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Unit Number and Title	**12: Data Analytics**
Academic Year	2020
Unit Tutor	Eduardo Caro
Assignment Title	**Data Analytics: Descriptive, inference, and predictive techniques**
Issue Date	**January 29th, 2020**
Submission Date	March 27th, 2020
IV Name & Date	Javier Cara

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

A. Introduction to data analytics

1. Give an example for the following terms:
    a. Data. - Representación de un atributo o variable cuantitativa o cualitativa.
        i. Nombres de las calles -
    b. Information. - Datos procesados con significado.
        i. Mapa -
    c. Knowledge. - Integrar datos e información con experiencia para la toma de decisiones. - Inferencia.
        i. Ruta -

2. Go to the web https://www.teoalida.com/cardatabase/, section "European Car Models", and download the "Demo/sample free" Excel database. Please, organize the data in the following categories:
    - Categorical data
        - *Nominal data*
        - *Ordinal data*
    - Numerical data
        - *Discrete data*
        - *Continuous data*

Categorical data - Cualitativos - NO medibles - determinan modalidades

- ***Nominal data*** *- Nominales - no Ordinales - no se pueden ordenar, no tiene sentido ordenarlas, No puedo calcular la media, Los datos son principalmente alfabéticos, son datos "etiquetados" o "nombrados" que pueden dividirse en varios grupos*

    European / World classification
    Make
    Model
    Country of origin
    Country
    American classification
    Description
    Pre-1990 car models

- ***Ordinal data*** *- Ordinales - se pueden ordenar, tiene sentido ordenarlas, tienen un orden de categorías mientras que los nominales no.*

    Platform / generation number
    Sold in Western Europe
    Sold in North America
    Sold in Europe
    Sold in North America
    Sold in India
    Timeline included
    Class

Numerical data - Cuantitativos - medibles

- ***Discrete data*** *- Discretos - número finito de valores enteros. - barras*

    Units produced
    Production years

Model Years (US/Canada)
Model Years (North America)
Units produced
Models included (WORLD)
Models included (EURO)
Company Founded
First car produced
Last car produced
Years produced
Year
models
Number of car models by the year of launch

- ***Continuous data*** *- Continuos - cualquier valor real infinito dentro de un intervalo. - histogramas*

B. Descriptive Analytics

3. For the data file "*Tablet Computer Sales.txt*", find the average number, standard deviation, variance, and interquartile range of units sold per week.

```
(base) hadoop@ubuntu-hokkaido-3568:~/R/Data$ cat Tablet_Computer_Sales
.txt
Week    Units_Sold
1       88
2       44
3       60
4       56
5       70
6       91
7       54
8       60
9       48
10      35
11      49
12      44
13      61
14      68
15      82
16      71
17      50
(base) hadoop@ubuntu-hokkaido-3568:~/R/Data$
```

Leer el fichero

> TablaVentas=read.table("Tablet_Computer_Sales.txt", header=T)

El fichero contiene 17 pares de valores Units_Sold y Week:

> length(TablaVentas[[1]])
[1] 17

Los nombres de los campos de los ficheros son:

> names(TablaVentas)
[1] "Week" "Units_Sold"

La media de las unidades vendidas es:

> mean(TablaVentas$Units_Sold)
[1] 60.64706

La varianza de las unidades vendidas es:

```
> var(TablaVentas$Units_Sold)
[1] 253.8676
```

La desviación estándar de las unidades vendidas es:

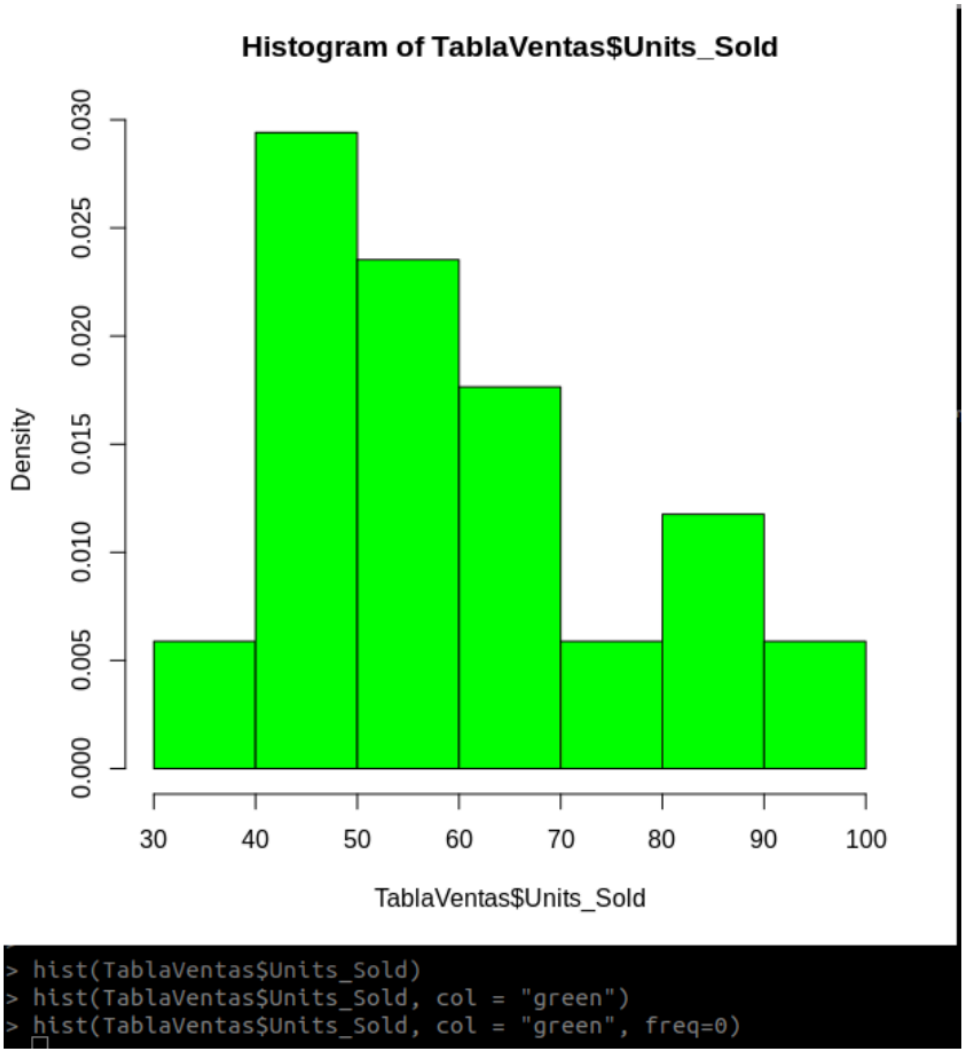
```
> sqrt(var(TablaVentas$Units_Sold))
[1] 15.93322
```

La mediana de las unidades vendidas es:

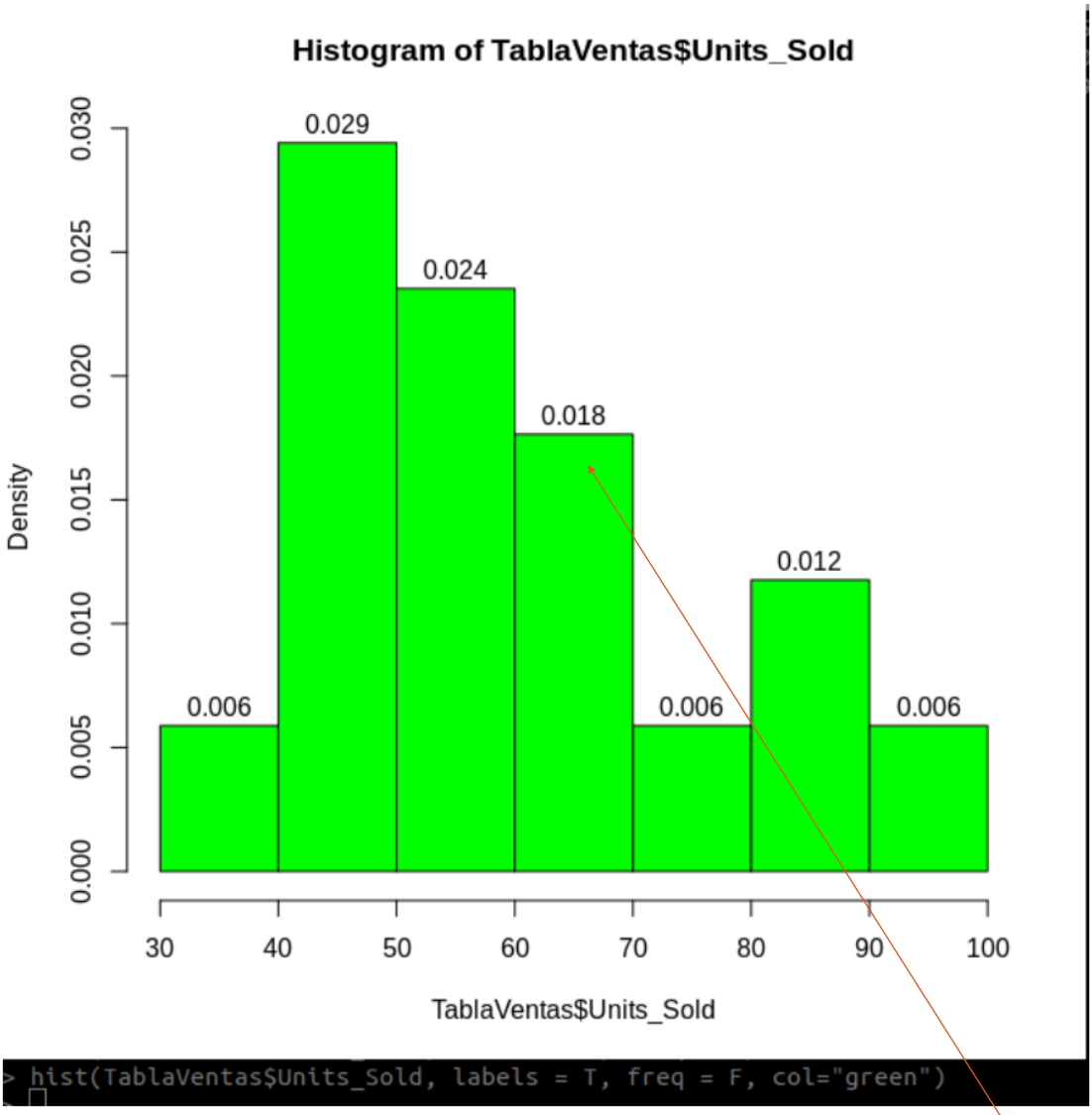
```
> median(TablaVentas$Units_Sold)
[1] 60
```

