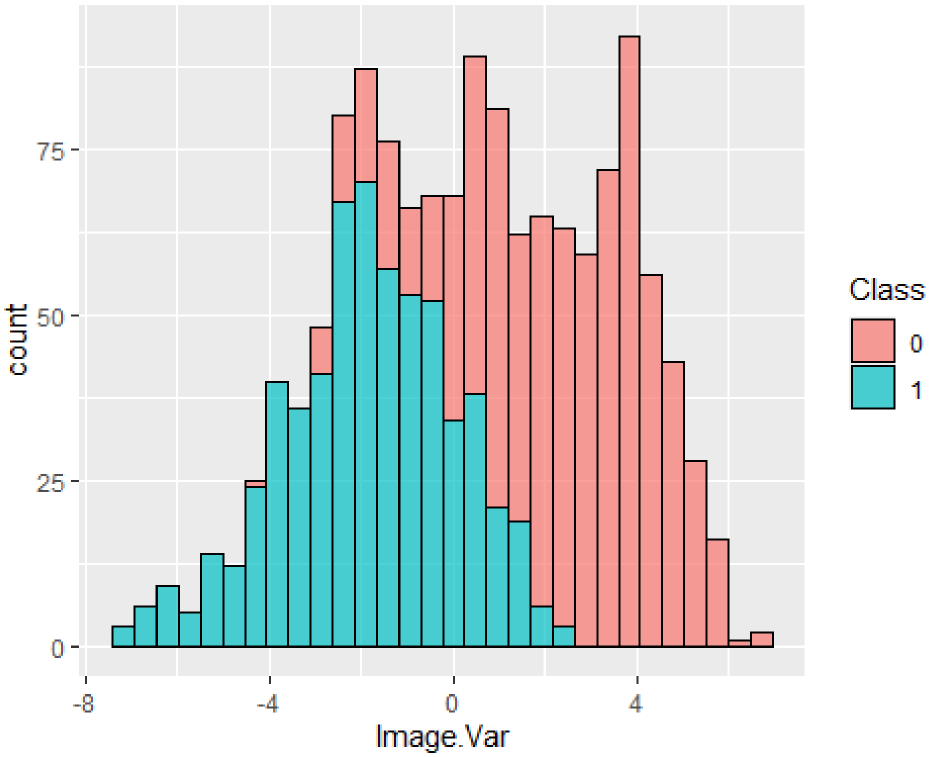
2024-06-12

```
library(corrgram)
library(corrplot)

## corrplot 0.92 loaded

library(caTools)
library(Amelia)

## Loading required package: Rcpp

## ##
## ## Amelia II: Multiple Imputation
## ## (Version 1.8.2, built: 2024-04-10)
## ## Copyright (C) 2005-2024 James Honaker, Gary King and Matthew Blackwell
## ## Refer to http://gking.harvard.edu/amelia/ for more information
## ##

library(ggplot2)
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(rpart)
library(rpart.plot)
library(randomForest)

## randomForest 4.7-1.1

## Type rfNews() to see new features/changes/bug fixes.

##
## Attaching package: 'randomForest'
```

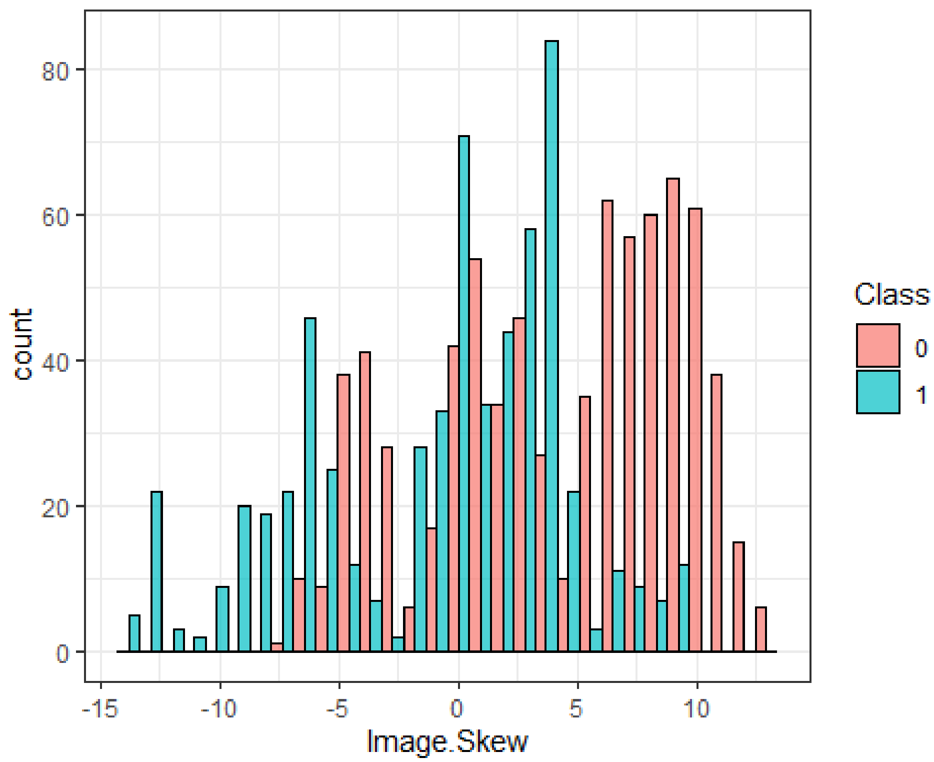
```
## The following object is masked from 'package:dplyr':
##
##     combine

## The following object is masked from 'package:ggplot2':
##
##     margin

library(ISLR)
library(e1071)
library(cluster)
library(tm)

## Loading required package: NLP

##
## Attaching package: 'NLP'

## The following object is masked from 'package:ggplot2':
##
##     annotate

library(twitteR)

##
## Attaching package: 'twitteR'

## The following objects are masked from 'package:dplyr':
##
##     id, location

library(wordcloud)

## Loading required package: RColorBrewer

library(RColorBrewer)
library(neuralnet)

##
## Attaching package: 'neuralnet'

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

#### getting the data

df <- read.csv('bank_note_data.csv')

head(df)

##   Image.Var Image.Skew Image.Curt  Entropy Class
## 1   3.62160     8.6661    -2.8073 -0.44699     0
```

```
## 2   4.54590     8.1674    -2.4586 -1.46210     0
## 3   3.86600    -2.6383     1.9242  0.10645     0
## 4   3.45660     9.5228    -4.0112 -3.59440     0
## 5   0.32924    -4.4552     4.5718 -0.98880     0
## 6   4.36840     9.6718    -3.9606 -3.16250     0

View(df)

#### normalize the data

var(df[,3])

## [1] 18.57636

var(df[,4])

## [1] 4.414256

standard.df <- scale(df[1:4])

var(standard.df[,3])

## [1] 1

var(standard.df[,4])

## [1] 1

#### adding the last column back in

new.df <- cbind(standard.df,df[5])

View(new.df)

#### train and test

sample <- sample.split(new.df,SplitRatio = 0.7)

train <- subset(new.df,sample == TRUE)
test <- subset(new.df, sample == FALSE)

#### making model

model <- neuralnet(Class ~ Image.Var + Image.Skew + Image.Curt +
Entropy,train, hidden=c(5,3),
                   linear.output = FALSE)

predict.model <- compute(model,test[1:4])

head(predict.model$net.result)
```

```
##             [,1]
## 2  0.0007897753
## 3  0.0008783631
## 7  0.0007901702
## 8  0.0008577052
## 12 0.0008442159
## 13 0.0007891577

#### rounding to 0 and 1

prediction <- sapply(predict.model$net.result,round)

head(prediction)

## [1] 0 0 0 0 0 0

table(prediction)

## prediction
##   0   1
## 305 244

#### confusion matrix

table(prediction,test$Class)

##
## prediction   0   1
##          0 305   0
##          1   0 244

#### seems too good to be true as its coming out almost without any error or
false positives or false negatives
#### quickly using the random forest to check the accuracy of the neural
network result

df <- read.csv('bank_note_data.csv')

df$Class <- factor(df$Class)

#### EDA time

ggplot(df,aes(Image.Var)) + geom_histogram(aes(fill =
Class),color='black',alpha=0.7)

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
#### we see from the data plotted above that the image variance really
matters to confirm the bank note is real or not, which honestly is not a
surprise

ggplot(df,aes(Image.Skew)) + geom_histogram(aes(fill =
Class),color='black',alpha=0.7,position = 'dodge') + theme_bw()

## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```r
ggplot(df,aes(Image.Var,Image.Skew)) + geom_point(aes(color=Class)) +
theme_bw()
```

```r
#### the scatter plot clearly shows the higher the variance or skew the higher is the probability of the bill being fake


str(df)

## 'data.frame':    1372 obs. of  5 variables:
##  $ Image.Var : num  3.622 4.546 3.866 3.457 0.329 ...
##  $ Image.Skew: num  8.67 8.17 -2.64 9.52 -4.46 ...
##  $ Image.Curt: num  -2.81 -2.46 1.92 -4.01 4.57 ...
##  $ Entropy   : num  -0.447 -1.462 0.106 -3.594 -0.989 ...
##  $ Class     : Factor w/ 2 levels "0","1": 1 1 1 1 1 1 1 1 1 1 ...

sample <- sample.split(df$Class,SplitRatio = 0.7)

train <- subset(df,sample == TRUE)
test <- subset(df,sample == FALSE)

model <- randomForest(Class ~.,train)

table(model$predicted)

## 
##   0   1 
## 531 429

predict.model <- predict(model,test[1:4])

table(predict.model,test$Class)

##              
## predict.model   0   1
##             0 225   1
##             1   4 182

table.predict <- cbind(predict.model,test[5])

print(table.predict)

##      predict.model Class
## 1                0     0
## 2                0     0
## 6                0     0
## 8                0     0
## 10               0     0
## 14               0     0
## 15               0     0
## 21               0     0
## 22               0     0
## 24               0     0
## 26               0     0
```

```
## 28                0      0
## 31                1      0
## 35                0      0
## 39                0      0
## 41                0      0
## 43                0      0
## 63                0      0
## 67                0      0
## 73                0      0
## 74                0      0
## 81                0      0
## 82                0      0
## 85                0      0
## 88                0      0
## 100               0      0
## 102               0      0
## 108               0      0
## 112               0      0
## 114               0      0
## 125               0      0
## 132               0      0
## 134               0      0
## 136               0      0
## 147               0      0
## 152               0      0
## 162               0      0
## 165               0      0
## 166               0      0
## 174               0      0
## 179               0      0
## 192               0      0
## 194               0      0
## 197               0      0
## 204               0      0
## 208               0      0
## 213               0      0
## 230               0      0
## 233               0      0
## 235               0      0
## 237               0      0
## 238               0      0
## 241               0      0
## 243               0      0
## 250               0      0
## 255               0      0
## 256               0      0
## 257               0      0
## 259               0      0
## 264               0      0
## 266               0      0
```

```
## 269                0      0
## 270                0      0
## 271                0      0
## 274                0      0
## 276                0      0
## 279                0      0
## 284                0      0
## 286                0      0
## 291                0      0
## 293                0      0
## 295                0      0
## 298                0      0
## 303                0      0
## 309                0      0
## 311                0      0
## 313                0      0
## 317                0      0
## 320                0      0
## 322                0      0
## 325                0      0
## 328                0      0
## 331                0      0
## 334                0      0
## 336                0      0
## 342                0      0
## 343                0      0
## 346                0      0
## 350                1      0
## 352                0      0
## 354                0      0
## 355                0      0
## 356                0      0
## 363                0      0
## 364                0      0
## 367                0      0
## 368                0      0
## 371                0      0
## 381                0      0
## 388                0      0
## 389                0      0
## 390                0      0
## 392                0      0
## 393                0      0
## 395                0      0
## 397                0      0
## 399                0      0
## 402                0      0
## 403                0      0
## 407                0      0
## 411                0      0
```

```
## 412                0      0
## 416                0      0
## 418                0      0
## 419                0      0
## 420                0      0
## 426                0      0
## 427                0      0
## 431                0      0
## 432                0      0
## 437                0      0
## 439                0      0
## 440                0      0
## 449                0      0
## 452                0      0
## 454                0      0
## 459                0      0
## 460                0      0
## 462                0      0
## 466                0      0
## 467                0      0
## 468                0      0
## 469                0      0
## 471                0      0
## 478                0      0
## 491                0      0
## 493                0      0
## 500                0      0
## 503                0      0
## 507                0      0
## 511                0      0
## 516                0      0
## 517                0      0
## 518                0      0
## 520                0      0
## 523                0      0
## 524                0      0
## 533                0      0
## 538                0      0
## 542                0      0
## 543                0      0
## 546                0      0
## 548                0      0
## 549                0      0
## 550                0      0
## 553                0      0
## 555                0      0
## 556                0      0
## 558                0      0
## 560                0      0
## 562                0      0
```

```
## 570                 0      0
## 572                 0      0
## 573                 0      0
## 574                 0      0
## 576                 0      0
## 577                 0      0
## 582                 0      0
## 583                 0      0
## 584                 0      0
## 591                 0      0
## 593                 0      0
## 594                 1      0
## 599                 0      0
## 602                 0      0
## 614                 0      0
## 621                 0      0
## 622                 0      0
## 624                 0      0
## 626                 0      0
## 627                 0      0
## 638                 0      0
## 643                 0      0
## 645                 0      0
## 648                 0      0
## 651                 0      0
## 653                 0      0
## 656                 0      0
## 657                 0      0
## 658                 0      0
## 665                 0      0
## 666                 0      0
## 670                 0      0
## 672                 0      0
## 675                 0      0
## 676                 0      0
## 679                 0      0
## 680                 0      0
## 681                 0      0
## 682                 0      0
## 687                 0      0
## 692                 0      0
## 693                 0      0
## 694                 0      0
## 695                 0      0
## 696                 0      0
## 699                 0      0
## 700                 0      0
## 702                 0      0
## 710                 0      0
## 711                 0      0
```

```
## 718              0    0
## 720              0    0
## 722              0    0
## 726              0    0
## 727              0    0
## 728              0    0
## 730              1    0
## 732              0    0
## 734              0    0
## 735              0    0
## 736              0    0
## 737              0    0
## 738              0    0
## 740              0    0
## 743              0    0
## 745              0    0
## 746              0    0
## 759              0    0
## 770              1    1
## 772              1    1
## 773              1    1
## 779              1    1
## 784              1    1
## 785              1    1
## 795              1    1
## 797              1    1
## 798              1    1
## 799              1    1
## 807              1    1
## 810              1    1
## 811              1    1
## 813              1    1
## 816              1    1
## 823              1    1
## 827              1    1
## 828              1    1
## 831              1    1
## 834              1    1
## 839              1    1
## 840              1    1
## 841              1    1
## 844              1    1
## 848              1    1
## 849              1    1
## 852              1    1
## 856              1    1
## 864              1    1
## 866              1    1
## 867              1    1
## 868              1    1
```

```
## 870                 1      1
## 875                 1      1
## 876                 1      1
## 878                 1      1
## 879                 1      1
## 882                 1      1
## 893                 1      1
## 895                 1      1
## 897                 1      1
## 905                 1      1
## 908                 1      1
## 909                 1      1
## 914                 1      1
## 915                 1      1
## 916                 1      1
## 919                 1      1
## 922                 1      1
## 924                 1      1
## 925                 1      1
## 929                 1      1
## 935                 1      1
## 948                 1      1
## 952                 1      1
## 953                 1      1
## 955                 1      1
## 958                 1      1
## 963                 1      1
## 964                 1      1
## 967                 1      1
## 974                 1      1
## 975                 1      1
## 978                 1      1
## 981                 0      1
## 989                 1      1
## 997                 1      1
## 998                 1      1
## 999                 1      1
## 1001                1      1
## 1002                1      1
## 1003                1      1
## 1007                1      1
## 1008                1      1
## 1022                1      1
## 1023                1      1
## 1027                1      1
## 1030                1      1
## 1031                1      1
## 1037                1      1
## 1038                1      1
## 1044                1      1
```

```
## 1048                 1      1
## 1052                 1      1
## 1056                 1      1
## 1060                 1      1
## 1065                 1      1
## 1070                 1      1
## 1071                 1      1
## 1073                 1      1
## 1075                 1      1
## 1083                 1      1
## 1085                 1      1
## 1087                 1      1
## 1090                 1      1
## 1098                 1      1
## 1100                 1      1
## 1103                 1      1
## 1111                 1      1
## 1113                 1      1
## 1118                 1      1
## 1119                 1      1
## 1120                 1      1
## 1121                 1      1
## 1123                 1      1
## 1127                 1      1
## 1128                 1      1
## 1129                 1      1
## 1130                 1      1
## 1133                 1      1
## 1138                 1      1
## 1139                 1      1
## 1145                 1      1
## 1147                 1      1
## 1154                 1      1
## 1160                 1      1
## 1161                 1      1
## 1162                 1      1
## 1168                 1      1
## 1169                 1      1
## 1171                 1      1
## 1172                 1      1
## 1175                 1      1
## 1176                 1      1
## 1179                 1      1
## 1181                 1      1
## 1186                 1      1
## 1190                 1      1
## 1192                 1      1
## 1195                 1      1
## 1196                 1      1
## 1199                 1      1
```

```
## 1201                 1       1
## 1207                 1       1
## 1208                 1       1
## 1209                 1       1
## 1211                 1       1
## 1221                 1       1
## 1225                 1       1
## 1227                 1       1
## 1228                 1       1
## 1232                 1       1
## 1240                 1       1
## 1241                 1       1
## 1242                 1       1
## 1243                 1       1
## 1244                 1       1
## 1246                 1       1
## 1250                 1       1
## 1256                 1       1
## 1266                 1       1
## 1271                 1       1
## 1274                 1       1
## 1278                 1       1
## 1283                 1       1
## 1285                 1       1
## 1286                 1       1
## 1289                 1       1
## 1293                 1       1
## 1294                 1       1
## 1297                 1       1
## 1300                 1       1
## 1305                 1       1
## 1307                 1       1
## 1312                 1       1
## 1314                 1       1
## 1318                 1       1
## 1320                 1       1
## 1323                 1       1
## 1326                 1       1
## 1328                 1       1
## 1334                 1       1
## 1336                 1       1
## 1344                 1       1
## 1349                 1       1
## 1351                 1       1
## 1358                 1       1
## 1359                 1       1
## 1363                 1       1
## 1364                 1       1
## 1367                 1       1
```

```
## 1369              1      1
## 1372              1      1

#### even the random forest is pretty accurate in this case
```