title: "Estadística Aplicada II- Taller # 1"
author: "David Rojas y Felipe Palomino"
date: "31/03/2023"
output:
html_document: default

Tarea 1

A) Describa las variables e individuos del subgrupo asignado en la base Yarn. Realice el gráfico de dispersión entre las variables y=densidad y la variable x=NIR_j que presentan la mayor correlación.\ **Estadísticas descriptivas:** Para el cálculo de estas estadística realizamos una función que agrupaba diferentes descriptivas en una sola tabla, añadiendo a su vez, histogramas, junto con las correlaciones lineales de pearson entre las covariables.

```
#Importamos la base de datos
###############################
options(scipen=999) # Realizamos este cambio en options para trabajar sin notación científica
#
library(easypackages) #Librería para la carga de base de datos
lib_req<-c('psych','car','lmtest','MASS','xtable','latex2exp',
           'orcutt','nlme',
           'mixtools',"alr4","depth","readr",
           "ddalpha","robustbase","rrcov","zoom",
           'ggfortify','readxl')# Listado de librerias requeridas por el script
easypackages::packages(lib_req)
data <- read_excel("C:/Users/sebas/OneDrive/Escritorio/Octavo Semestre/OctavoSemestre/Estadística Aplica
#Función creada para las estadística descriptivas
resumen<- function(x){
  X<- matrix(0,7,1)
  resumen<- round(c(mean(x),median(x),min(x),max(x)
                  ,sd(x),quantile(x,0.25),
                    quantile(x,0.75)),4)
  for( i  in 1:7){
    X[i,]<- resumen[i]
  }
  rownames(X)<-c('Media','Mediana','Min','Max','Sd','1st Qu.','3rd Qu')
  colnames(X)<- (paste(colnames(x)))
  return(X)
}
X<- data
################ Selección de las variables dadas por el docente
X<- cbind(X[,1:30],X[,colnames(X)=='density'])
# EstadC-stica descriptivas
summary<- matrix(0,31,7)
for(i in 1:31){
  summary[i,]<- t(resumen(X[,i]))
}
rownames(summary)<-colnames(X)
colnames(summary)<-c('Media','Mediana','Min','Max','Sd','1st Qu.','3rd Qu')
print(summary)
```

```
##           Media Mediana    Min      Max      Sd 1st Qu.  3rd Qu
```

```
## NIR1      3.0915  3.0970 2.8733   3.1948  0.0579  3.0749  3.1238
## NIR2      3.0674  3.0874 2.6803   3.1762  0.0996  3.0709  3.1151
## NIR3      3.0056  3.0526 2.4531   3.1329  0.1541  2.9842  3.1014
## NIR4      2.9009  2.9707 2.2380   3.0996  0.2051  2.8474  3.0260
## NIR5      2.7564  2.8309 2.0406   3.0249  0.2411  2.6713  2.8987
## NIR6      2.5992  2.6676 1.8602   2.9345  0.2649  2.4897  2.7686
## NIR7      2.4557  2.4997 1.7071   2.8884  0.2840  2.2896  2.6405
## NIR8      2.3365  2.3747 1.5946   2.8716  0.3019  2.1641  2.5185
## NIR9      2.2482  2.2618 1.5207   2.8850  0.3244  2.0728  2.4643
## NIR10     2.1909  2.1788 1.4652   2.9260  0.3578  1.9656  2.4368
## NIR11     2.1574  2.1368 1.4177   2.9908  0.4021  1.8764  2.4382
## NIR12     2.1426  2.1382 1.3805   3.0716  0.4522  1.8550  2.4615
## NIR13     2.1445  2.1408 1.3522   3.1508  0.5000  1.8555  2.5006
## NIR14     2.1597  2.1597 1.3305   3.2129  0.5397  1.8664  2.5519
## NIR15     2.1778  2.1854 1.3147   3.2603  0.5751  1.8816  2.6067
## NIR16     2.1811  2.1945 1.3045   3.2946  0.6116  1.8902  2.6454
## NIR17     2.1670  2.1808 1.2206   3.3168  0.6437  1.8436  2.6576
## NIR18     2.1424  2.1525 1.1410   3.3254  0.6584  1.7923  2.6396
## NIR19     2.1042  2.1044 1.1161   3.3066  0.6499  1.7518  2.5851
## NIR20     2.0450  2.0324 1.1329   3.2575  0.6194  1.7158  2.4873
## NIR21     1.9613  1.9386 1.1604   3.1723  0.5725  1.6660  2.3504
## NIR22     1.8536  1.8243 1.1638   3.0267  0.5166  1.5873  2.1876
## NIR23     1.7424  1.7112 1.1527   2.8334  0.4590  1.5025  2.0294
## NIR24     1.6474  1.6189 1.1228   2.6243  0.4012  1.4293  1.8937
## NIR25     1.5621  1.5368 1.1170   2.4256  0.3488  1.3780  1.7713
## NIR26     1.4846  1.4568 1.0681   2.2585  0.3105  1.3052  1.6629
## NIR27     1.4115  1.3705 1.0197   2.0801  0.2709  1.2327  1.5629
## NIR28     1.3242  1.2939 1.0084   1.8021  0.2009  1.1805  1.4481
## NIR29     1.2470  1.2267 1.0321   1.5330  0.1246  1.1558  1.3263
## NIR30     1.2089  1.2107 1.0828   1.3570  0.0681  1.1618  1.2605
## density 33.7507 31.2200 0.0000 100.0000 26.9621 20.2625 50.5000
```

```
#Selección de variables con mayor correlación lineal de pearson positiva o negativa
Y<-cor(X)
Y
```

```
##              NIR1      NIR2      NIR3      NIR4      NIR5      NIR6      NIR7
## NIR1    1.0000000 0.9336895 0.8271767 0.7301449 0.6572028 0.6124462 0.5830712
## NIR2    0.9336895 1.0000000 0.9693335 0.9099968 0.8508457 0.8010142 0.7519698
## NIR3    0.8271767 0.9693335 1.0000000 0.9820789 0.9458777 0.9037250 0.8515718
## NIR4    0.7301449 0.9099968 0.9820789 1.0000000 0.9887406 0.9611587 0.9165710
## NIR5    0.6572028 0.8508457 0.9458777 0.9887406 1.0000000 0.9905637 0.9608255
## NIR6    0.6124462 0.8010142 0.9037250 0.9611587 0.9905637 1.0000000 0.9892109
## NIR7    0.5830712 0.7519698 0.8515718 0.9165710 0.9608255 0.9892109 1.0000000
## NIR8    0.5536266 0.6923002 0.7814142 0.8492555 0.9060586 0.9531898 0.9870466
## NIR9    0.5183440 0.6215203 0.6957228 0.7628037 0.8293193 0.8931549 0.9487814
## NIR10   0.4818226 0.5513759 0.6100258 0.6741144 0.7469263 0.8234082 0.8964127
## NIR11   0.4483129 0.4896387 0.5344758 0.5948422 0.6713283 0.7566188 0.8423596
## NIR12   0.4199655 0.4391514 0.4727853 0.5296054 0.6080726 0.6992464 0.7939335
## NIR13   0.4010473 0.4054690 0.4312663 0.4852606 0.5644827 0.6589761 0.7590249
## NIR14   0.3925363 0.3884835 0.4093346 0.4612862 0.5404651 0.6363572 0.7389590
## NIR15   0.3873480 0.3762532 0.3928280 0.4429367 0.5218057 0.6184970 0.7228074
## NIR16   0.3761710 0.3548226 0.3656174 0.4133665 0.4920934 0.5902466 0.6973332
## NIR17   0.3596791 0.3275539 0.3326881 0.3782791 0.4572318 0.5573164 0.6677180
```

```
## NIR18   0.3461650 0.3078184 0.3100466 0.3546778 0.4341444 0.5357743 0.6485356
## NIR19   0.3400799 0.3020373 0.3050270 0.3501902 0.4303625 0.5327944 0.6463730
## NIR20   0.3410749 0.3090182 0.3160315 0.3630843 0.4441077 0.5466024 0.6595164
## NIR21   0.3439597 0.3197370 0.3320471 0.3815991 0.4635423 0.5657491 0.6773308
## NIR22   0.3440910 0.3253035 0.3416262 0.3931224 0.4758039 0.5778209 0.6884346
## NIR23   0.3459385 0.3313372 0.3505305 0.4032622 0.4861992 0.5877518 0.6973042
## NIR24   0.3510587 0.3405570 0.3621578 0.4157554 0.4985584 0.5992798 0.7074424
## NIR25   0.3436977 0.3283934 0.3477717 0.4004731 0.4833460 0.5848835 0.6945066
## NIR26   0.3145695 0.2810532 0.2912324 0.3402646 0.4233666 0.5280349 0.6432486
## NIR27   0.2830656 0.2286796 0.2277408 0.2718394 0.3542954 0.4615599 0.5821727
## NIR28   0.2756032 0.2043712 0.1932093 0.2321299 0.3127154 0.4206469 0.5440124
## NIR29   0.2999990 0.2177514 0.1983865 0.2321527 0.3095349 0.4158645 0.5387129
## NIR30   0.3714598 0.2850437 0.2589771 0.2861393 0.3566092 0.4562573 0.5722615
## density 0.1878568 0.4241582 0.5316576 0.5498071 0.5003448 0.4038553 0.2727738
##              NIR8        NIR9      NIR10      NIR11      NIR12      NIR13
## NIR1    0.5536266  0.51834397  0.4818226  0.4483129  0.4199655  0.4010473
## NIR2    0.6923002  0.62152032  0.5513759  0.4896387  0.4391514  0.4054690
## NIR3    0.7814142  0.69572281  0.6100258  0.5344758  0.4727853  0.4312663
## NIR4    0.8492555  0.76280366  0.6741144  0.5948422  0.5296054  0.4852606
## NIR5    0.9060586  0.82931931  0.7469263  0.6713283  0.6080726  0.5644827
## NIR6    0.9531898  0.89315495  0.8234082  0.7566188  0.6992464  0.6589761
## NIR7    0.9870466  0.94878142  0.8964127  0.8423596  0.7939335  0.7590249
## NIR8    1.0000000  0.98713529  0.9557311  0.9175188  0.8805464  0.8527056
## NIR9    0.9871353  1.00000000  0.9904562  0.9691859  0.9447449  0.9248131
## NIR10   0.9557311  0.99045620  1.0000000  0.9938726  0.9808455  0.9682603
## NIR11   0.9175188  0.96918590  0.9938726  1.0000000  0.9963570  0.9899071
## NIR12   0.8805464  0.94474490  0.9808455  0.9963570  1.0000000  0.9983755
## NIR13   0.8527056  0.92481309  0.9682603  0.9899071  0.9983755  1.0000000
## NIR14   0.8361650  0.91235698  0.9597288  0.9847405  0.9959038  0.9994047
## NIR15   0.8224986  0.90167258  0.9520010  0.9796082  0.9928833  0.9978951
## NIR16   0.8009401  0.88472235  0.9395226  0.9709866  0.9873631  0.9945348
## NIR17   0.7758719  0.86491700  0.9247311  0.9604525  0.9802145  0.9896843
## NIR18   0.7597931  0.85232280  0.9153558  0.9537405  0.9755731  0.9863840
## NIR19   0.7584664  0.85173304  0.9152681  0.9539401  0.9759032  0.9866842
## NIR20   0.7703085  0.86175057  0.9232564  0.9599981  0.9802860  0.9897646
## NIR21   0.7859119  0.87447416  0.9329010  0.9667835  0.9846443  0.9922761
## NIR22   0.7954223  0.88190706  0.9380699  0.9698176  0.9858552  0.9920620
## NIR23   0.8027411  0.88732979  0.9415312  0.9714922  0.9860381  0.9911129
## NIR24   0.8110114  0.89343969  0.9455346  0.9736665  0.9867415  0.9907661
## NIR25   0.8000995  0.88482071  0.9389898  0.9688117  0.9832154  0.9880713
## NIR26   0.7566077  0.85028458  0.9128439  0.9497065  0.9697139  0.9782751
## NIR27   0.7034483  0.80655809  0.8781779  0.9227921  0.9490625  0.9618386
## NIR28   0.6697986  0.77854146  0.8558108  0.9053990  0.9357116  0.9513006
## NIR29   0.6646371  0.77392103  0.8520421  0.9025319  0.9335353  0.9496696
## NIR30   0.6906429  0.79211151  0.8635626  0.9088222  0.9356994  0.9492173
## density 0.1169328 -0.04258148 -0.1789989 -0.2852590 -0.3642581 -0.4142005
##              NIR14      NIR15      NIR16      NIR17      NIR18      NIR19
## NIR1     0.3925363  0.3873480  0.3761710  0.3596791  0.3461650  0.3400799
## NIR2     0.3884835  0.3762532  0.3548226  0.3275539  0.3078184  0.3020373
## NIR3     0.4093346  0.3928280  0.3656174  0.3326881  0.3100466  0.3050270
## NIR4     0.4612862  0.4429367  0.4133665  0.3782791  0.3546778  0.3501902
## NIR5     0.5404651  0.5218057  0.4920934  0.4572318  0.4341444  0.4303625
## NIR6     0.6363572  0.6184970  0.5902466  0.5573164  0.5357743  0.5327944
## NIR7     0.7389590  0.7228074  0.6973332  0.6677180  0.6485356  0.6463730
```

```
## NIR8     0.8361650  0.8224986  0.8009401  0.7758719  0.7597931  0.7584664
## NIR9     0.9123570  0.9016726  0.8847223  0.8649170  0.8523228  0.8517330
## NIR10    0.9597288  0.9520010  0.9395226  0.9247311  0.9153558  0.9152681
## NIR11    0.9847405  0.9796082  0.9709866  0.9604525  0.9537405  0.9539401
## NIR12    0.9959038  0.9928833  0.9873631  0.9802145  0.9755731  0.9759032
## NIR13    0.9994047  0.9978951  0.9945348  0.9896843  0.9863840  0.9866842
## NIR14    1.0000000  0.9995236  0.9975287  0.9940143  0.9913836  0.9914705
## NIR15    0.9995236  1.0000000  0.9991996  0.9967749  0.9946108  0.9943790
## NIR16    0.9975287  0.9991996  1.0000000  0.9991527  0.9977884  0.9973171
## NIR17    0.9940143  0.9967749  0.9991527  1.0000000  0.9996353  0.9991572
## NIR18    0.9913836  0.9946108  0.9977884  0.9996353  1.0000000  0.9997691
## NIR19    0.9914705  0.9943790  0.9973171  0.9991572  0.9997691  1.0000000
## NIR20    0.9935221  0.9954009  0.9971620  0.9980769  0.9984790  0.9993272
## NIR21    0.9946259  0.9951414  0.9953228  0.9949413  0.9949670  0.9965132
## NIR22    0.9932537  0.9926179  0.9915265  0.9901643  0.9899793  0.9921764
## NIR23    0.9914245  0.9899313  0.9878688  0.9857244  0.9853239  0.9879565
## NIR24    0.9903508  0.9881893  0.9853028  0.9824093  0.9816883  0.9845332
## NIR25    0.9879691  0.9859416  0.9834339  0.9811285  0.9809051  0.9839984
## NIR26    0.9800559  0.9793590  0.9790562  0.9793984  0.9809576  0.9843960
## NIR27    0.9658534  0.9668050  0.9691110  0.9724756  0.9759668  0.9796060
## NIR28    0.9570533  0.9594965  0.9638543  0.9693013  0.9739144  0.9773532
## NIR29    0.9560212  0.9591881  0.9643404  0.9703483  0.9751241  0.9783457
## NIR30    0.9545573  0.9573175  0.9614577  0.9658681  0.9693915  0.9722233
## density -0.4397251 -0.4581160 -0.4869876 -0.5203107 -0.5426243 -0.5476814
##              NIR20      NIR21      NIR22      NIR23      NIR24      NIR25
## NIR1     0.3410749  0.3439597  0.3440910  0.3459385  0.3510587  0.3436977
## NIR2     0.3090182  0.3197370  0.3253035  0.3313372  0.3405570  0.3283934
## NIR3     0.3160315  0.3320471  0.3416262  0.3505305  0.3621578  0.3477717
## NIR4     0.3630843  0.3815991  0.3931224  0.4032622  0.4157554  0.4004731
## NIR5     0.4441077  0.4635423  0.4758039  0.4861992  0.4985584  0.4833460
## NIR6     0.5466024  0.5657491  0.5778209  0.5877518  0.5992798  0.5848835
## NIR7     0.6595164  0.6773308  0.6884346  0.6973042  0.7074424  0.6945066
## NIR8     0.7703085  0.7859119  0.7954223  0.8027411  0.8110114  0.8000995
## NIR9     0.8617506  0.8744742  0.8819071  0.8873298  0.8934397  0.8848207
## NIR10    0.9232564  0.9329010  0.9380699  0.9415312  0.9455346  0.9389898
## NIR11    0.9599981  0.9667835  0.9698176  0.9714922  0.9736665  0.9688117
## NIR12    0.9802860  0.9846443  0.9858552  0.9860381  0.9867415  0.9832154
## NIR13    0.9897646  0.9922761  0.9920620  0.9911129  0.9907661  0.9880713
## NIR14    0.9935221  0.9946259  0.9932537  0.9914245  0.9903508  0.9879691
## NIR15    0.9954009  0.9951414  0.9926179  0.9899313  0.9881893  0.9859416
## NIR16    0.9971620  0.9953228  0.9915265  0.9878688  0.9853028  0.9834339
## NIR17    0.9980769  0.9949413  0.9901643  0.9857244  0.9824093  0.9811285
## NIR18    0.9984790  0.9949670  0.9899793  0.9853239  0.9816883  0.9809051
## NIR19    0.9993272  0.9965132  0.9921764  0.9879565  0.9845332  0.9839984
## NIR20    1.0000000  0.9988818  0.9960165  0.9928490  0.9901351  0.9896236
## NIR21    0.9988818  1.0000000  0.9991045  0.9973551  0.9956141  0.9951094
## NIR22    0.9960165  0.9991045  1.0000000  0.9995340  0.9986436  0.9982936
## NIR23    0.9928490  0.9973551  0.9995340  1.0000000  0.9997500  0.9994820
## NIR24    0.9901351  0.9956141  0.9986436  0.9997500  1.0000000  0.9996982
## NIR25    0.9896236  0.9951094  0.9982936  0.9994820  0.9996982  1.0000000
## NIR26    0.9890493  0.9931388  0.9954969  0.9959718  0.9953623  0.9972806
## NIR27    0.9828767  0.9850472  0.9861607  0.9856268  0.9839932  0.9876707
## NIR28    0.9792025  0.9794294  0.9790209  0.9773451  0.9747451  0.9791121
## NIR29    0.9795766  0.9788852  0.9775838  0.9753068  0.9722601  0.9761831
```

```
## NIR30    0.9737344  0.9733351  0.9719123  0.9697812  0.9671607  0.9694874
## density -0.5366243 -0.5191321 -0.5069834 -0.4958683 -0.4829328 -0.4987156
##              NIR26      NIR27      NIR28      NIR29      NIR30     density
## NIR1     0.3145695  0.2830656  0.2756032  0.2999990  0.3714598  0.18785681
## NIR2     0.2810532  0.2286796  0.2043712  0.2177514  0.2850437  0.42415816
## NIR3     0.2912324  0.2277408  0.1932093  0.1983865  0.2589771  0.53165763
## NIR4     0.3402646  0.2718394  0.2321299  0.2321527  0.2861393  0.54980711
## NIR5     0.4233666  0.3542954  0.3127154  0.3095349  0.3566092  0.50034480
## NIR6     0.5280349  0.4615599  0.4206469  0.4158645  0.4562573  0.40385529
## NIR7     0.6432486  0.5821727  0.5440124  0.5387129  0.5722615  0.27277376
## NIR8     0.7566077  0.7034483  0.6697986  0.6646371  0.6906429  0.11693283
## NIR9     0.8502846  0.8065581  0.7785415  0.7739210  0.7921115 -0.04258148
## NIR10    0.9128439  0.8781779  0.8558108  0.8520421  0.8635626 -0.17899885
## NIR11    0.9497065  0.9227921  0.9053990  0.9025319  0.9088222 -0.28525901
## NIR12    0.9697139  0.9490625  0.9357116  0.9335353  0.9356994 -0.36425811
## NIR13    0.9782751  0.9618386  0.9513006  0.9496696  0.9492173 -0.41420050
## NIR14    0.9800559  0.9658534  0.9570533  0.9560212  0.9545573 -0.43972514
## NIR15    0.9793590  0.9668050  0.9594965  0.9591881  0.9573175 -0.45811600
## NIR16    0.9790562  0.9691110  0.9638543  0.9643404  0.9614577 -0.48698764
## NIR17    0.9793984  0.9724756  0.9693013  0.9703483  0.9658681 -0.52031069
## NIR18    0.9809576  0.9759668  0.9739144  0.9751241  0.9693915 -0.54262433
## NIR19    0.9843960  0.9796060  0.9773532  0.9783457  0.9722233 -0.54768143
## NIR20    0.9890493  0.9828767  0.9792025  0.9795766  0.9737344 -0.53662425
## NIR21    0.9931388  0.9850472  0.9794294  0.9788852  0.9733351 -0.51913210
## NIR22    0.9954969  0.9861607  0.9790209  0.9775838  0.9719123 -0.50698335
## NIR23    0.9959718  0.9856268  0.9773451  0.9753068  0.9697812 -0.49586830
## NIR24    0.9953623  0.9839932  0.9747451  0.9722601  0.9671607 -0.48293275
## NIR25    0.9972806  0.9876707  0.9791121  0.9761831  0.9694874 -0.49871555
## NIR26    1.0000000  0.9965026  0.9911440  0.9876371  0.9759642 -0.55762713
## NIR27    0.9965026  1.0000000  0.9984497  0.9943889  0.9772784 -0.62007626
## NIR28    0.9911440  0.9984497  1.0000000  0.9976484  0.9806208 -0.65693381
## NIR29    0.9876371  0.9943889  0.9976484  1.0000000  0.9909867 -0.66071886
## NIR30    0.9759642  0.9772784  0.9806208  0.9909867  1.0000000 -0.61289059
## density -0.5576271 -0.6200763 -0.6569338 -0.6607189 -0.6128906  1.00000000
```

```r
Y<-Y[,-31]
cor<-c(max(Y[31,]),min(Y[31,]))
which(Y[31,]==cor[1])
```

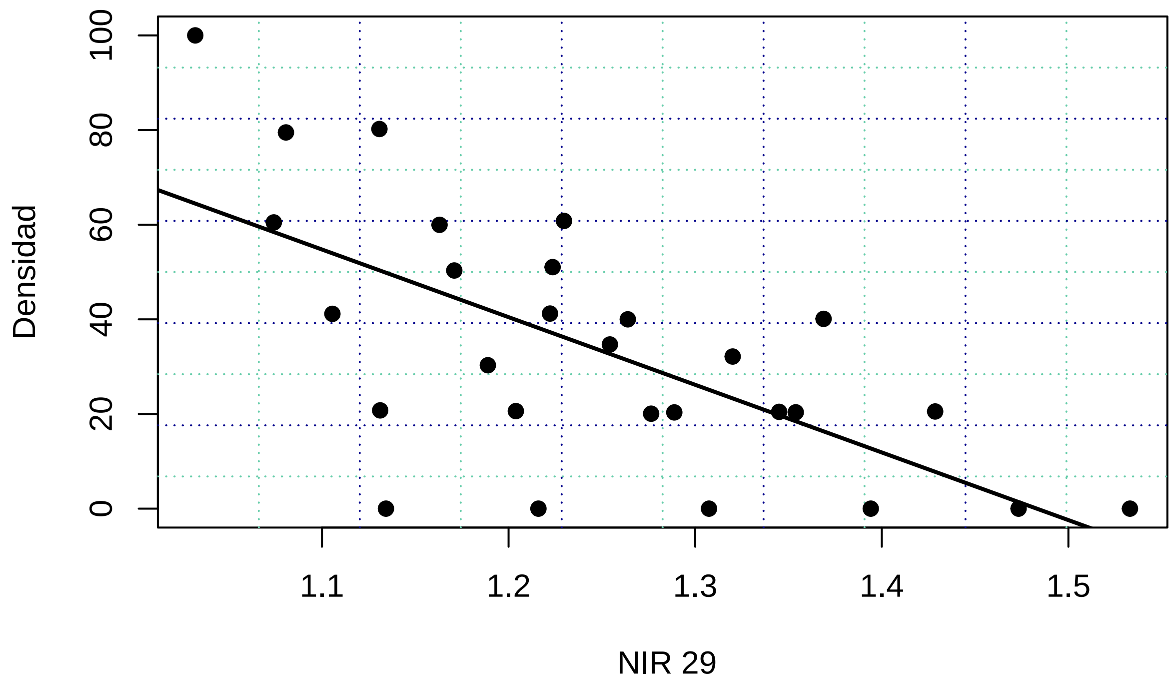
```
## NIR4
##    4
```

```r
which(Y[31,]==cor[2])
```

```
## NIR29
##    29
```

```r
windows(height=10, width=10)
#Creación del panel de fondo
par(mfrow=c(1,1))
plot(seq(min(X[,29]),max(X[,29]),length.out=30),seq(min(X[,31]),max(X[,31]),length.out=30),type='n',xlab
grid(10,10,col=c('aquamarine3','blue4'))
```

```
par(new=T)
plot(X[,31]~X[,29],ylab='Densidad',xlab=' NIR 29',pch=19,axes=F)
model<- lm(density~NIR29,data=X)
abline(model,lwd=2)
```




```
summary(model)
```

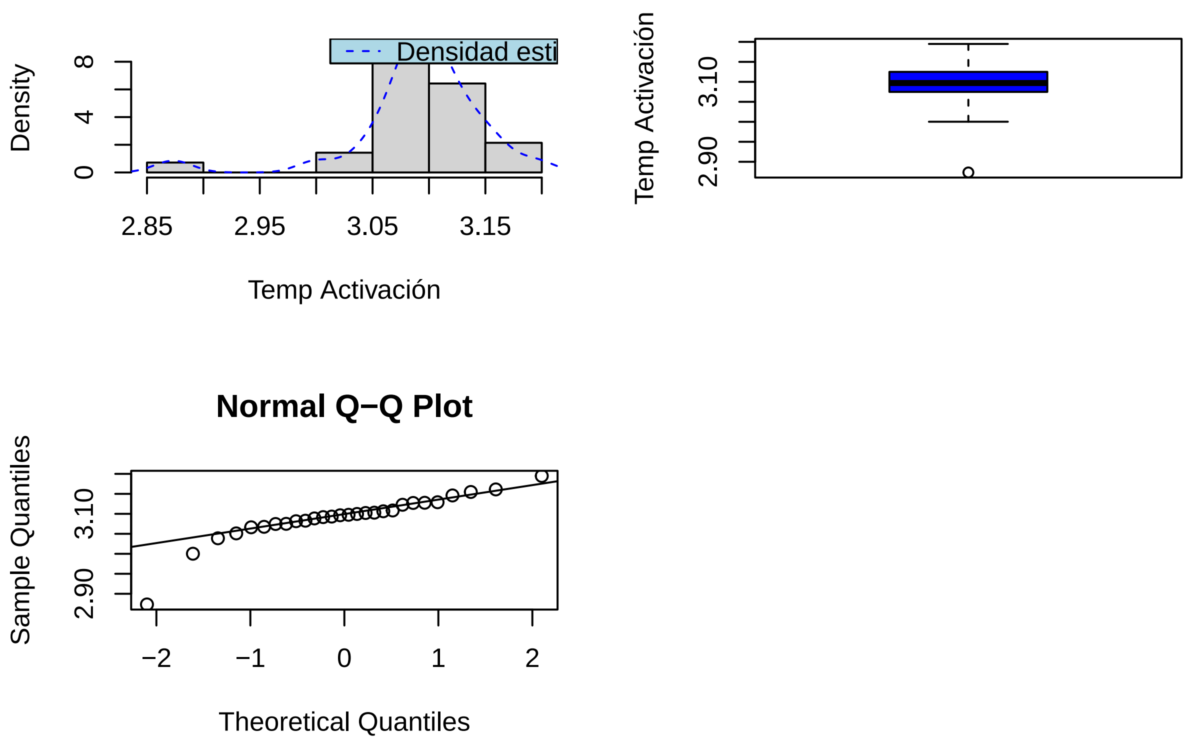
```
##
## Call:
## lm(formula = density ~ NIR29, data = X)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -49.856 -11.991   2.011  13.049  35.533
##
## Coefficients:
##             Estimate Std. Error t value  Pr(>|t|)
## (Intercept)   212.02      39.91   5.312 0.0000148 ***
## NIR29        -142.96      31.85  -4.488   0.00013 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 20.62 on 26 degrees of freedom
## Multiple R-squared:  0.4365, Adjusted R-squared:  0.4149
## F-statistic: 20.14 on 1 and 26 DF,  p-value: 0.0001298
```

$$H_0 : \mu = 130 \qquad vs \qquad H_1 : \mu = 130$$

« echo=TRUE,warning=FALSE, message=FALSE»=

```
windows(height=8, width=10)                # Nueva ventana gráfica, con dimensiones preestablecidas
par(mfrow=c(2,2))                          # particón dela ventana gráfica

hist(X[,1], freq=F,main="",xlab="Temp Activación")
lines(density(X[,1]), col="blue",lty=2)
legend("topright","Densidad estimada",lty=2, col="blue",bg='lightblue')
boxplot(X[,1],col="Blue", ylab="Temp Activación")
qqnorm(X[,1]); qqline(X[,1])
```



@

La forma asimétrica del histograma y del boxplot, ademas de la distancia de los puntos a la linea recta en el *qqplot*, sugieren que los datos no provienen de una distribución *Normal*. Este resultados son corroborados por el *test de Shapiro-Wilk*.

```
# Un Test formal de Normalidad
shapiro.test(X[,1])
```

```
##
##  Shapiro-Wilk normality test
##
## data:  X[, 1]
## W = 0.84011, p-value = 0.0005942
```

Ejercicio 4. Al seleccionar un concreto azufrado para la construcción de carreteras en regiones que experimentan congelamiento intenso, es importante que el concreto tenga baja conductividad térmica, a fin de reducir el da?o posterior debido a temperaturas cambiantes. Se ha pensado que la adición de agregados graduados a las mezcla de concreto puede disminuir su conductividad media. Para ello se ha diseñado un experimento que consiste en generar especímenes de prueba bajo las dos condiciones, (con agregados, sin agregados). Los resultados son lo siguientes:

Con agregados

0.166, 0.296, 0.249, 0.366, 0.415, 0.388, 0.273, 0.324, 0.413, 0.280, 0.247, 0.130, 0.279, 0.364, 0.402, 0.202, 0.255, 0.315, 0.375, 0.316

Sin agregados

0.426, 0.461, 0.476, 0.467, 0.436, 0.509, 0.428, 0.508, 0.457, 0.513, 0.448, 0.523, 0.431, 0.439, 0.395, 0.443, 0.361, 0.480, 0.467, 0.436, 0.471, 0.487, 0.498, 0.538, 0.500

De acuerdo con los datos, incorporar agregados disminuye la conductividad térmica del material?

```
#Ingresando los datos en el formato variable - indicador
rt = c(0.166, 0.296, 0.249, 0.366, 0.415, 0.388, 0.273, 0.324, 0.413, 0.280, 0.247, 0.130,
       0.279, 0.364, 0.402, 0.202, 0.255, 0.315, 0.375, 0.316,
       0.426, 0.461, 0.476, 0.467, 0.436, 0.509, 0.428, 0.508, 0.457, 0.513, 0.448, 0.523,
       0.431, 0.439, 0.395, 0.443, 0.361, 0.480, 0.467, 0.436, 0.471, 0.487, 0.498, 0.538, 0.500)
Ag = factor(c(rep("Con Agregado",20), rep("Sin Agregado",25)))
```

Inicialmente realizaremos un análisis exploratorio, que incluye el calculo de algunos indicadores descriptivos y la representación gráfica de los datos.

```
# Algunas medidas resumen.
promedios = tapply(rt,Ag,mean)
desviacion = tapply(rt,Ag,sd)
C_var = desviacion/promedios
resumen =round(cbind(promedios, desviacion, C_var),2)
colnames(resumen)= c("Promedio","Desviación","Coef.Var")
resumen
```

```
##              Promedio Desviación Coef.Var
## Con Agregado     0.30       0.08     0.27
## Sin Agregado     0.46       0.04     0.09
```

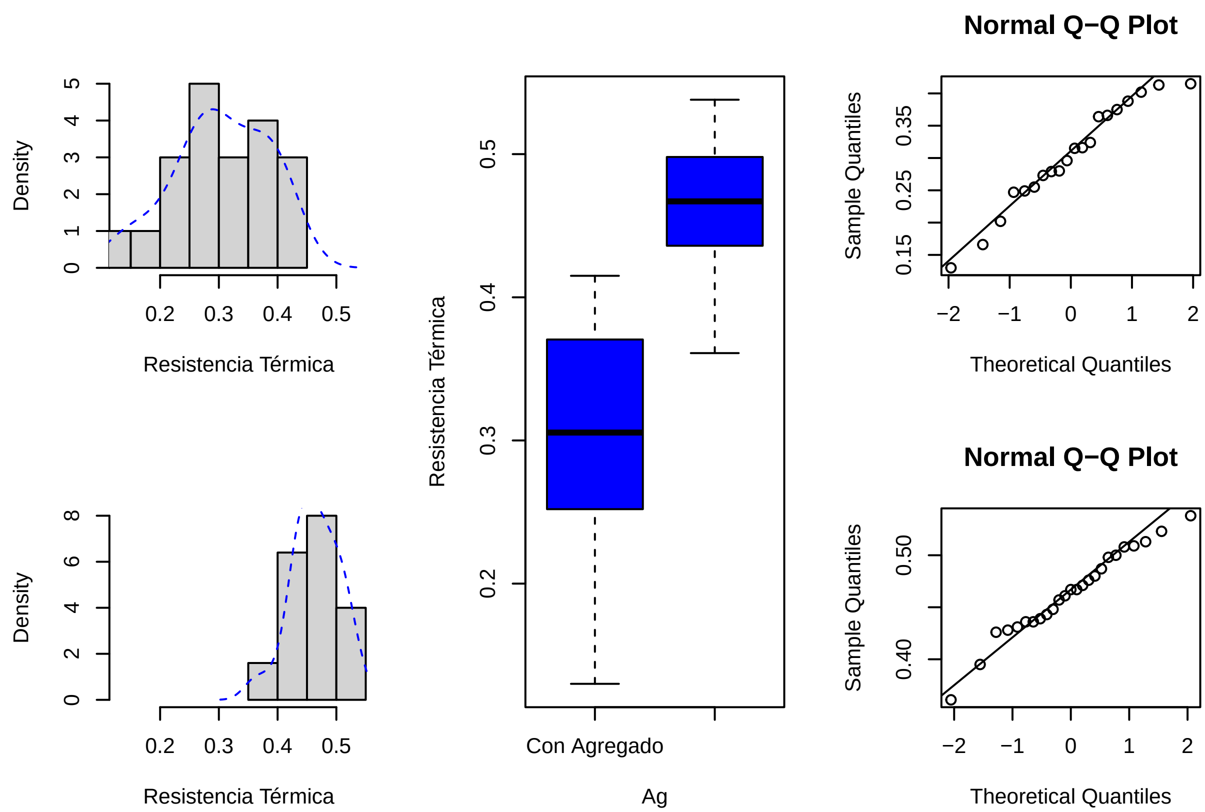
```
#Cambiando los datos al formato de columnas
rt_ca=rt[Ag =="Con Agregado"]                 #resistencia térmica con agregado
rt_sa=rt[Ag =="Sin Agregado"]                 #resistencia térmica sin agregado

#Preparando la ventana gráfica
M = matrix(c(1,2,3,3,4,5),ncol=3,byrow = F)  # matriz con la ubicación de 5 gráficos
windows(height=20, width=15)                  # Nueva ventana gráfica
layout(M)                                     # partición dela ventana gráfica según M

# Histogramas de frecuencia con densidad estimada - igualado el rango en el eje X.

hist(rt_ca, freq=F,main="",xlab="Resistencia Térmica",xlim=range(rt))
lines(density(rt_ca), col="blue",lty=2)
hist(rt_sa, freq=F,main="",xlab="Resistencia Térmica",xlim=range(rt))
lines(density(rt_sa), col="blue",lty=2)
```

```r
boxplot(rt~Ag,col="Blue", ylab="Resistencia Térmica")
qqnorm(rt_ca); qqline(rt_ca)
qqnorm(rt_sa); qqline(rt_sa)
```



Los resultados muestran que la muestra obtenida con la adición de agregados tiene una menor conductividad eléctrica que aquella muestra que no incorporó estos agregados. La representación gráfica también sugiere que la distribución de la variable, en ambos casos, es simétrica y no se aleja mucho de la distribución normal. Lo anterior se corroboró con el test *Shapiro-Wilk* para ambas muestras.

```r
# Un Test de Normalidad
shapiro.test(rt_ca)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  rt_ca
## W = 0.95628, p-value = 0.4724
```

```r
shapiro.test(rt_sa)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  rt_sa
## W = 0.97688, p-value = 0.8171
```

Verificado el supuesto de normalidad para ambas poblaciones, procedemos a desarrollar el test de hipotésis:

$$H_0 : \mu_{CA} = \mu_{SA} \qquad vs \qquad H_1 : \mu_{CA} < \mu_{SA}$$

los resultados del test son los siguientes:

```r
# Un Test de Hipotesis Paramétrico
t.test(rt_ca,rt_sa,alternative = "less")
```

```
##
##  Welch Two Sample t-test
##
## data:  rt_ca and rt_sa
## t = -8.0981, df = 26.806, p-value = 0.000000005608
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf -0.127262
## sample estimates:
## mean of x mean of y
##   0.30275   0.46392
```

De acuerdo con el $valor - p$ si existe una reducción en la conductividad térmica del concreto cuando se adicionan los agregados en la mezcla