El eje x de la gráfica nos muestra las Unidades Vendidas y en el eje y podemos ver la frecuencia relativa de estas ventas por semana.

```
> hist(TablaVentas$Units_Sold, col = "green", freq=0)
```



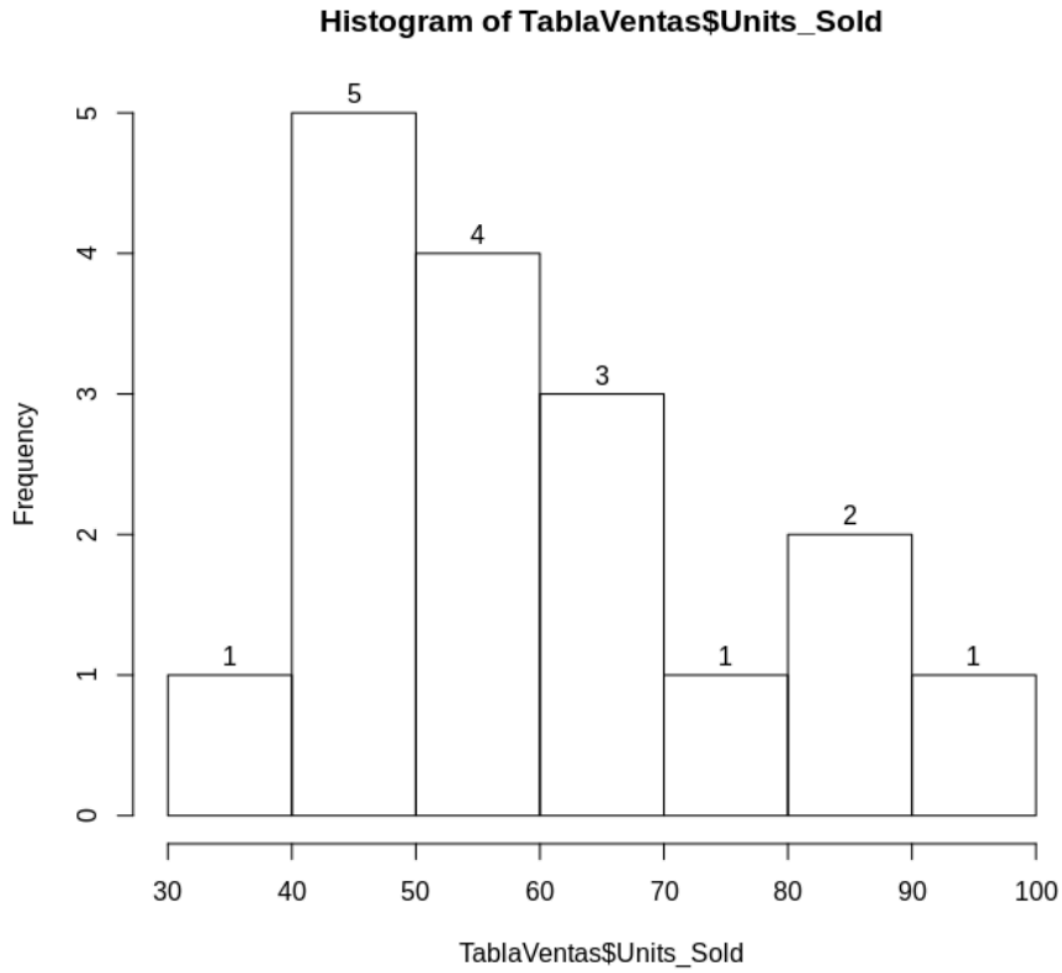
> hist(TablaVentas$Units_Sold, labels = T, freq = F, col="green")



esta frecuencia se multiplica por la amplitud del rango (el ancho de la base) y nos indica que el 18% de las unidades vendidas esta entre 60 y 70.

En el Histograma podemos ver el comportamiento de las ventas

> hist(TablaVentas$Units_Sold, labels = T)




```
> TablaVentas=read.table("Tablet_Computer_Sales.txt", header=T)
> hist(TablaVentas$Units_Sold, labels = T)
```

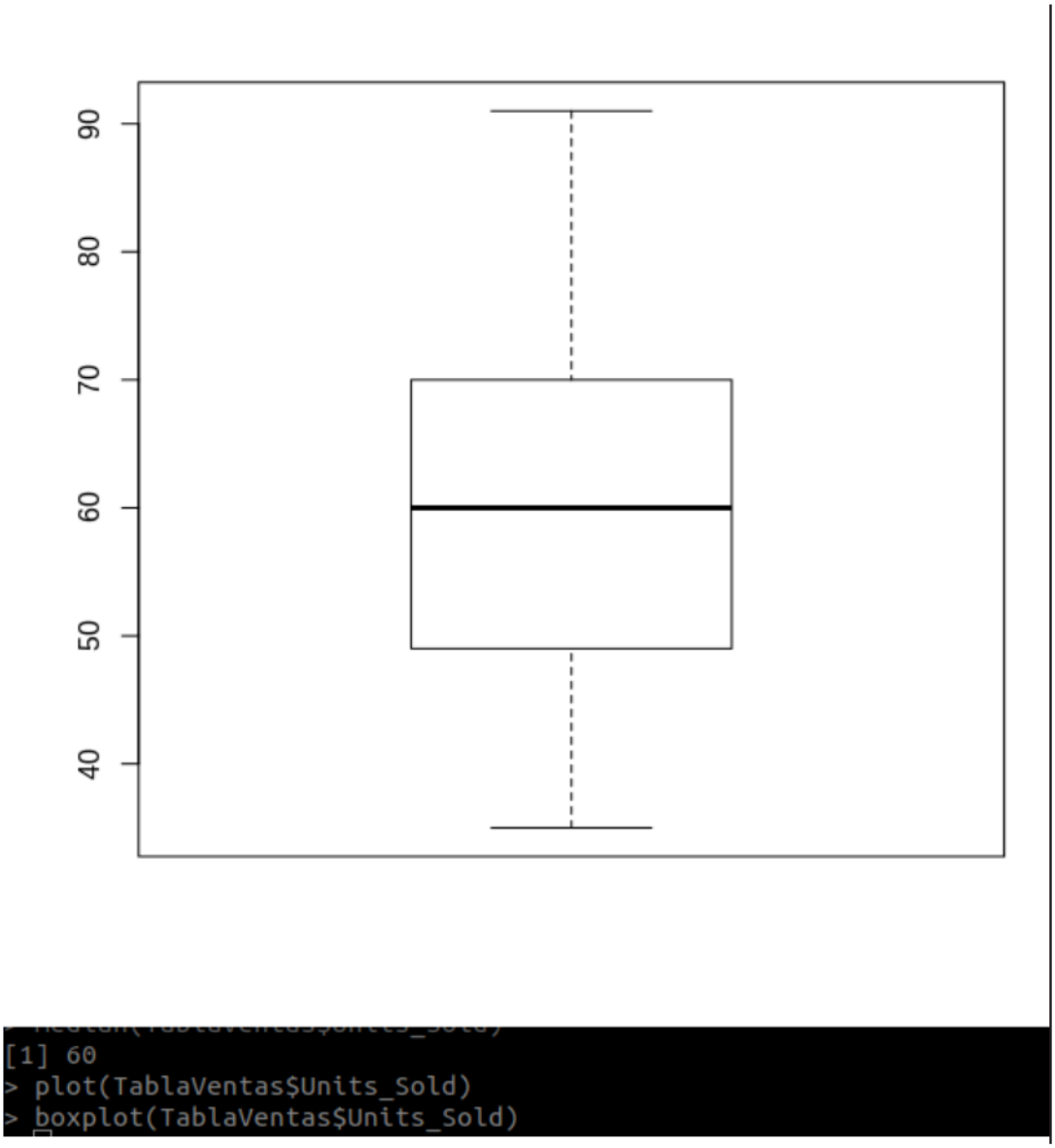
El eje x de la gráfica nos muestra las Unidades Vendidas y en el eje y podemos ver la frecuencia absoluta de estas ventas.

El 50% de las unidades vendidas están por debajo de la mediana, entre 30 y 60,
El 50% de las unidades vendidas están por encima de la mediana, entre 60 y 100.

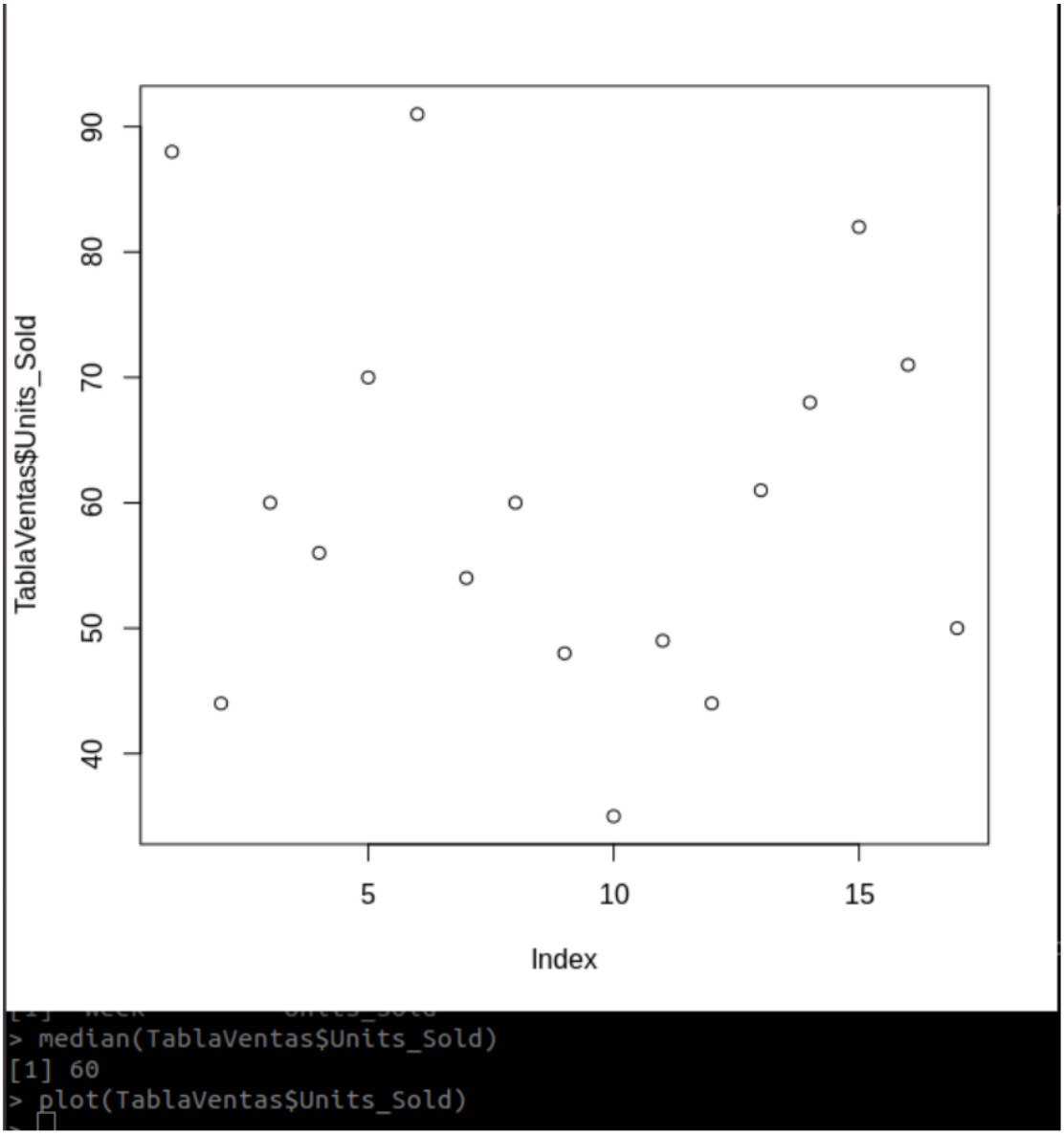
Por debajo de la mediana se han hecho 1+5+4 = 9 ventas, el 25%.
Por encima de la mediana se han hecho 3+1+2+1 = 7 ventas, el 25%

```
> quantile(TablaVentas$Units_Sold)
  0%  25%  50%  75% 100%
       Q1   60  Q3
  35   49   60   70   91
```

El 25% de las unidades vendidas están por debajo de el Q1= y
El 25% de las unidades vendidas están por encima de el Q3
La mitad de las ventas se hacen entre el Q1=50 y el Q3=70.
El Rango InterQuartil = Q3 - Q1 = 20 que nos indica la dispersión de los datos.



No tenemos puntos atípicos.


TablaVentas$Units_Sold
40
50
60
70
80
90
5
10
15
Index
> median(TablaVentas$Units_Sold)
[1] 60
> plot(TablaVentas$Units_Sold)

C. Probability -

4. Let us define X as a random variable Gaussian-distributed with $\mu = 4$ and $\sigma = 3$.
   - Compute $P(X \leq 6)$
   - Compute $P(3 \leq X \leq 6)$
   - Compute a such as $P(X \leq a) = 0.85$
   - Generate 1000 random numbers distributed as X.
     - Plot a histogram with these numbers, and superimpose the theoretical density function
     - Compute the proportion of the numbers that has been generated in the interval [3, 6], and compare with the probability computed above in $P(3 \leq X \leq 6)$
     - Check if the generated random numbers have a Gaussian distribution.

RNORM -> Crea n valores aleatorios con un mu y un sigma dado.
rnorm random de la distribución normal
rnorm(n, mean, sd)

Generate 1000 random numbers distributed as X.

```
> x = rnorm( 1000, 4, 3)
> x
  [1]  9.722570951  6.211427198  2.508262913  4.139724814  4.677790110
  [6]  1.230995381  1.965396672  6.488571367  3.072921287  6.790270359
 [11]  8.320486977  7.315415223  9.037359923  6.458714038  6.009824193
 [16]  4.607721569  4.207768344  4.719899337  2.479265433  2.602571266
 [21]  5.671424456  5.444647257  3.723626253  1.837756028  2.930583570
 [26]  7.917282936  3.012074310  5.188248465  8.024267729  5.421459376
 [31]  3.981487017  6.361560591  4.271581798  1.243004533  1.944055671
 [36]  1.530621602  2.480864685  4.240728436  1.882294691  1.337529812
 [41] -1.882293641  3.585676118  6.929947789  7.849017666  0.339912836
 [46]  1.983010350  2.730427892  3.896994672  5.918259763  7.162565008
 [51] -0.287221541  5.187820980  3.548050820  4.830088653  3.311645221
 [56]  0.915211273  3.612222944  9.842090769  4.742765099 -0.835973072
 [61]  1.766909070  1.671513668  6.495753925  5.129725893  3.918217479
 [66]  6.768604611  5.834482601  1.516918895  6.140512728  8.874400451
 [71]  4.514966635  2.532810399  5.432233809  0.726443464  4.271291944
 [76]  1.774256967  7.597992599 13.055332535  3.576914728  1.751239379
 [81]  4.952006568  2.370382055  1.079241610  6.795152411  3.321105427
```

```
 [86] -0.576366567  4.409198008 -1.238873051 -0.335542623  2.932252428
 [91] -0.822976474  5.862416781  5.224077734  1.298535381  5.560786148
 [96]  1.726152640  4.405386415  6.062141376  6.933085281  0.083971564
[101]  5.939252510  0.712851474  8.258705038  6.061144946  4.468130686
[106]  0.289010919  0.525983395  2.998358336  0.514076221  3.643954712
[111]  7.995448922  3.230590080  4.657879228  2.641335486  3.178088515
[116]  7.152351631  4.917588796  4.092624350  3.149892615  0.869055959
[121]  8.543357113  9.895700597  9.641745611 -0.903208267  1.698466801
[126]  3.741987027  2.600176448  8.851360217  5.114223753  3.378683645
[131] -5.468752355  0.219529107  4.177014481  7.445974180  1.282261997
[136]  6.364841480  4.158220335  2.429991719  7.112274650  1.523045448
[141]  0.177278636  2.817009377  3.879597499  1.458014354  8.364717483
[146]  2.626763080  5.992223951  1.497974660  1.471208855  2.472373746
[151]  2.140080913 -0.173138318  0.738701084  1.100190538  3.093848425
[156]  2.614752807 -1.269680625  4.113679107  0.630165691  8.225266756
[161]  0.390878421  1.328138590  4.312852878  4.624936995 -0.638777809
[166]  4.066598692  2.215765286  5.690783357 -0.910915638  4.446947131
[171]  0.811697070 10.765247879  1.208862971  4.663853639  6.174358129
[176]  5.210056644  2.756640294  5.905663114  6.637139488 -1.526801276
[181]  4.850419670  2.454648589  6.042974894  5.672352385  3.957725545
[186]  1.770495991 -0.236739938  3.628012973  3.027004404  0.254988469
[191]  5.506717494  1.850413858 -0.563487826  4.751301635  9.866927720
[196] -1.535536387  5.071618159  6.144802877  3.687932530  5.955797143
[201]  4.215097928  5.822850543  7.654388015  1.647258955  3.539643139
[206] -0.233199808  1.037190762  1.558937496 -0.686512648  3.841825701
[211]  2.392496050  5.991446739  8.566035726  4.111370956  4.371670295
[216]  8.282059268 -6.113036001 11.402304920  3.474051749  4.239006719
[221] -0.114112348  5.079776356 -3.809169347  7.036561787 -1.514828920
[226]  3.360214337  4.365131538  4.461060799  7.383020658 11.699878215
[231]  6.186755272  6.123775530  6.539739394  1.794553599  2.485610905
[236]  2.608139050  3.566808815  0.497721853  2.866089227  5.828394493
[241]  2.178345540  5.093038819  4.961607481  2.437286659  1.363423225
[246]  7.491729676  2.414379528  0.106438284  4.265413101  0.681171206
[251]  3.482857725  2.574357004  4.548963722 10.896553245  0.959729015
[256]  6.357540064 -2.745009234  6.829742809  0.721179865  6.199110413
[261]  3.765789212  1.705341167  0.278667849  1.696325044  4.077781824
[266]  3.432137284  7.761687800  3.724041081  8.545637001  9.422028957
[271]  5.415925932  4.638817511  8.386504230  6.678765443  1.897813242
[276]  3.423741539  1.793430722  2.329396411  6.039721013  2.264599874
[281]  7.161069995  1.220731111  1.314265577  7.696737849 12.913710838
[286]  7.666838966  4.385567897 -0.025855143  8.174583388  7.421116900
[291]  1.936413434  5.222448047  5.433769895  6.152562759 -2.393373931
[296] 10.550173858 -2.381103694 -0.259253982  2.798480173  2.904275533
[301]  1.619783402  5.069009040  5.284249074  5.996968546  4.768729185
[306]  7.487155127  6.990478337  0.558350666  7.996831624  9.180178705
[311]  1.096819799  0.708577377  3.173212465  3.401918301  1.099976911
[316]  1.728649864  5.812703433  0.959233117  2.754107096 10.343180638
[321]  6.002077412  4.806700449  5.513053738  2.441421099  4.266799649
[326]  6.718228634  3.976782440  7.893239060  8.171056814  5.700936398
```

```
[331]  5.715773094  5.605739732  5.261658432  8.457835117 -1.772544152
[336]  0.313950185  0.139520466 -1.984582319 -0.358700320 -0.263102154
[341]  0.586050407  1.285688944  6.010951138 -1.509690832  9.145090283
[346]  3.405104049  0.008460258  7.067317943  2.072413652  1.409091624
[351]  6.388530766  3.294254067  5.777705081  3.862223343  1.765908491
[356]  2.014202425  6.227685870  5.164518611  4.327541490  2.750391887
[361]  4.017437234 -3.419899582  4.577251596 -0.219982295  6.666242077
[366]  3.754189859  9.072962750  2.681111516  5.663441872  6.332012385
[371] 10.220133183  5.714244418  3.474496491  3.372059874  2.454697039
[376]  4.194899577  5.468510852 -0.783665169  1.734988793  2.897535699
[381]  2.008500508  0.747606127  6.645002321  2.958695091  6.995609988
[386]  1.099431493  2.561533184  3.565269981  2.181268612  4.715741589
[391]  3.334422765  6.078309463  6.479170667  5.641301272  2.351223746
[396]  6.748727574  3.438648621 -0.984403643  3.258230305  3.916405463
[401]  6.523336276  2.742001492  4.888083652  1.221543887  5.796572221
[406]  2.615260506  2.020880629  8.423752873  7.753089644  3.649085955
[411]  2.144595410  3.583692428  3.418949356  2.614139292  8.880841274
[416]  3.715306563 -0.644387593  2.174673450  5.619982301  0.554610257
[421]  3.664605347  6.653025570  6.306438095 -3.125562697  7.915400069
[426]  3.681465943  0.023515992  5.496227963  1.912540843  2.301665062
[431]  1.425172971  6.289315635  4.137596070  8.652135426  4.357716195
[436]  9.688389615 11.097061609  2.177468042  6.773638776  3.236352421
[441]  3.424033871 -0.529310312  4.871063188 -1.641336992  4.631817378
[446]  9.633210482 12.245507500  4.226492924 -2.446737578  4.645199327
[451]  5.072334883  1.975459207  6.545352273  1.981379664  1.460565884
[456]  4.631088143  3.675709009  4.379561070  3.192372357  5.061189990
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[466]  2.699422596  6.403515983  4.059579128  4.595158721  2.128305872
[471]  1.337695568  9.376709660  6.116801496  6.095803707  1.756079230
[476] -1.994034725  0.374882106  1.544116064  4.085145067  6.410087771
[481]  7.399036990  3.916130322  4.679054670  0.979837858  4.908624780
[486]  1.890664785  4.833422507  9.889101494  7.741111531  3.285925742
[491]  4.964946817  3.393052994  6.082636278  3.123121926 11.364334899
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[501]  2.493937434  4.029730951 -1.428867514  6.566986311  6.859171481
[506]  2.785994358 -1.177333526  1.043135236  5.571551876  4.071726459
[511]  5.802865302  6.458471352  4.494384196  0.672108448  8.339207597
[516] -0.694187917  5.753471120  6.161758453  3.813362365  9.026642099
[521]  4.920723262  3.017662911  5.758058290  3.776638176  5.713066712
[526]  6.717520510  8.571852809  8.356271972  8.425171910  7.384317832
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[546]  3.134906336  2.636938477  7.564451876  3.783923923  7.074039609
[551]  0.747876358  5.029983622  3.123774359  1.567869069  3.924607543
[556]  1.696671031  7.280866206  0.265342285  4.240395833  5.916836214
[561]  2.303462153  3.203209429  7.468445875  3.684980977  5.530153561
[566]  4.160483592 -0.617730561 -0.559640075  0.267257765  5.437319434
[571]  5.829950364  1.057053985 -0.021887972  4.504516478  6.898440572
```

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[576]  0.049168339  4.865983276  5.728722430  8.603317305  3.228644984
[581]  1.643562299  6.563363507  6.713575327  1.866850151  4.396785748
[586]  2.329852467  5.867410206  3.218018960  5.706537515  2.155291382
[591]  5.186967216 -4.343854430  6.875426612  3.481984436  3.245776003
[596] -0.619837891  3.967382207  0.785835133  2.896925374  0.447481059
[601]  5.388519671  7.895643684  6.050256180  6.065210797  3.538405686
[606] -1.980923129  3.991151349  2.560672766  2.916720680  3.200498488
[611]  0.987199092  0.123714759  6.870618245 -1.362221688  7.088870504
[616] -0.952470179  9.134490592  5.195534531  9.434308379  2.378293089
[621]  9.949477513  2.720707511  0.399286765  7.737786508  0.845552136
[626]  4.532702079  4.275943296  9.973260229  5.462484125  5.209040066
[631]  3.190813404  7.695102069  3.203859661  3.221599937  6.647455026
[636]  1.522869919  5.247372258  4.808008084  3.261479908  3.869782233
[641]  9.082012558  6.879933416  6.675219604  8.247169701  6.772527837
[646]  3.317865782  0.172107422  6.462343934  7.089053815 12.100819190
[651]  1.448039004  3.427384559  7.074528827  0.752427279  3.489820925
[656]  4.902163835 -0.405603491  2.348873931  6.286238261  6.236264022
[661]  6.689746628 -2.311298212  1.150579425  1.052796893  1.666651591
[666]  6.484820202  2.614540236  4.447779956  1.834115823  8.222455673
[671]  9.478416393 11.807093745  9.066914003  6.480361868  0.331249637
[676]  3.116467422  1.607748409  3.011952100  6.851059334  2.288312692
[681]  1.318825090  3.113127101  7.149866598  6.353973581  4.041625919
[686]  6.540997495  5.657859450  5.784999260  4.921612570  0.569106047
[691]  6.899596937  8.278806612  9.418848635  4.667785765  5.010480439
[696]  6.849067150  2.998923418  0.194999569  0.830643034 -1.703665134
[701]  4.423620743  5.530128807  5.832168866  7.295113537  5.430939950
[706]  3.798712695 -0.659069454  5.064475439  8.981936789  3.448453669
[711]  5.931427932  7.547698140 -0.068651111  0.876545805  4.311691798
[716]  2.782839192  4.436149155  3.657116238  2.400586382  6.195525581
[721]  5.433768829 -0.419938931  4.776671529  6.977721657  9.252854790
[726]  1.188472478  8.622609738  3.676219656  2.918144141  3.462001367
[731]  3.192548547  4.633496694  6.686889015  2.423551924  4.858554560
[736] -3.826658525  2.016617221  6.294495910  0.742242710  5.513646668
[741]  3.682213357  2.432986208  1.714940422  8.536148499  1.727820631
[746]  7.400382993  6.268730238 -0.100547394  2.992598117 10.239088016
[751]  0.377079593  1.307163822  9.481052138 -0.610184480  3.409957928
[756] -0.157292930  6.301604399  4.216543625  9.533605964  8.633555938
[761]  6.096183524  3.638639635  0.975317044  5.125299917  7.725145457
[766]  2.039650909  3.473240677 -3.823699615  4.323735351  9.584445785
[771]  8.441958706  4.973996546  1.391446783  0.197915150  2.350267556
[776]  6.655826449  3.217182008  8.403025471  1.762704936  2.328387307
[781] -0.800270146  2.572068771  2.386047458  3.241964880 -0.366419675
[786]  2.256641122  2.875214488  7.341394895 -0.055212531  6.525665636
[791]  3.616757834  2.775267178  2.881864591  1.461219143  3.106719755
[796]  4.390606324  4.407141063  3.214795843  9.033697695  4.700564903
[801]  4.275098151  2.738830189  4.457127847 -0.201995279  7.033111677
[806]  6.893747737  0.298077240  0.112085491 -1.195432870  3.454119713
[811]  1.669384094  7.257897452  3.736462251  3.308560151  4.574995281
[816]  3.559881939  3.275774048  5.772927225  3.315348544  2.619204467
```

```
[821]  6.174814610  4.741439332  0.990673810 -0.609219512  2.734989995
[826] 10.145072186  7.147153262  4.832156640  5.850977952  0.599510927
[831]  5.947160676  0.666216323  6.676434553 -0.482537939 -1.900172763
[836]  3.048900638  7.838839390  5.851302513  6.823795786  7.622565426
[841]  2.155805800  4.454464392 -2.864232298  3.730787576  1.120894235
[846]  0.104634148 -2.498893482  8.550164250  5.903829403 -0.780464293
[851]  0.833347259  3.743421608  4.654216211  4.112404714  6.452046902
[856]  2.115153668  3.292777150  4.460443593  5.803095809  1.986178477
[861]  3.651534724  2.209781762  3.061074017  6.125712681  7.652292576
[866]  5.954147369  0.641963218 -2.030439149 -0.221400731  5.813850201
[871]  7.807039328  6.772659234  3.810651952  5.726720584 -0.127383625
[876]  0.220868545  3.839319307  9.391743706  3.294372582  7.543433686
[881]  6.240118606  9.815001498  4.164777359  2.643334865  4.923317586
[886]  3.086636336  3.322454892  8.085314508  3.169242515 -0.292071627
[891]  5.928410471  3.623712369  0.809973052  6.922605274  7.403139386
[896]  7.094559573  5.496784410  2.855290592  2.978759222 -1.044969746
[901]  2.410711240  3.870699755  6.478521724  1.187777273  5.772889807
[906]  7.154531467  4.284654211  3.201363701  4.896757445  2.732244214
[911]  7.676932284  3.289225515  2.501054648  4.199085588  8.234579629
[916]  8.959128329  3.620792197  6.739632937  1.195287454  6.378219374
[921]  1.169563754 -0.989844446  1.913297041 -2.248200791  3.369106795
[926]  5.229325213  6.424564818  7.271546502  0.306133700  5.245739608
[931]  6.541283057  0.532106227  8.508294597  9.272515031 -3.964967504
[936]  5.908047796  0.329210230  0.851137323  4.710201587  3.689213706
[941]  3.425921543  3.725367522 10.072711343  7.826463739  3.373082876
[946]  2.211918808  5.076166422  1.831917174  4.838812525  1.821511528
[951] 10.055279490  9.085432287  6.226849496  5.378771335  4.440647634
[956]  0.898951431  8.990225899  8.137731194 10.412555275  1.548484348
[961]  6.427600105  3.785829083  3.665892064  3.483239993  8.124939878
[966]  8.236620858  4.214459737  5.700270755  6.415499418  6.353337432
[971]  9.115362245  4.316094520  5.997749778  5.719000083  8.863206817
[976]  5.727793109  3.708372726  2.664170473  1.084940086 -0.424586902
[981]  2.033561889  2.115813583  4.310248773  1.551119406  4.185972246
[986]  2.867766666  3.386759483 -1.161971444  6.829082800  4.699670773
[991]  3.621348788  6.557779893  2.022140773  7.489283598 10.234863323
[996] -0.466739909  8.887104089  4.004537421  6.949013300  2.850796691
```

pnorm —> Calcula la probabilidad - AREA - dando un mu y un sigma - sólo calcula las areas a la izquierda

- Compute $P(X \leq 6)$

$\text{pnorm}(6, 4, 3) = 0.7475$

- Compute $P(3 \leq X \leq 6)$

$\text{pnorm}(6, 4, 3) = 0.7475$
$\text{pnorm}(3, 4, 3) = 0.3694$

$\text{pnorm}(6, 4, 3)$ - $\text{pnorm}(3, 4, 3) = 0.7475 - 0.3694 = 0{,}3780$

- Compute a such as $P(X \leq a) = 0.85$

qnorm —> devuelve la altura de la curva, con un mu= 4 y un sigma = 3.

qnorm(0.85,4,3) = 7.1093 —> por tanto el 0,85% de los números están por debajo de 7.1093

Plot a histogram with these numbers, and superimpose the theoretical density function -

- Compute the proportion of the numbers that has been generated in the interval [3, 6], and compare with the probability computed above in $P(3 \leq X \leq 6)$

pnorm —> me devuelve p; la probabilidad

pnorm(1000, 4, 3) = 1 —> Teorico

Partiendo de que la muestra es de 1000 datos y sabiendo que se trata de una distribución normal…

Calculo la suma de los números que son mayores ó iguales a 3 de la muestra x
> sum(x >= 3)
[1] 646

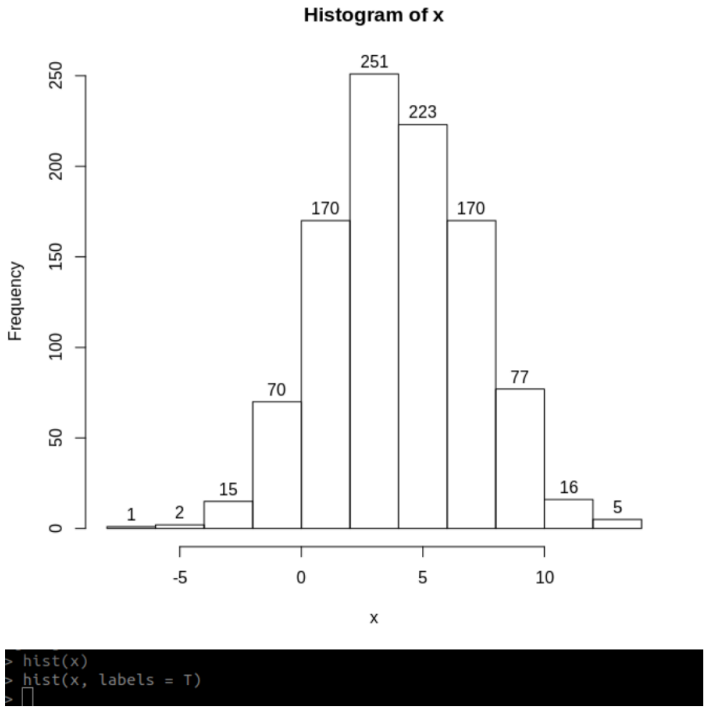
Calculo la suma de los números menores ó iguales a 6 de la muestra x
> sum(x <= 6)
[1] 732

Saco la diferencia y lo divido entre la muestra 1000 y tenemos una probabilidad de:
732 - 368 = 364
364/1000 = 0,364

Al realizar la comparación obtenida del calculo de los random de la variable Gaussian-distributed nos damos cuenta que la variación de la probabilidad es mínima.

Este histograma tiene una distribución normal "Experimental", —> tomando todos los x generados. (el histograma representa la curva de la muestra).

> hist(x, labels=T, freq=F)

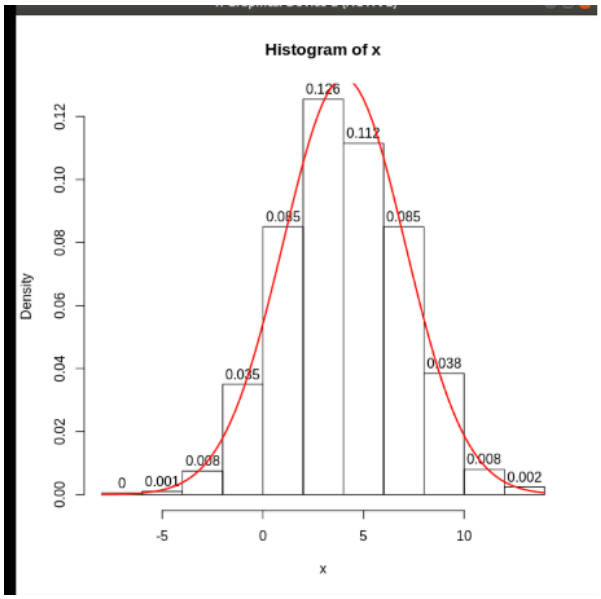


Check if the generated random numbers have a Gaussian distribution.

> media = mean(x) # calculo la media de x

> desv = sd(x) # calculo la desviación típica de x

> curve(dnorm(x,media, desv), add = T, col = "red", lwd = 2) # superpongo la función de la densidad, previamente calculada la media y la desviación típica.



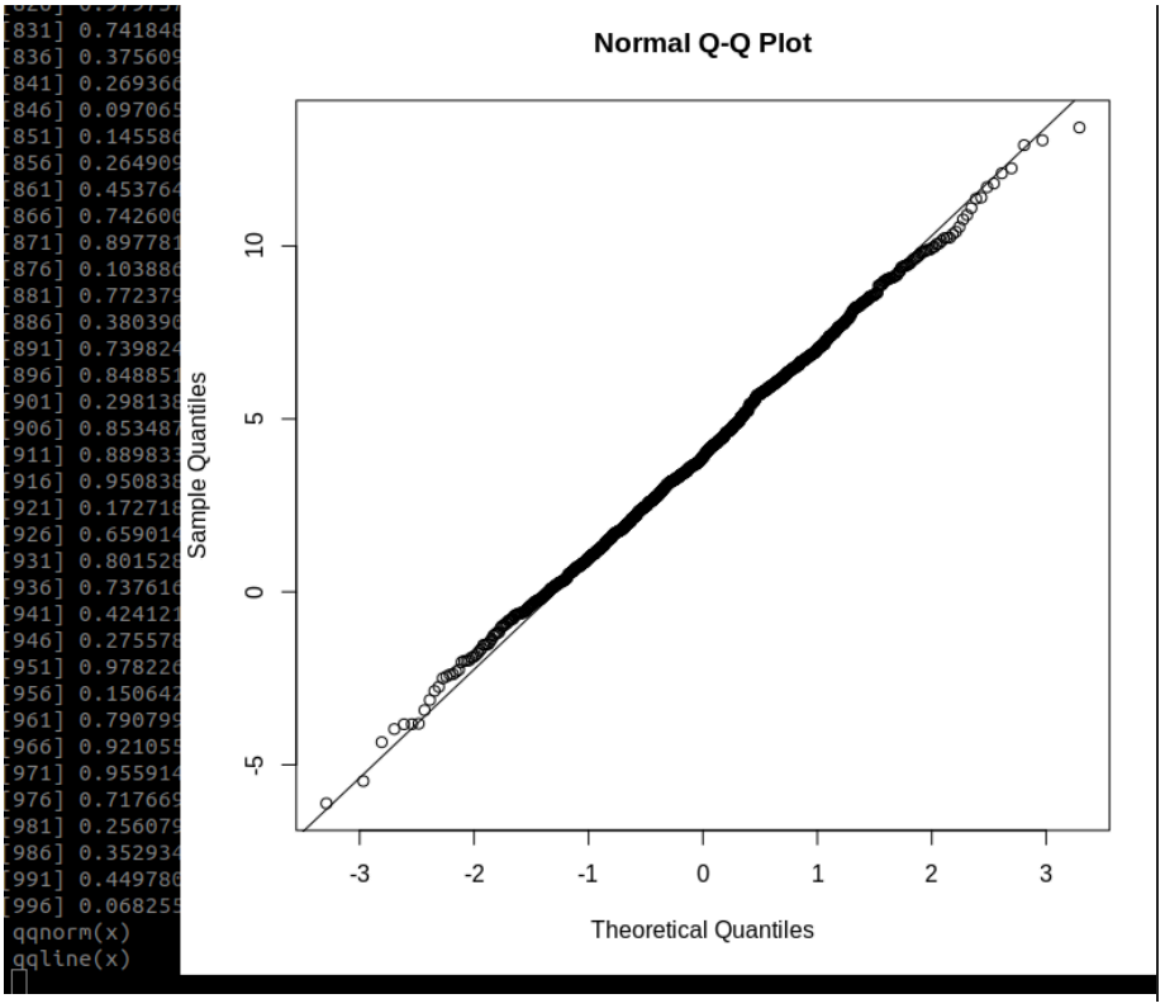
De esta manera defino de forma unívoca la distribución normal.

Curve me genera una gráfica de la función distribución de la distribución normal (Teórica con infinitos datos..), en función de x, con la media y desviación calculadas previamente.

Con el Q-QPlot —> Quantile-Quantile Plots - podemos ver gráficamente por medio de qqnorm y qqline.

Aquí podemos comprobar que las observaciones siguen una distribución normal siempre que los puntos de la gráfica de la distribución real "siguen" bastante bien la línea de la gráfica de la distribución teórica.

> qqnorm(x) # calculo de qq normal para x - distribución real -
> qqline(x) # adiciona la qqline al plot - distribución teórica



D. Inference

5. Some studies suggest that there is a relationship between the cheese's flavour and their chemical composition, especially with the lactic acid content.
   The lactic acid content has been measured in ten cheeses, resulting the following values:
   0.86, 1.53, 1.57, 1.81, 0.99, 1.09, 1.29, 1.78, 1.29, 1.58

Assuming that the lactic acid content can be modelled as a Gaussian distributed random variable:

- Estimate a value for the mean μ and variance σ^2
- Compute a confidence interval for the mean μ ($\alpha = 0.05$)
- Compute a confidence interval for the variance σ^2 ($\alpha = 0.05$)
- Solve the following hypothesis test ($\alpha = 0.05$):

$$H_0 : \mu = 1$$
$$H_1 : \mu \neq 1$$

- Estimate a value for the mean μ and variance σ^2

```
> acidL # lactic acid

> acidL = c( 0.86, 1.53,1.57, 1.81, 0.99, 1.09, 1.29, 1.78, 1.29, 1.58 )

> acidL
 [1] 0.86 1.53 1.57 1.81 0.99 1.09 1.29 1.78 1.29 1.58

> summary (acidL)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  0.860   1.140   1.410   1.379   1.577   1.810

> var (acidL)          > sd( acidL )          > sd( acidL ) ^2       > sqrt(var(acidL))
[1] 0.1073656          [1] 0.3276668          [1] 0.1073656          [1] 0.3276668
```

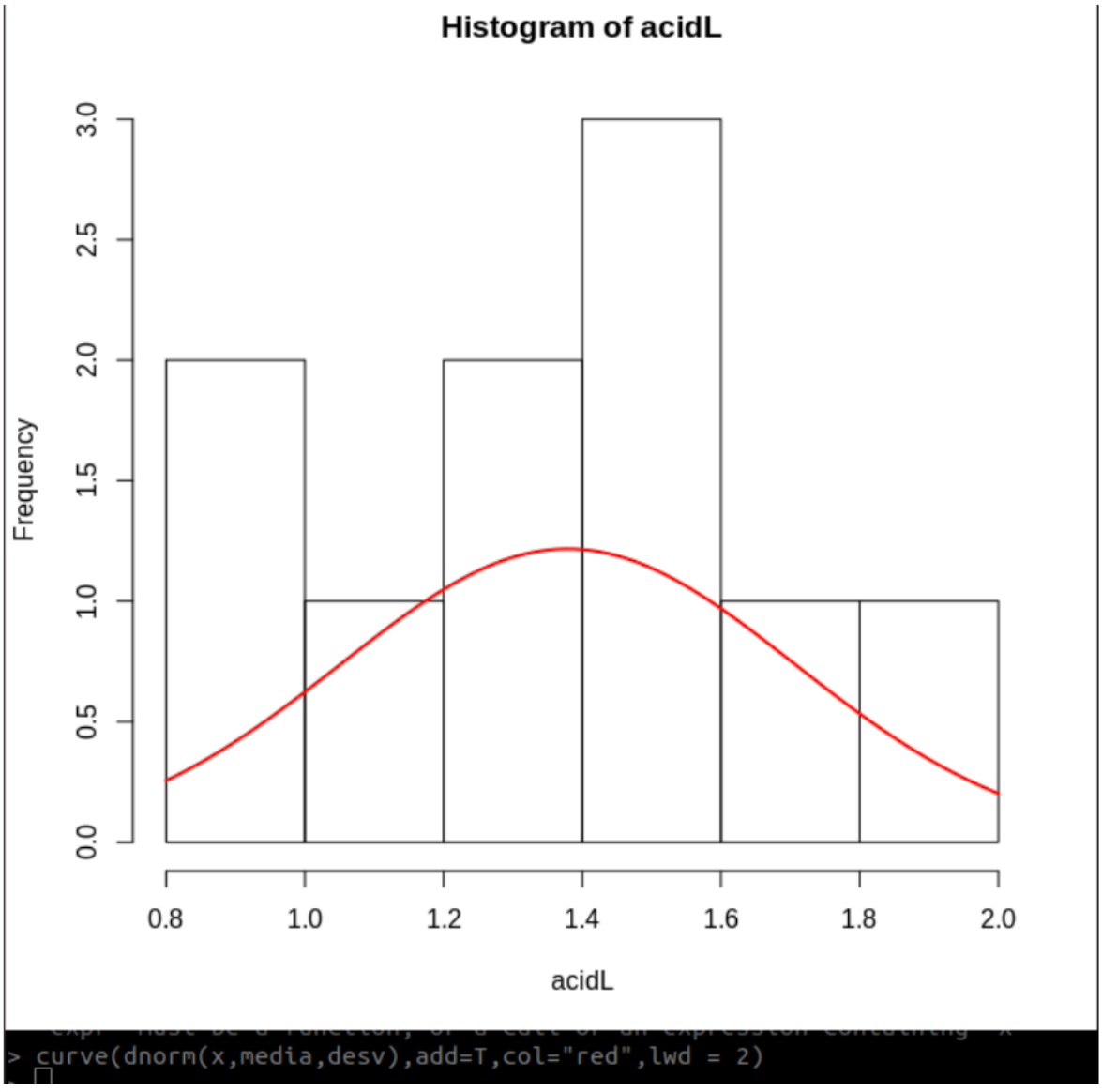
> media = mean(acidL)
> media
[1] **1.379**

> desv = sd(acidL)
> desv
[1] **0.3276668**

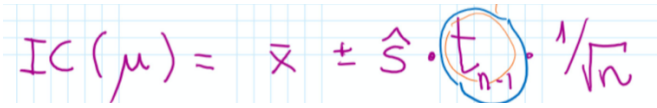
> var (acidL)
[1] 0.1073656

> n = length(acidL)
> n
[1] **10**

> hist(acidL) —> curva de la muestra
> curve(dnorm (x, media, desv), add=T, col="red", lwd = 2) —> curva de la distribución normal



- Compute a confidence interval for the mean μ ($\alpha = 0.05$)



> # Intervalo de confianza de la media con un 90% es:

media + desv * (tstudent (0.05) , (n-1)) * (1 / sqrt (n))
media - desv * (tstudent (0.05) , (n-1)) * (1 / sqrt (n))

> media-desv*qt(0.05,n-1)/sqrt(n)
[1] 1.568942

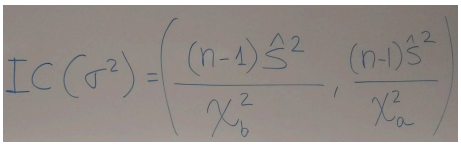
> media+desv*qt(0.05,n-1)/sqrt(n)
[1] 1.189058

> 1.568942-1.189058
[1] **0.379884**

Con un **90%** de confianza puedo afirmar que la media del acidL está entre el **1.568942-1.189058**, con una precisión aproximada de: **0.379884.**

Sé que entre 1.568942-1.189058 está la media del acidL # lactic acid, con una precisión aproximada de 0.379884.

- Compute a confidence interval for the variance σ^2 ($\alpha = 0.05$)



> # Intervalo de confianza para la varianza

(n-1) * desv ^ 2 / qchisq (1-0.05 , n-1)
(n-1) * desv ^ 2 / qchisq (0.05 , n-1)

> (n-1) * desv ^ 2 / qchisq (1 - 0.05, n-1)
[1] 0.05711279

> (n-1) * desv ^ 2 / qchisq (0.05, n-1)
[1] 0.2906037

Con un **90%** de confianza puedo afirmar que la la σ del acidL está entre **3.325113 y 16.91898**

Con un **90%** de confianza puedo afirmar que (σ), esta entre estos valores

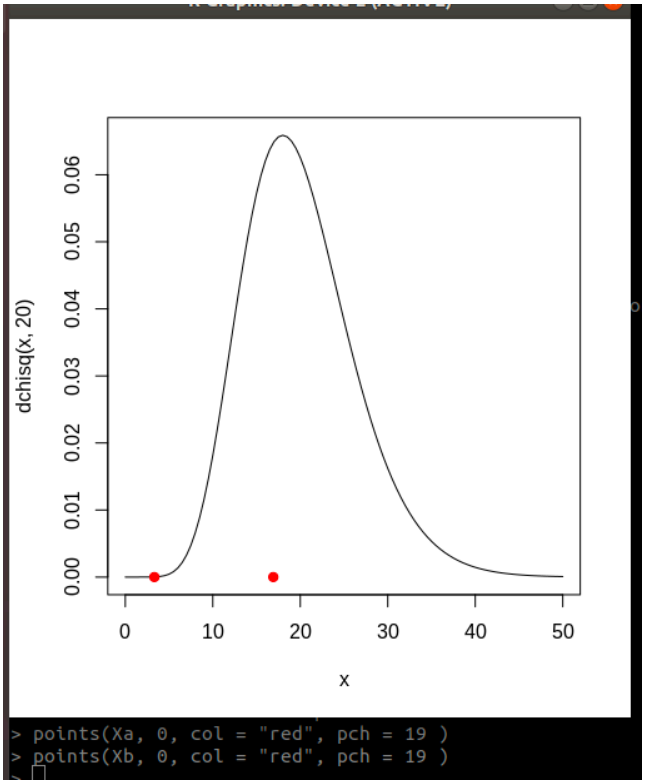
Limite de las (X).

> Xa = qchisq(0.05 , n-1)
> Xa
[1] 3.325113

> Xb = qchisq(1 - 0.05 , n-1)
> Xb
[1]16.91898

> (n-1) * desv ^ 2 / Xb
[1] 0.05711279

> (n-1) * desv ^ 2 / Xa
[1] 0.2906037



> curve(dchisq (x, 20) , xlim = c(0, 50))

> points (qchisq(1 - 0.05,5) , 0, col = “red” , pch = 19)

> points (qchisq(0.05,5) , 0, col = “red” , pch = 19)

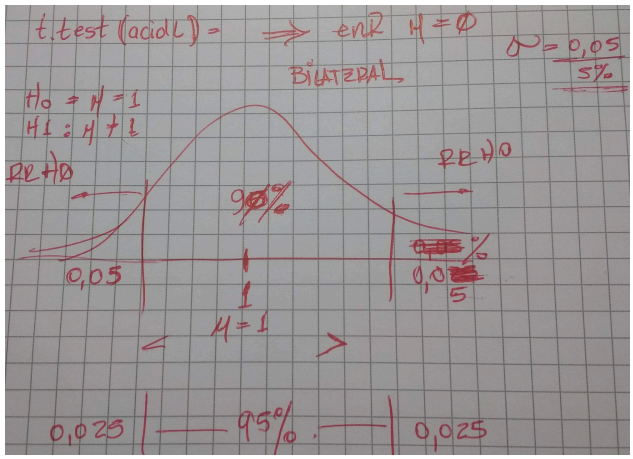
- Solve the following hypothesis test ($\alpha = 0.05$):

$$H_0 : \mu = 1$$
$$H_1 : \mu \neq 1$$

Queremos comprobar que la **μ** = 1 ó es diferente de 1.

Seguramente para cualquier muestra que seleccione.., la **μ** va a estar a la derecha ó a la izquierda de este valor. - Por lo tanto es un Contraste Bilateral, ya que tiene una región de rechazo. RRH0 a cada lado, estas serán las regiones en las que puedo decir que **μ** no es igual a 1.

Es decir, si **H0 : μ = 1**, y suponiendo que esto es cierto, entonces siempre va a dar una 1 < **μ** < 1; por tanto **H1: μ ≠ 1.**
Si **α** = 0.05, entonces se establece un límite de 90% para el cual **μ = 1**
Si quiero saber si **μ ≠ 1**



> t.test(acidL) μ = 0 —> default de R
One Sample t-test
data: acidL
t = 13.309, df = 9, **p-value = 3.174e-07**
alternative hypothesis: true mean is not equal to 0
95 percent confidence interval:
1.144601 1.613399
sample estimates:
mean of x
1.379

> t.test(acidL, mu = 1, conf.level = 0.90, alternative = "two.sided") => μ = 1

One Sample t-test

data: acidL
t = 3.6577, df = 9, **p-value = 0.005254 < 0.05 => p-value < α => rechazo H0**
alternative hypothesis: true mean is not equal to 1
95 percent confidence interval:
1.144601 1.613399
sample estimates:
mean of x
1.379

Con un **90 %** de confianza puedo decir que **μ ≠ 1 porque p-valor es menor que α ,** No tengo evidencias suficientes como para decir que **μ = 1.**

6. A laboratory is analysing the performance of two chemical formulas. The results for both types are the following:

A: 0.0105 0.0145 0.1060 0.0130 0.0156 0.0104

B: 0.0222 0.0245 0.0320 0.015

Assuming that the each of the previous formula values

are independent Gaussian-distributed random variables:

- Test if there is a significative difference between the means. (α=0.05)
- Test if there is a significative difference between the variances. (α=0.05)

- **Test if there is a significative difference between the means. (α=0.05)**

Definición del modelo de distribución de probabilidad: Hipótesis Parámetros

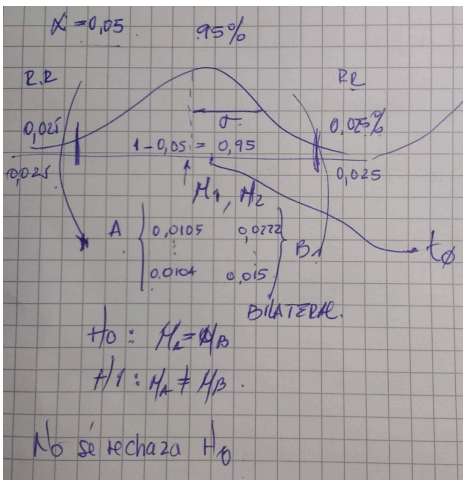
Estimación de los parámetros

Diagnosis de las hipótesis

Aplicación

A: 0.0105 0.0145 0.1060 0.0130 0.0156 0.0104

B: 0.0222 0.0245 0.0320 0.015




```
> A = c(0.0105,0.0145,0.1060,0.0130,0.0156,0.0104)
> B = c(0.0222,0.0245,0.0320,0.015)
> A
[1] 0.0105 0.0145 0.1060 0.0130 0.0156 0.0104
> B
[1] 0.0222 0.0245 0.0320 0.0150

> nA = length(A)
> nB = length(B)
> nA
[1] 6
> nB
[1] 4
```

$$H_0: \quad \mu_1 = \mu_2$$
$$H_1: \quad \mu_1 \neq \mu_2$$

```
> summary (A)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.01040 0.01112 0.01375 0.02833 0.01533 0.10600
> summary (B)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.01500 0.02040 0.02335 0.02343 0.02637 0.03200
```

Utilizando la formula de la Varianza Residual tenemos:

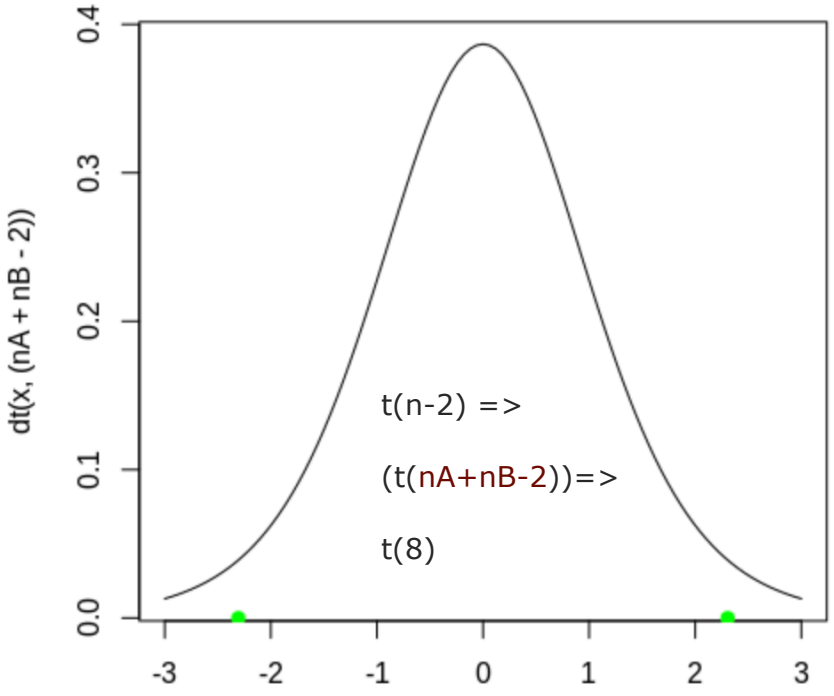
$$\hat{S}^2_R = \frac{(n_A - 1)\hat{S}^2_A + (n_B - 1)\hat{S}^2_B}{n_A + n_B - 2}$$

```
> mediaA = mean(A)
> mediaB = mean(B)
> varA = var(A)
> varA
[1] 0.001452071
> varB= var(B)
> varB
[1] 4.905583e-05
> numerador = (nA - 1) * varA + (nB - 1) * varB
> denominador = nA + nB - 2
> denominador
[1] 8
> ResiVar = numerador / denominador
> ResiVar = sqrt ( numerador / denominador )
> ResiVar
[1] 0.0009259401
```

$$t_0 = \frac{\bar{y}_{1\bullet} - \bar{y}_{2\bullet}}{\hat{s}_R \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \rightarrow t_{n-2}$$

```
> numeradort0 = mediaA - mediaB
> denominadort0 = sqrt(ResiVar) * sqrt ( 1/nA + 1/nB )
> t0 = numeradort0 / denominadort0
> t0
[1] 0.2498896
```

```
> curve( dt (x , (nA+nB-2)) , xlim = c( -3, 3 ) )
> points(qt (0.975, (nA+nB-2)), 0, col = 'green' , pch = 19 )
> points(qt (0.025, (nA+nB-2)), 0, col = 'green' , pch = 19 )
```



t0 = 0.24989,

p-value = 0.809, es decir > (α=0.05)

Por lo tanto No se rechaza H0

Está dentro de la zona de aceptación muy cerca a 0 por lo tanto puedo decir que H0 es cierto y que no hay diferencias significativas.

En R lo haríamos con la función t.test:

```
> t.test (A, B, var.equal = T)

Two Sample t-test

data:  A and B
t = 0.24989, df = 8, p-value = 0.809 > (α=0.05)
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04038621  0.05020288
sample estimates:
 mean of x  mean of y
0.02833333 0.02342500
```

Las dos muestras

Contraste de la t-student

- t = donde está posicionado el estadístico
- df = grados de libertad
- p-value = seguridad para aceptar ó rechazar Hipotesis

hypothesis alternativa: indica que es bilateral

Intervalo de confianza: 95 % que -> la diferencia de las muestras esta entre -0.04038621 y -0.05020288

sample estimates: medias estimadas

mean of x mean of y

0.02833333 0.02342500

- **Test if there is a significative difference between the variances.**

  (α=0.05)

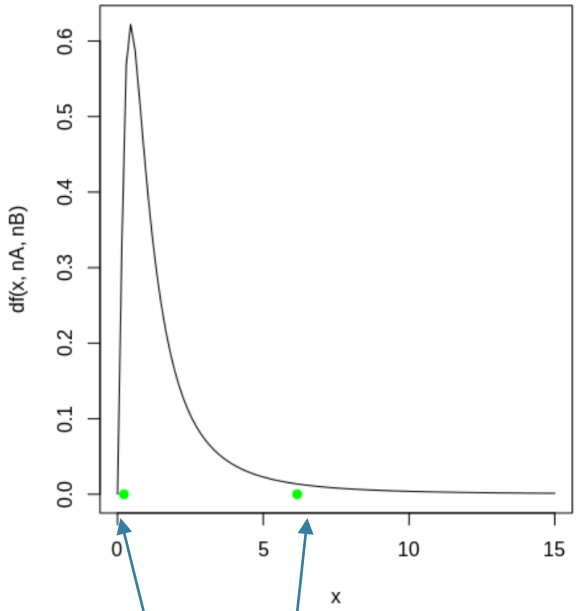
```
> A = c(0.0105,0.0145,0.1060,0.0130,0.0156,0.0104)
> B = c(0.0222,0.0245,0.0320,0.015)
```

Puede ser que aunque las medias son iguales, pero que las dispersiones de una ú otra son significativamente diferente.

Si H0 es cierto => Siguen una distribución **F de Fisher-Snedecor.**

Si H0 es cierto podemos decir que

La región de aceptación estará en el medio de la distribución.




```
> curve(df(x, nA , nB ), xlim = c( 0, 15))
> points(qf(0.05, nA, nB), 0, col = 'green', pch = 19)
> points(qf(0.95, nA, nB), 0, col = 'green', pch = 19)
```

```
> qf(0.90, nA, nB)
[1] 4.009749
> curve(df(x, nA , nB ), xlim = c( 0, 15))
> points(qf(0.05, nA, nB), 0, col = 'green', pch = 19)
> points(qf(0.95, nA, nB), 0, col = 'green', pch = 19)
```

Si las varianzas son diferentes el valor qf va a estar fuera de la región delimitada por Fa y Fb

Si H0 es cierto, la región de aceptación estará en el medio de la distribución.

```
> nA = length(A)
> nA
[1] 6
> nB = length(B)
> nB
[1] 4
> qf(0.90, nA, nB).   > qf(0.90, nB, nA)
[1] 4.009749          [1] 3.180763
```

En R podemos hacerlo de la siguiente manera:

```
> A = c(0.0105,0.0145,0.1060,0.0130,0.0156,0.0104)
> B = c(0.0222,0.0245,0.0320,0.015)
> mediaA = mean(A)
> varA = var(A)
> varB = var(B)
> mediaB = mean(B)
> qf(0.90, nB, nA)
[1] 3.180763
> varA / varB
[1] 29.60037
> varB / varA
[1] 0.03378336
>
```

p-value < α => Rechazo H0

No quiere decir que estoy demostrando H1,

Quiere decir que **NO** tengo evidencias suficientes como para demostrar lo contrario.

```
>
> var.test(A, B)

F test to compare two variances

data:  A and B
F = 29.6, num df = 5, denom df = 3, p-value = 0.01868
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
  1.988627 229.805097
sample estimates:
ratio of variances
         29.60037

> var.test(B, A)

F test to compare two variances

data:  B and A
F = 0.033783, num df = 3, denom df = 5, p-value = 0.01868
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 0.004351514 0.502859406
sample estimates:
ratio of variances
       0.03378336
95 percent confidence interval:
 0.1679171 8.5756582
sample estimates:
ratio of variances
          1.2
```

7. Using the data file “Facebook_Survey.txt”, determine if the mean number of hours spent online per week is the same for males as it is for females.

E. Predictive Analysis

8. The file Credit_Card_Spending.csv provides a database of 49 families, their income and the family size.

a. Identify and describe which analytic technique can be used to analyse the influence of income and family size in the credit card spending.

b. Make a scatter plot for credit card spending versus income and credit card spending versus family size, and describe the relation between each pair of variables.

c. Does the income variable appear to be a significant factor on credit card spending?

d. Does the family size variable appear to be a significant factor on credit card spending?

e. Explain how this analytic technique can be used for forecasting.

f. Predict de average expense of a family that has two members and an income of $188,00 per annum, and another that has three members and an income of $39,000 per annum.

9. The file Credit_Risk_Data.csv provides a database about loan applications, along with a classification of credit risk:

a. Identify and describe which predictive analytic techniques can be applied to classify the data.

b. Explain how logistic regression can be used to classify these data.

c. Sample 200 records from the data set and form the training and validation data sets.

d. Apply logistic regression to classify training and validation data set.

e. Summarize your findings.

10. The file Inflation_Rates.csv provides data (in %) from January-1990 to December-2014.

a. Make a plot of the data.

b. Identify which predictive analytics techniques can be applied to these data and describe these techniques.

c. Explain how you would use these models to forecast, and how far into the future it would be appropriate to forecast.

d. Using MSE and MAPE as guidance, find the best forecasting model.

e. Use this model to generate forecasts for the next two months.

Student declaration

I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.

Student signature: Date: