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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
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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 -

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

*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
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

La varianza de las unidades vendidas es:

```
> varTablaVentas$Units_Sold)  
[1] 253.8676
```

La desviación estándar de las unidades vendidas es:

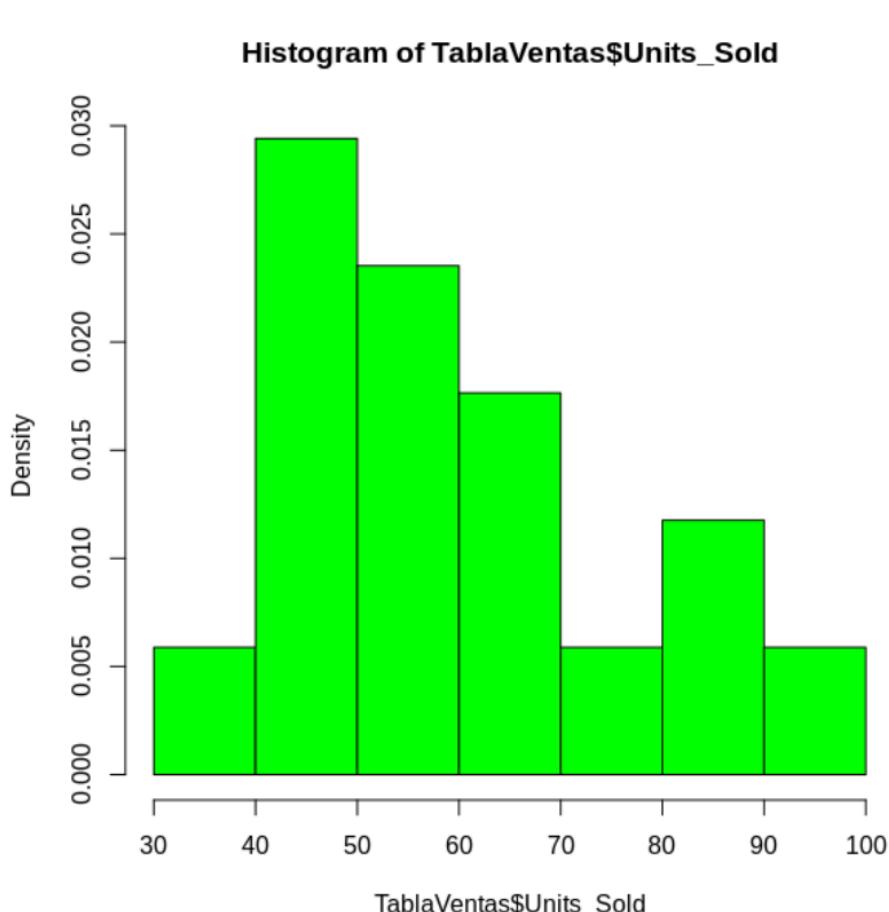
```
> sqrt(varTablaVentas$Units_Sold))  
[1] 15.93322
```

La mediana de las unidades vendidas es:

```
> medianTablaVentas$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.

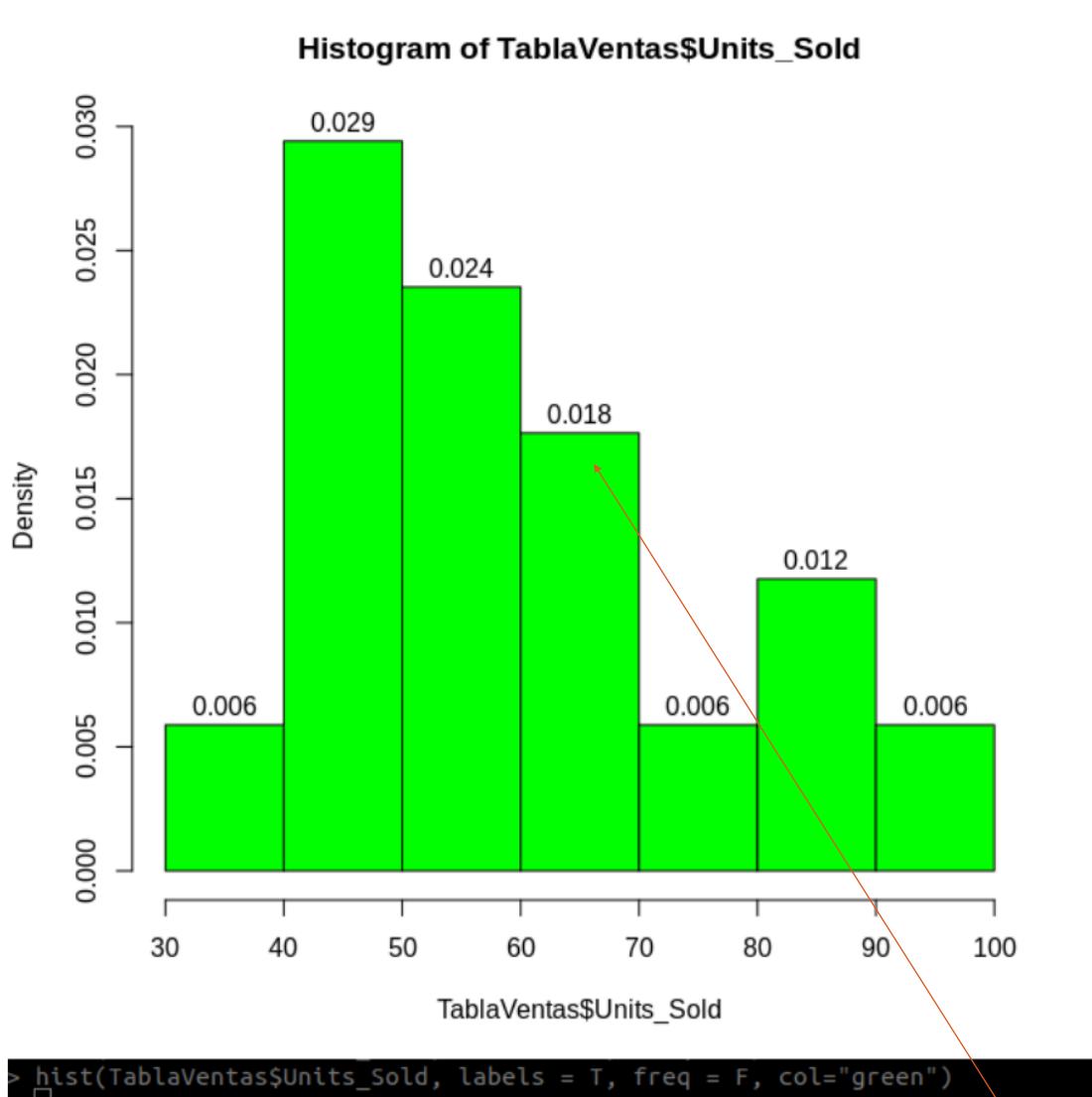
```
> histTablaVentas$Units_Sold, col = "green", freq=0)
```



```
> histTablaVentas$Units_Sold)  
> histTablaVentas$Units_Sold, col = "green")  
> histTablaVentas$Units_Sold, col = "green", freq=0)  
□
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> histTablaVentas$Units_Sold, labels = T, freq = F, col="green")
```

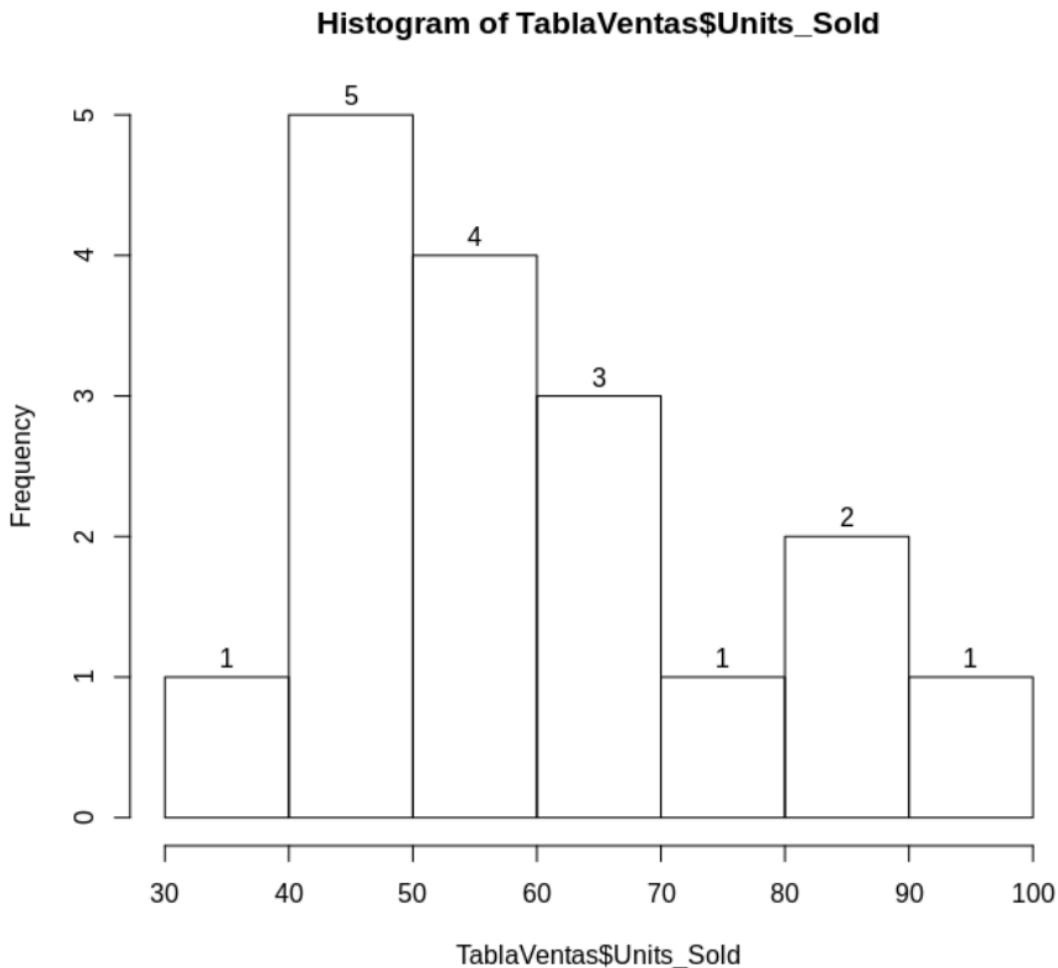


esta frecuencia se multiplica por la amplitud del rango (el ancho de la base) y nos indica que el 18% de las unidades vendidas esta entre 60 y 70.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

En el Histograma podemos ver el comportamiento de las ventas

```
> histTablaVentas$Units_Sold, labels = T)
```



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

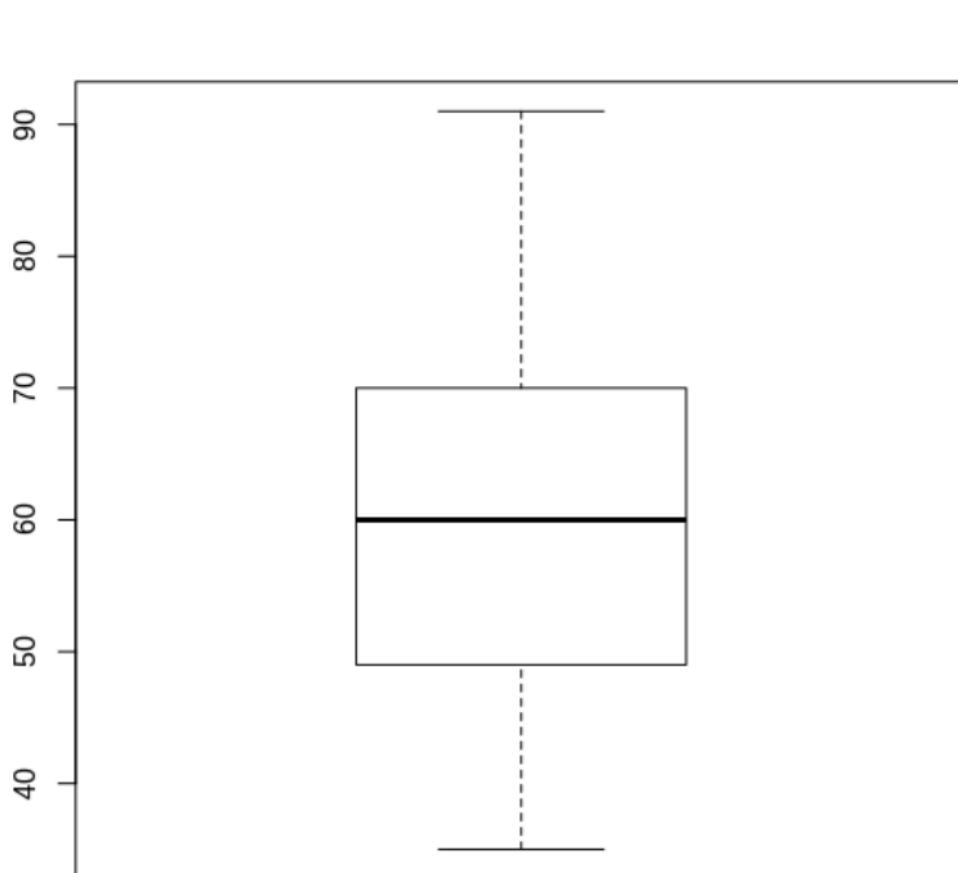
Por debajo de la mediana se han hecho $1+5+4 = 9$ ventas, el 25%.

Por encima de la mediana se han hecho $3+1+2+1 = 7$ ventas, el 25%

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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

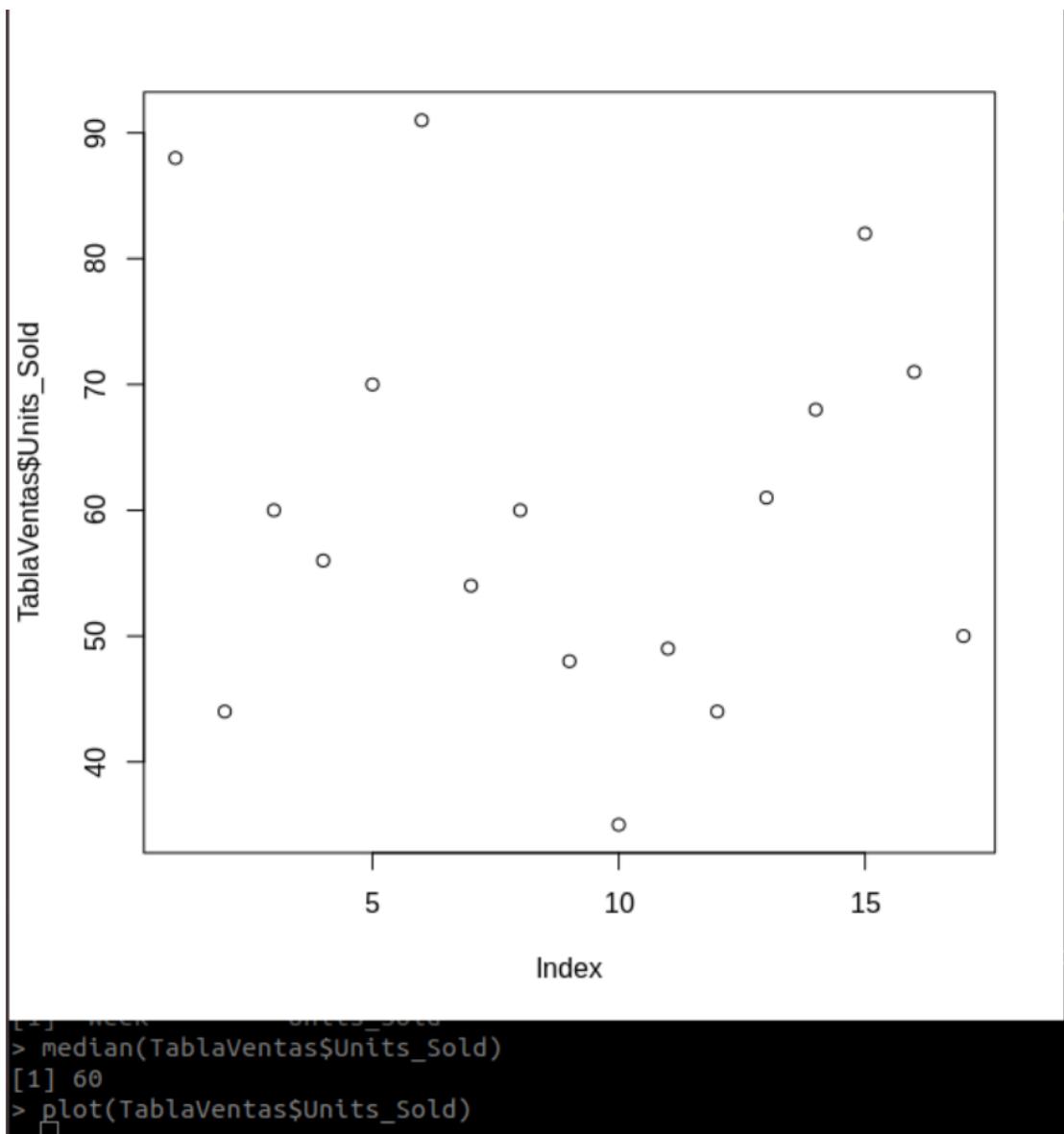
El 25% de las unidades vendidas están por debajo de el Q1= y
El 25% de las unidades vendidas están por encima de el Q3
La mitad de las ventas se hacen entre el Q1=50 y el Q3=70.
El Rango InterQuartil = Q3 - Q1 = 20 que nos indica la dispersión de los datos.



```
> median(tablaVentas$Units_Sold)
[1] 60
> plot(tablaVentas$Units_Sold)
> boxplot(tablaVentas$Units_Sold)
```

No tenemos puntos atípicos.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES



DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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
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 [311] 1.096819799 0.708577377 3.173212465 3.401918301 1.099976911
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[331] 5.715773094 5.605739732 5.261658432 8.457835117 -1.772544152
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 [366] 3.754189859 9.072962750 2.681111516 5.663441872 6.332012385
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 [376] 4.194899577 5.468510852 -0.783665169 1.734988793 2.897535699
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 [396] 6.748727574 3.438648621 -0.984403643 3.258230305 3.916405463
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 [416] 3.715306563 -0.644387593 2.174673450 5.619982301 0.554610257
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 [446] 9.633210482 12.245507500 4.226492924 -2.446737578 4.645199327
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 [506] 2.785994358 -1.177333526 1.043135236 5.571551876 4.071726459
 [511] 5.802865302 6.458471352 4.494384196 0.672108448 8.339207597
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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
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 [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
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 [651] 1.448039004 3.427384559 7.074528827 0.752427279 3.489820925
 [656] 4.902163835 -0.405603491 2.348873931 6.286238261 6.236264022
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 [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 $P(X \leq 6)$

`pnorm(6, 4, 3) = 0.7475`

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

`pnorm(6, 4, 3) = 0.7475`

`pnorm(3, 4, 3) = 0.3694`

`pnorm(6, 4, 3) - pnorm(3, 4, 3) = 0.7475 - 0.3694 = 0.3780`

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

- 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

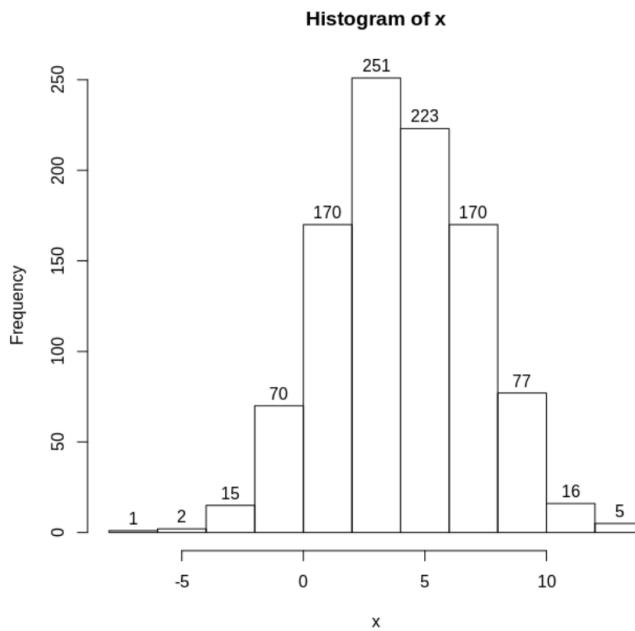
364/1000 = 0,364

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.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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)
```



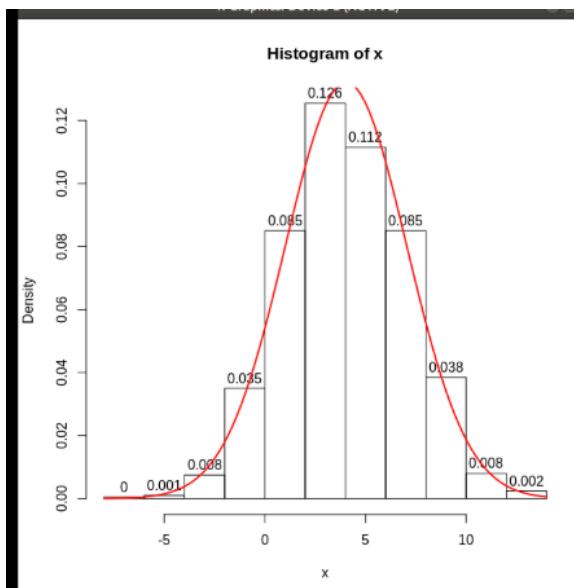
```
> hlst(x)
> hist(x, labels = T)
> }
```

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.
```



DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

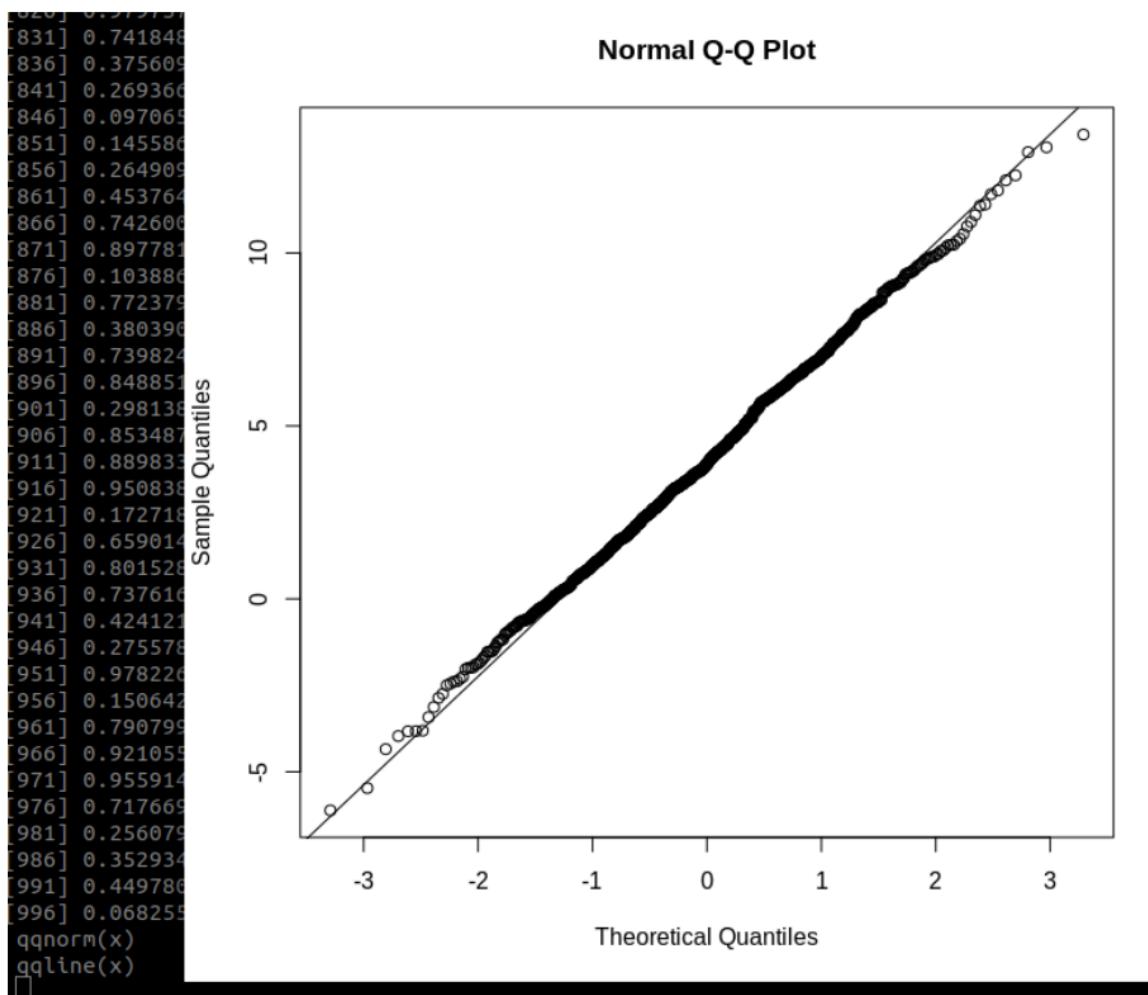
De esta manera defino de forma unívoca la distribución normal.

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
```

<code>> var (acidL)</code>	<code>> sd(acidL)</code>	<code>> sd(acidL) ^2</code>	<code>> sqrt(var(acidL))</code>
[1] 0.1073656	[1] 0.3276668	[1] 0.1073656	[1] 0.3276668

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> media = mean(acidL)
```

```
> media
```

```
[1] 1.379
```

```
> desv = sd(acidL)
```

```
> desv
```

```
[1] 0.3276668
```

```
> var ( acidL )
```

```
[1] 0.1073656
```

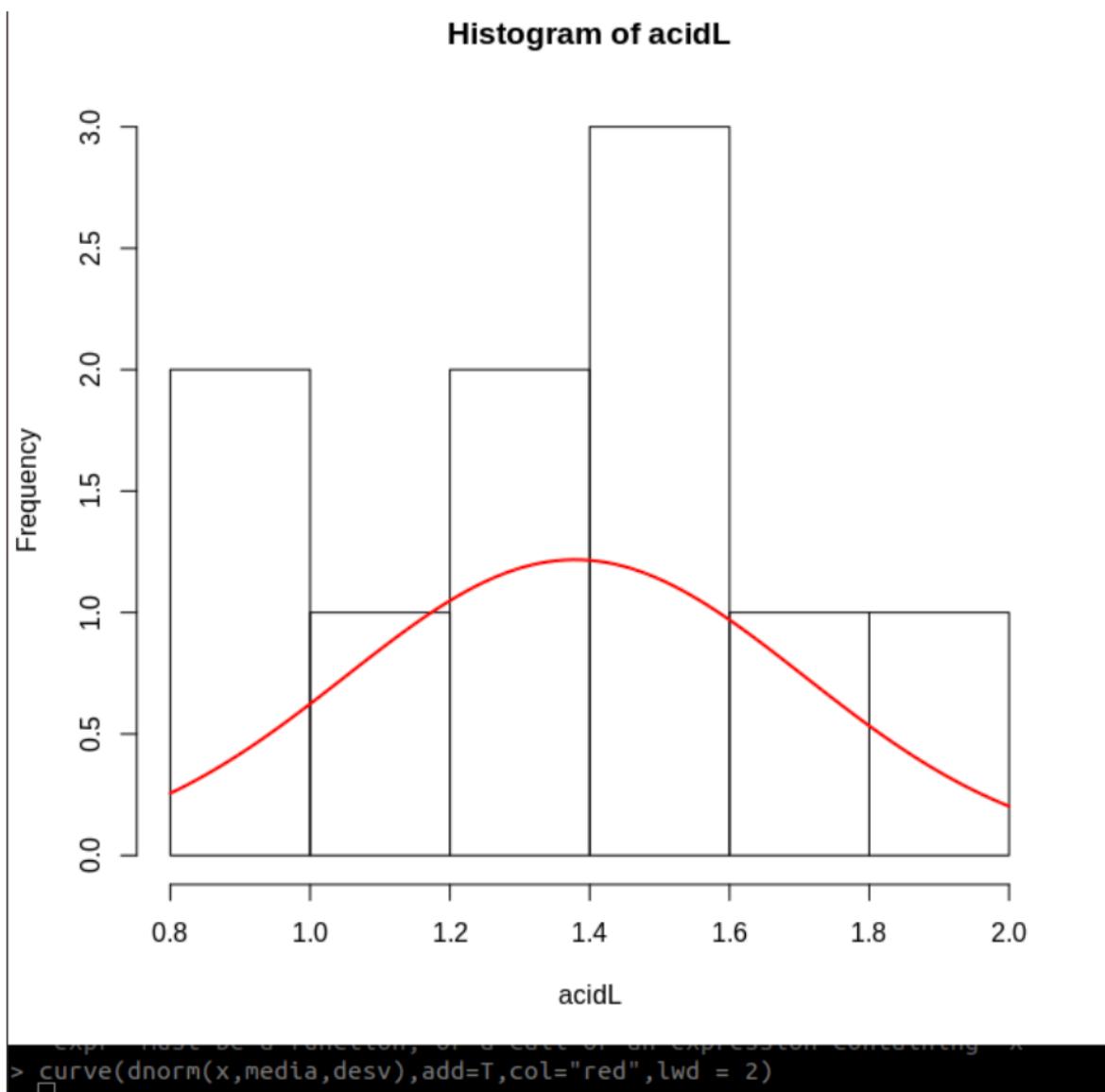
```
> n = length(acidL)
```

```
> 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
```



DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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

$$IC(\mu) = \bar{x} \pm \hat{s} \cdot t_{n-1} \cdot \frac{1}{\sqrt{n}}$$

> # 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 ($\alpha = 0.05$)

$$IC(\sigma^2) = \left(\frac{(n-1)\hat{s}^2}{\chi^2_{\alpha}}, \frac{(n-1)\hat{s}^2}{\chi^2_{\alpha}} \right)$$

> # 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 σ del acidL está entre **1.44601 y 1.613399**

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

Límite de las (X).

```
> Xa = qchisq(0.05 , n-1)
```

```
> Xa
```

```
[1] 3.325113
```

```
> Xb = qchisq(1 - 0.05 , n-1)
```

```
> Xb
```

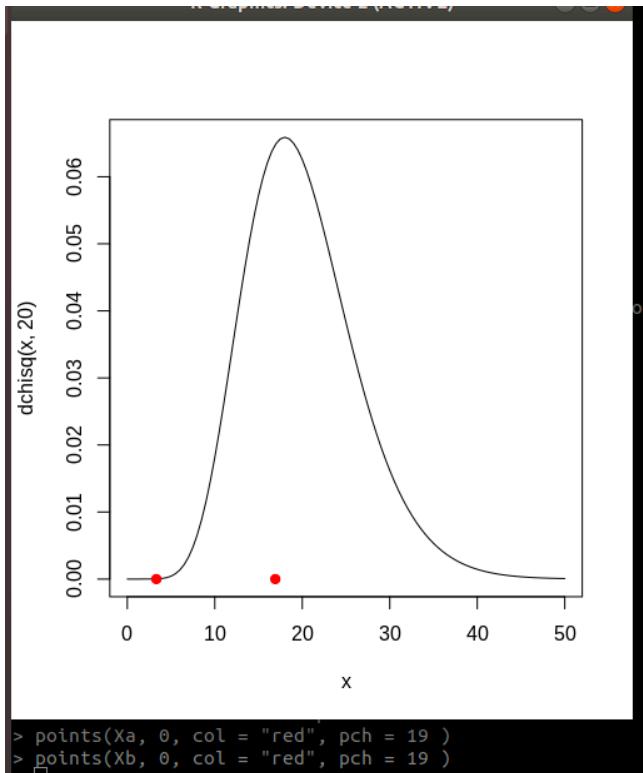
```
[1] 1.613399
```

```
> (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)
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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

$$H_0 : \mu = 1$$

$$H_1 : \mu \neq 1$$

Queremos comprobar que la $\mu = 1$ 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 : $\mu = 1$** , y suponiendo que esto es cierto, entonces siempre va a dar una $1 < \mu < 1$; por tanto **H1: $\mu \neq 1$** .

Si $\alpha = 0.05$, entonces se establece un límite

de 90% para el cual **$\mu = 1$**

Si quiero saber si **$\mu \neq 1$**

> **t.test(acidL) $\mu = 0$ —> 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

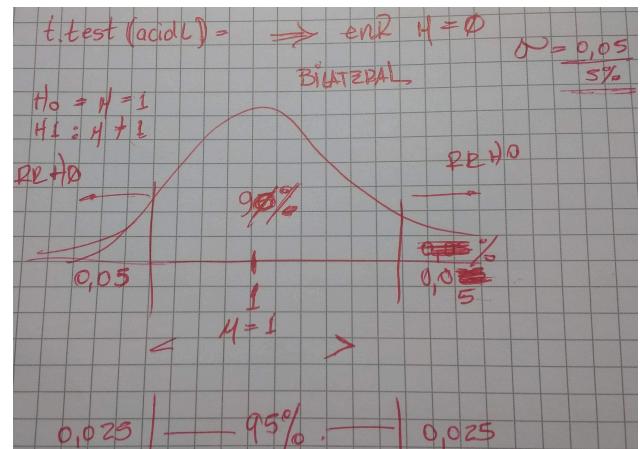
95 percent confidence interval:

1.144601 1.613399

sample estimates:

mean of x

1.379



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

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 **$\mu \neq 1$ porque p-valor es menor que α**, No tengo evidencias suficientes como para decir que **$\mu = 1$** .

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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 each of the previous formula values

are independent Gaussian-distributed random variables:

- Test if there is a significative difference between the means. ($\alpha=0.05$)
- Test if there is a significative difference between the variances. ($\alpha=0.05$)
- **Test if there is a significative difference between the means.**
($\alpha=0.05$)

Definición del modelo de distribución de probabilidad: Hipótesis Parámetros

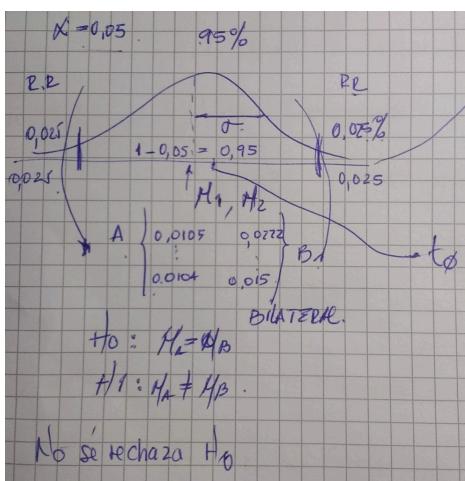
Estimación de los parámetros

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)
```

$$H_0: \mu_1 = \mu_2$$

```
> nA
```

$$H_1: \mu_1 \neq \mu_2$$

```
[1] 6
```

```
> nB
```

```
[1] 4
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> 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:

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

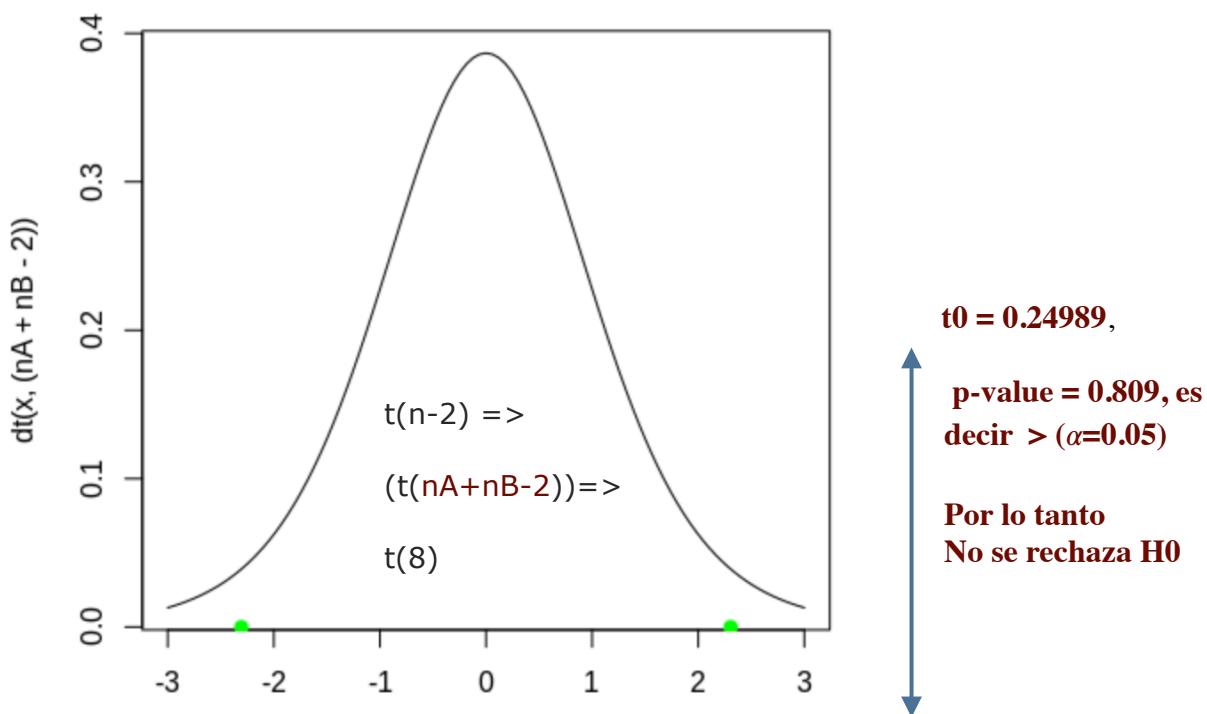
```
> mediaA = mean(A)
> mediaB = mean(B)
> varA = var(A)
> varA
[1] 0.001452071
> varB = var(B)
> varB
[1] 4.905583e-05
> numerador = (nA - 1) * varA + (nB - 1) * varB
> denominador = nA + nB - 2
> denominador
[1] 8
> ResiVar = numerador / denominador
> ResiVar = sqrt( numerador / denominador )
> ResiVar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

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> 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)
```



Está dentro de la zona de aceptación muy cerca a 0 por lo tanto puedo

dicho que H_0 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 > (alpha=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
- $p\text{-value}$ = seguridad para aceptar ó rechazar Hipótesis

hipótesis alternativa: indica que es bilateral

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

sample estimates: medias estimadas

mean of x mean of y

0.02833333 0.02342500

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

- **Test if there is a significative difference between the variances.**
- ($\alpha=0.05$)**

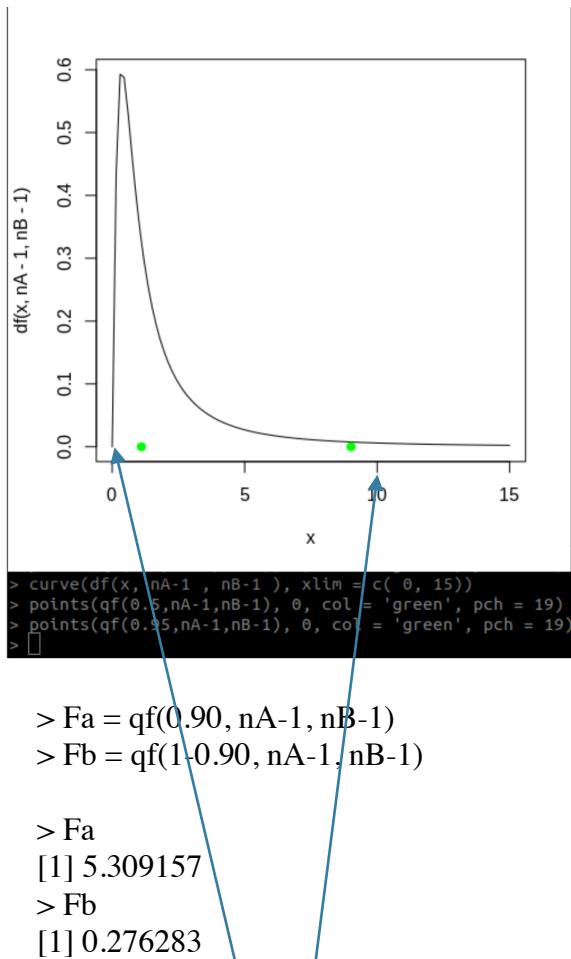
```
> A = c(0.0105,0.0145,0.1060,0.0130,0.0156,0.0104)
> B = c(0.0222,0.0245,0.0320,0.015)
```

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

Si H_0 es cierto => Siguen una distribución **F de Fisher-Snedecor**.

Si H_0 es cierto podemos decir que

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



```
> curve(df(x, nA-1 , nB-1 ), xlim = c( 0, 15))
> points(qf(0.5,nA-1,nB-1), 0, col = 'green', pch = 19)
> points(qf(0.95,nA-1,nB-1), 0, col = 'green', pch = 19)
```

```
> Fa = qf(0.90, nB-1, nA-1)
> Fb = qf(1-0.90, nB-1, nA-1)
```

```
> Fa
[1] 3.619477
> Fb
[1] 0.1883538
```

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

Si H_0 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
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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.

```
> facebook = read.table('Facebook_survey.txt', header = T)
```

```
> facebook
```

	Student	Gender	Hours_week	Friends
1	1	female	4	150
2	2	female	10	400
3	3	male	7	120
4	4	male	15	500
5	5	female	9	260
6	6	female	5	70
7	7	female	7	90
8	8	male	5	250
9	9	female	12	110
10	10	female	2	30
11	11	female	6	80
12	12	female	2	30
13	13	male	3	200
14	14	female	6	240
15	15	male	6	150
16	16	male	4	90
17	17	female	8	340
18	18	male	10	450
19	19	female	4	50
20	20	male	4	120
21	21	male	6	180
22	22	female	4	280
23	23	female	5	60
24	24	female	9	100
25	25	female	12	380
26	26	male	8	430
27	27	female	2	80
28	28	female	7	170
29	29	male	6	90
30	30	male	4	50
31	31	female	2	50
32	32	male	5	70
33	33	female	7	170

```
> names(facebook)
[1] "Student"    "Gender"     "Hours_week"  "Friends"
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> summary(facebook)
  Student   Gender   Hours_week   Friends
Min. : 1 female:20 Min. :2.000  Min. :30
1st Qu.: 9 male :13 1st Qu.:4.000  1st Qu.:80
Median :17          Median :6.000  Median :120
Mean  :17          Mean  :6.242  Mean  :177
3rd Qu.:25          3rd Qu.:8.000  3rd Qu.:250
Max.  :33          Max. :15.000  Max. :500

> length(facebook)
[1] 4 --> columns
> lf = length(facebook[[1]])
> lf
[1] 33 --> registros

> names(facebook)
[1] "Student"    "Gender"     "Hours_week"  "Friends"
> facebook$Gender
[1] female female male  male  female female female male  female female
[11] female female male  female male  male  female male  female male
[21] male  female female female male  female female male  male
[31] female male  female
Levels: female male

> facebook$Gender == "female"
[1] TRUE TRUE FALSE FALSE TRUE TRUE TRUE FALSE TRUE TRUE TRUE
TRUE
[13] FALSE TRUE FALSE FALSE TRUE FALSE TRUE FALSE FALSE TRUE TRUE
TRUE
[25] TRUE FALSE TRUE TRUE FALSE FALSE TRUE FALSE TRUE

> facebook$Hours_week
[1] 4 10 7 15 9 5 7 5 12 2 6 2 3 6 6 4 8 10 4 4 6 4 5 9 12
[26] 8 2 7 6 4 2 5 7

> F = facebook$Hours_week [facebook$Gender == "female"]
> nF = length(F)
> nF
[1] 20
> mediaF = mean(F)
> mediaF
[1] 6.15
> varF = var(F)
> varF
[1] 10.02895
```

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

```
> M = facebook$Hours_week [facebook$Gender == "male"]
> varM = var(M)
> varM
[1] 10.25641
> mediaM = mean(M)
> mediaM
[1] 6.384615
> nM = length(M)
> nM
[1] 13
```

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

```
> numerador = (nF - 1) * varF + (nM - 1) * varM
> denominador = nF + nM - 2
> ResiVar = sqrt ( numerador / denominador )
> ResiVar
[1] 3.180723
```

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

```
> numeradort0 = mediaF - mediaM
> denominadort0 = sqrt(ResiVar) * sqrt ( 1/nF + 1/nM )
> t0 = numeradort0 / denominadort0
> t0
[1] -0.3692524
```

> t.test(F,M)

Welch Two Sample t-test

data: F and M
t = -0.20654, df = 25.576, **p-value = 0.838 > α => Acepto H0**
 alternative hypothesis: true difference in means is not equal to 0
 95 percent confidence interval:
 -2.571496 2.102266
 sample estimates:
 mean of x mean of y
 6.150000 6.384615

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

> t.test(M,F)

Welch Two Sample t-test

data: M and F

t = 0.20654, df = 25.576, p-value = 0.838 > α => Acepto H0

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

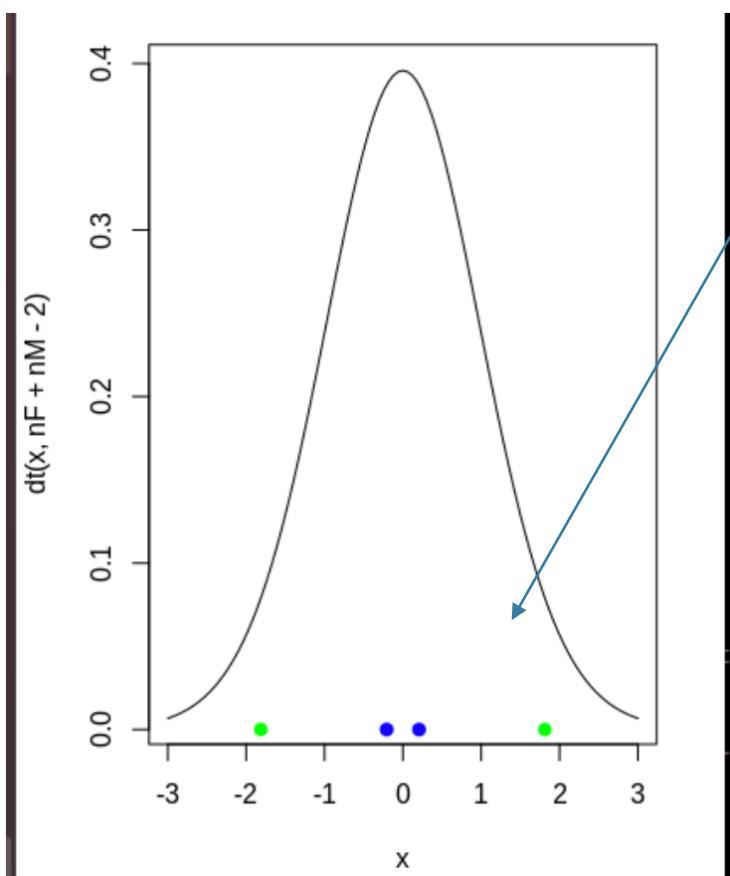
-2.102266 2.571496

sample estimates:

mean of x mean of y

6.384615 6.150000

```
> curve(dt(x,nF+nM-2), xlim= c(-3,3))
> points(qt(0.05,10), 0, col='green',pch=19)
> points(qt(0.95,10), 0, col='green',pch=19)
> points(-0.20654, 0, col='blue', pch=19)
> points(0.20654, 0, col='blue', pch=19)
```



```
> curve(dt(x,nF+nM-2), xlim= c(-3,3))
> points(qt(0.05,10), 0, col='green',pch=19)
> points(qt(0.95,10), 0, col='green',pch=19)
> points(-0.20654, 0, col='blue', pch=19)
> points(0.20654, 0, col='blue', pch=19)
> □
```

Podemos concluir que: No hay diferencia significativa porque al calcular el valor

Al ubicarlo en la t-student con $nF+nM-2$ grados de libertad y ubicamos la RR que esta en -2,2 y 2,2.

No hay referencia suficiente entre las medias de las muestras para Poder afirmar que hay diferencias significativas.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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.

DATA ANALYTICS: DESCRIPTIVE, INFERENCE, AND PREDICTIVE TECHNIQUES

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: