Laboratorio 3

Rudik R. Rompich - 1987

Colocar el directorio de datos

```
getwd()
```

```
## [1] "/Users/rudiks/Git/UVG-DataMining-Notas-6-Semestre/Laboratorio3"
```

Cargar datos

```
df <- read.csv("student-mat.csv",sep =";", stringsAsFactors =  T)
head(df)
```

```
##   school sex age address famsize Pstatus Medu Fedu     Mjob     Fjob     reason
## 1     GP   F  18       U     GT3       A    4    4  at_home  teacher     course
## 2     GP   F  17       U     GT3       T    1    1  at_home    other     course
## 3     GP   F  15       U     LE3       T    1    1  at_home    other      other
## 4     GP   F  15       U     GT3       T    4    2   health services       home
## 5     GP   F  16       U     GT3       T    3    3    other    other       home
## 6     GP   M  16       U     LE3       T    4    3 services    other reputation
##   guardian traveltime studytime failures schoolsup famsup paid activities
## 1   mother          2         2        0       yes     no   no         no
## 2   father          1         2        0        no    yes   no         no
## 3   mother          1         2        3       yes     no  yes         no
## 4   mother          1         3        0        no    yes  yes        yes
## 5   father          1         2        0        no    yes  yes         no
## 6   mother          1         2        0        no    yes  yes        yes
##   nursery higher internet romantic famrel freetime goout Dalc Walc health
## 1     yes    yes       no       no      4        3     4    1    1      3
## 2      no    yes      yes       no      5        3     3    1    1      3
## 3     yes    yes      yes       no      4        3     2    2    3      3
## 4     yes    yes      yes      yes      3        2     2    1    1      5
## 5     yes    yes       no       no      4        3     2    1    2      5
## 6     yes    yes      yes       no      5        4     2    1    2      5
##   absences G1 G2 G3
## 1        6  5  6  6
## 2        4  5  5  6
## 3       10  7  8 10
## 4        2 15 14 15
## 5        4  6 10 10
## 6       10 15 15 15
```

Un resumen de los datos

```
summary(df)
```

```
##  school   sex          age       address famsize   Pstatus      Medu
##  GP:349   F:208   Min.   :15.0   R: 88   GT3:281   A: 41   Min.   :0.000
##  MS: 46   M:187   1st Qu.:16.0   U:307   LE3:114   T:354   1st Qu.:2.000
##                   Median :17.0                             Median :3.000
##                   Mean   :16.7                             Mean   :2.749
##                   3rd Qu.:18.0                             3rd Qu.:4.000
##                   Max.   :22.0                             Max.   :4.000
##       Fedu             Mjob           Fjob            reason      guardian
##  Min.   :0.000   at_home : 59   at_home : 20   course    :145   father: 90
##  1st Qu.:2.000   health  : 34   health  : 18   home      :109   mother:273
##  Median :2.000   other   :141   other   :217   other     : 36   other : 32
##  Mean   :2.522   services:103   services:111   reputation:105
##  3rd Qu.:3.000   teacher : 58   teacher : 29
##  Max.   :4.000
##    traveltime      studytime        failures      schoolsup famsup     paid
##  Min.   :1.000   Min.   :1.000   Min.   :0.0000   no :344   no :153   no :214
##  1st Qu.:1.000   1st Qu.:1.000   1st Qu.:0.0000   yes: 51   yes:242   yes:181
##  Median :1.000   Median :2.000   Median :0.0000
##  Mean   :1.448   Mean   :2.035   Mean   :0.3342
##  3rd Qu.:2.000   3rd Qu.:2.000   3rd Qu.:0.0000
##  Max.   :4.000   Max.   :4.000   Max.   :3.0000
##  activities nursery   higher    internet  romantic      famrel
##  no :194    no : 81   no : 20   no : 66   no :263   Min.   :1.000
##  yes:201    yes:314   yes:375   yes:329   yes:132   1st Qu.:4.000
##                                                     Median :4.000
##                                                     Mean   :3.944
##                                                     3rd Qu.:5.000
##                                                     Max.   :5.000
##     freetime         goout            Dalc            Walc
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  1st Qu.:3.000   1st Qu.:2.000   1st Qu.:1.000   1st Qu.:1.000
##  Median :3.000   Median :3.000   Median :1.000   Median :2.000
##  Mean   :3.235   Mean   :3.109   Mean   :1.481   Mean   :2.291
##  3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:2.000   3rd Qu.:3.000
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :5.000
##      health         absences            G1              G2
##  Min.   :1.000   Min.   : 0.000   Min.   : 3.00   Min.   : 0.00
##  1st Qu.:3.000   1st Qu.: 0.000   1st Qu.: 8.00   1st Qu.: 9.00
##  Median :4.000   Median : 4.000   Median :11.00   Median :11.00
##  Mean   :3.554   Mean   : 5.709   Mean   :10.91   Mean   :10.71
##  3rd Qu.:5.000   3rd Qu.: 8.000   3rd Qu.:13.00   3rd Qu.:13.00
##  Max.   :5.000   Max.   :75.000   Max.   :19.00   Max.   :19.00
##        G3
##  Min.   : 0.00
##  1st Qu.: 8.00
##  Median :11.00
##  Mean   :10.42
##  3rd Qu.:14.00
##  Max.   :20.00
```

Estructura de las columnas

```
str(df)
```

```
## 'data.frame':    395 obs. of  33 variables:
##  $ school    : Factor w/ 2 levels "GP","MS": 1 1 1 1 1 1 1 1 1 1 ...
##  $ sex       : Factor w/ 2 levels "F","M": 1 1 1 1 1 2 2 1 2 2 ...
##  $ age       : int  18 17 15 15 16 16 16 17 15 15 ...
##  $ address   : Factor w/ 2 levels "R","U": 2 2 2 2 2 2 2 2 2 2 ...
##  $ famsize   : Factor w/ 2 levels "GT3","LE3": 1 1 2 1 1 2 2 1 2 1 ...
##  $ Pstatus   : Factor w/ 2 levels "A","T": 1 2 2 2 2 2 2 1 1 2 ...
##  $ Medu      : int  4 1 1 4 3 4 2 4 3 3 ...
##  $ Fedu      : int  4 1 1 2 3 3 2 4 2 4 ...
##  $ Mjob      : Factor w/ 5 levels "at_home","health",..: 1 1 1 2 3 4 3 3 4 3 ...
##  $ Fjob      : Factor w/ 5 levels "at_home","health",..: 5 3 3 4 3 3 3 5 3 3 ...
##  $ reason    : Factor w/ 4 levels "course","home",..: 1 1 3 2 2 4 2 2 2 2 ...
##  $ guardian  : Factor w/ 3 levels "father","mother",..: 2 1 2 2 1 2 2 2 2 2 ...
##  $ traveltime: int  2 1 1 1 1 1 1 2 1 1 ...
##  $ studytime : int  2 2 2 3 2 2 2 2 2 2 ...
##  $ failures  : int  0 0 3 0 0 0 0 0 0 0 ...
##  $ schoolsup : Factor w/ 2 levels "no","yes": 2 1 2 1 1 1 1 2 1 1 ...
##  $ famsup    : Factor w/ 2 levels "no","yes": 1 2 1 2 2 2 1 2 2 2 ...
##  $ paid      : Factor w/ 2 levels "no","yes": 1 1 2 2 2 2 1 1 2 2 ...
##  $ activities: Factor w/ 2 levels "no","yes": 1 1 1 2 1 2 1 1 1 2 ...
##  $ nursery   : Factor w/ 2 levels "no","yes": 2 1 2 2 2 2 2 2 2 2 ...
##  $ higher    : Factor w/ 2 levels "no","yes": 2 2 2 2 2 2 2 2 2 2 ...
##  $ internet  : Factor w/ 2 levels "no","yes": 1 2 2 2 1 2 2 1 2 2 ...
##  $ romantic  : Factor w/ 2 levels "no","yes": 1 1 1 2 1 1 1 1 1 1 ...
##  $ famrel    : int  4 5 4 3 4 5 4 4 4 5 ...
##  $ freetime  : int  3 3 3 2 3 4 4 1 2 5 ...
##  $ goout     : int  4 3 2 2 2 2 4 4 2 1 ...
##  $ Dalc      : int  1 1 2 1 1 1 1 1 1 1 ...
##  $ Walc      : int  1 1 3 1 2 2 1 1 1 1 ...
##  $ health    : int  3 3 3 5 5 5 3 1 1 5 ...
##  $ absences  : int  6 4 10 2 4 10 0 6 0 0 ...
##  $ G1        : int  5 5 7 15 6 15 12 6 16 14 ...
##  $ G2        : int  6 5 8 14 10 15 12 5 18 15 ...
##  $ G3        : int  6 6 10 15 10 15 11 6 19 15 ...
```

Valores faltantes

```
any(is.na(df))
```

```
## [1] FALSE
```

Análisis de correlación

```
library(ggplot2)
library(ggthemes)
library(dplyr)
```

```
##
```

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

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

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

```
library(corrplot)
```

```
## corrplot 0.90 loaded
```

Evaluar que columnas son verdaderas

```
vector_num <- sapply(df,is.numeric)
vector_num
```

```
##     school        sex        age    address    famsize    Pstatus       Medu
##      FALSE      FALSE       TRUE      FALSE      FALSE      FALSE       TRUE
##       Fedu       Mjob       Fjob     reason   guardian traveltime  studytime
##       TRUE      FALSE      FALSE      FALSE      FALSE       TRUE       TRUE
##   failures  schoolsup     famsup       paid activities    nursery     higher
##       TRUE      FALSE      FALSE      FALSE      FALSE      FALSE      FALSE
##   internet   romantic     famrel   freetime      goout       Dalc       Walc
##      FALSE      FALSE       TRUE       TRUE       TRUE       TRUE       TRUE
##     health   absences         G1         G2         G3
##       TRUE       TRUE       TRUE       TRUE       TRUE
```

Vector de valores lógicos para filtrar numéricos

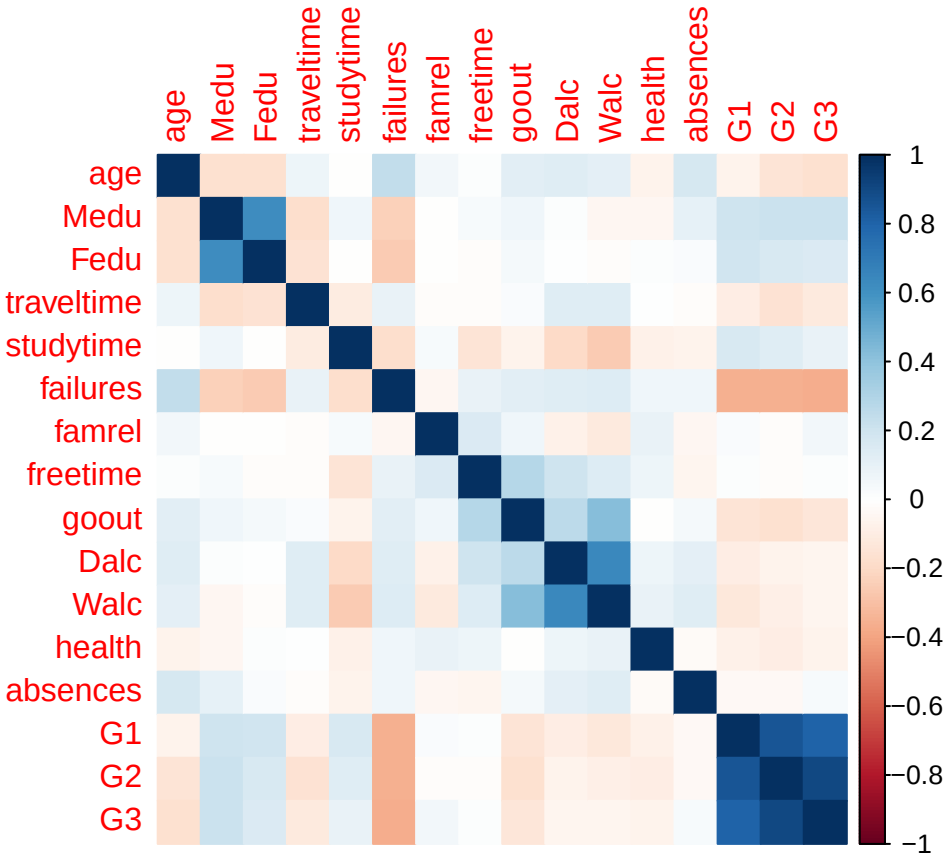
```
cor_df <- cor(df[,vector_num])
cor_df
```

```
##                     age         Medu         Fedu   traveltime    studytime
## age         1.000000000 -0.163658419 -0.163438069  0.070640721 -0.004140037
## Medu       -0.163658419  1.000000000  0.623455112 -0.171639305  0.064944137
## Fedu       -0.163438069  0.623455112  1.000000000 -0.158194054 -0.009174639
## traveltime  0.070640721 -0.171639305 -0.158194054  1.000000000 -0.100909119
## studytime  -0.004140037  0.064944137 -0.009174639 -0.100909119  1.000000000
## failures    0.243665377 -0.236679963 -0.250408444  0.092238746 -0.173563031
## famrel      0.053940096 -0.003914458 -0.001369727 -0.016807986  0.039730704
## freetime    0.016434389  0.030890867 -0.012845528 -0.017024944 -0.143198407
## goout       0.126963880  0.064094438  0.043104668  0.028539674 -0.063903675
## Dalc        0.131124605  0.019834099  0.002386429  0.138325309 -0.196019263
## Walc        0.117276052 -0.047123460 -0.012631018  0.134115752 -0.253784731
## health     -0.062187369 -0.046877829  0.014741537  0.007500606 -0.075615863
## absences    0.175230079  0.100284818  0.024472887 -0.012943775 -0.062700175
## G1         -0.064081497  0.205340997  0.190269936 -0.093039992  0.160611915
## G2         -0.143474049  0.215527168  0.164893393 -0.153197963  0.135879999
## G3         -0.161579438  0.217147496  0.152456939 -0.117142053  0.097819690
##                failures       famrel    freetime        goout         Dalc
## age         0.24366538  0.053940096  0.01643439  0.126963880  0.131124605
```

```
## Medu       -0.23667996 -0.003914458  0.03089087  0.064094438  0.019834099
## Fedu       -0.25040844 -0.001369727 -0.01284553  0.043104668  0.002386429
## traveltime  0.09223875 -0.016807986 -0.01702494  0.028539674  0.138325309
## studytime  -0.17356303  0.039730704 -0.14319841 -0.063903675 -0.196019263
## failures    1.00000000 -0.044336626  0.09198747  0.124560922  0.136046931
## famrel     -0.04433663  1.000000000  0.15070144  0.064568411 -0.077594357
## freetime    0.09198747  0.150701444  1.00000000  0.285018715  0.209000848
## goout       0.12456092  0.064568411  0.28501871  1.000000000  0.266993848
## Dalc        0.13604693 -0.077594357  0.20900085  0.266993848  1.000000000
## Walc        0.14196203 -0.113397308  0.14782181  0.420385745  0.647544230
## health      0.06582728  0.094055728  0.07573336 -0.009577254  0.077179582
## absences    0.06372583 -0.044354095 -0.05807792  0.044302220  0.111908026
## G1         -0.35471761  0.022168316  0.01261293 -0.149103967 -0.094158792
## G2         -0.35589563 -0.018281347 -0.01377714 -0.162250034 -0.064120183
## G3         -0.36041494  0.051363429  0.01130724 -0.132791474 -0.054660041
##                   Walc       health    absences          G1          G2
## age         0.11727605 -0.062187369  0.17523008 -0.06408150 -0.14347405
## Medu       -0.04712346 -0.046877829  0.10028482  0.20534100  0.21552717
## Fedu       -0.01263102  0.014741537  0.02447289  0.19026994  0.16489339
## traveltime  0.13411575  0.007500606 -0.01294378 -0.09303999 -0.15319796
## studytime  -0.25378473 -0.075615863 -0.06270018  0.16061192  0.13588000
## failures    0.14196203  0.065827282  0.06372583 -0.35471761 -0.35589563
## famrel     -0.11339731  0.094055728 -0.04435409  0.02216832 -0.01828135
## freetime    0.14782181  0.075733357 -0.05807792  0.01261293 -0.01377714
## goout       0.42038575 -0.009577254  0.04430222 -0.14910397 -0.16225003
## Dalc        0.64754423  0.077179582  0.11190803 -0.09415879 -0.06412018
## Walc        1.00000000  0.092476317  0.13629110 -0.12617921 -0.08492735
## health      0.09247632  1.000000000 -0.02993671 -0.07317207 -0.09771987
## absences    0.13629110 -0.029936711  1.00000000 -0.03100290 -0.03177670
## G1         -0.12617921 -0.073172073 -0.03100290  1.00000000  0.85211807
## G2         -0.08492735 -0.097719866 -0.03177670  0.85211807  1.00000000
## G3         -0.05193932 -0.061334605  0.03424732  0.80146793  0.90486799
##                    G3
## age        -0.16157944
## Medu        0.21714750
## Fedu        0.15245694
## traveltime -0.11714205
## studytime   0.09781969
## failures   -0.36041494
## famrel      0.05136343
## freetime    0.01130724
## goout      -0.13279147
## Dalc       -0.05466004
## Walc       -0.05193932
## health     -0.06133460
## absences    0.03424732
## G1          0.80146793
## G2          0.90486799
## G3          1.00000000
```

Graficar

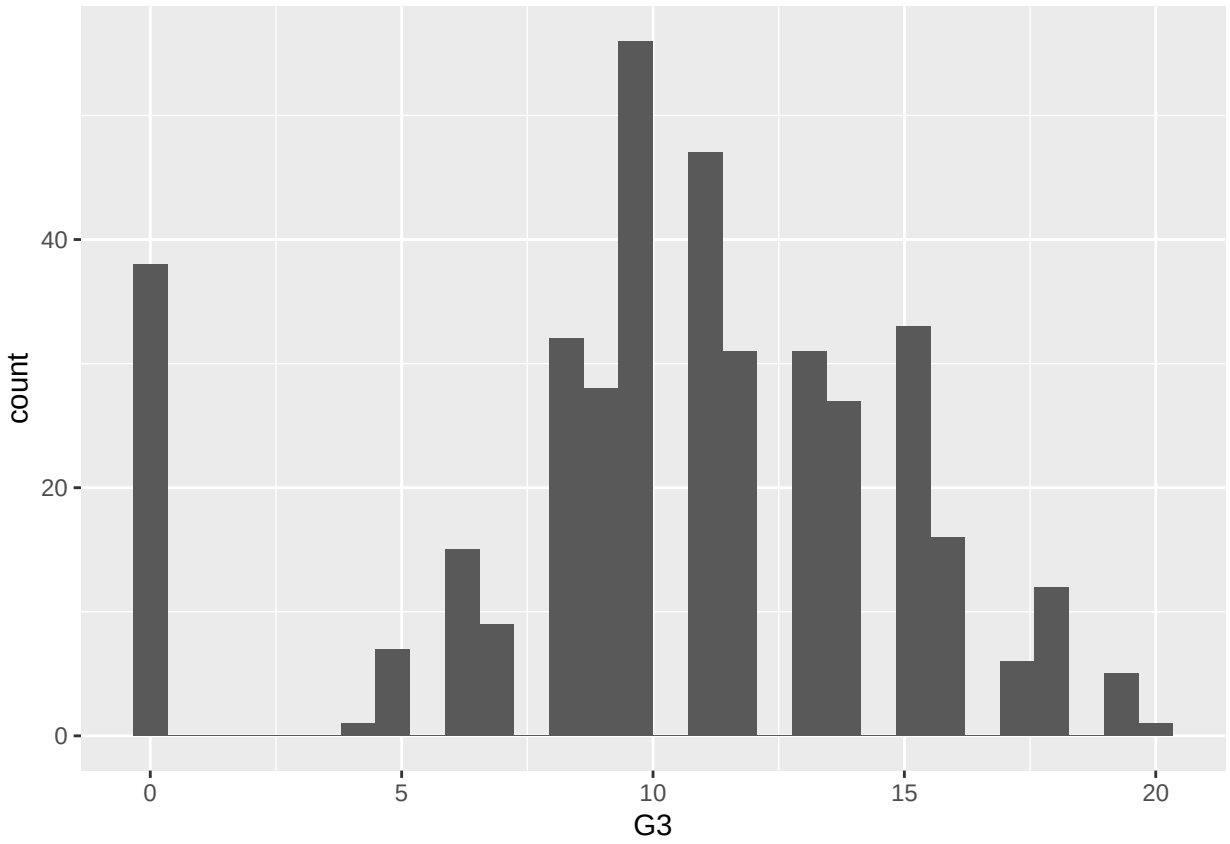
```
corrplot(cor_df,method ="color")
```



Visualizar con un histograma la variable G3

```
ggplot(df, aes(x=G3))+geom_histogram()
```

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



Proceso de partición de los datos

```
library(caTools)
```

Mismos parámetros

```
set.seed(101)
```

Partición de los datos

```
muestreo <- sample.split(df$G3, SplitRatio = 0.7)
head(muestreo)
```

```
## [1]  TRUE  TRUE  TRUE FALSE FALSE  TRUE
```

Set de entrenamiento

```
entrenamiento <- subset(df,muestreo==T)
prueba <- subset(df, muestreo == F)
```

Modelo de regresión lineal

```
modelo <- lm(G3 ~., entrenamiento)
summary(modelo)
```

```
##
## Call:
## lm(formula = G3 ~ ., data = entrenamiento)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.4250 -0.6478  0.2844  1.0442  4.9840
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       3.70763    2.69488   1.376  0.17019
## schoolMS          0.66981    0.47436   1.412  0.15926
## sexM              0.25730    0.29257   0.879  0.38006
## age              -0.36163    0.12949  -2.793  0.00566 **
## addressU          0.08123    0.35652   0.228  0.81996
## famsizeLE3        0.12222    0.28709   0.426  0.67070
## PstatusT          0.06807    0.43032   0.158  0.87444
## Medu              0.11100    0.18757   0.592  0.55455
## Fedu             -0.16373    0.15928  -1.028  0.30503
## Mjobhealth       -0.63993    0.65314  -0.980  0.32820
## Mjobother        -0.15730    0.42323  -0.372  0.71048
## Mjobservices     -0.15872    0.46682  -0.340  0.73415
## Mjobteacher      -0.04930    0.62335  -0.079  0.93702
## Fjobhealth        0.17565    0.83034   0.212  0.83265
## Fjobother        -0.29559    0.56012  -0.528  0.59818
## Fjobservices     -0.76964    0.59476  -1.294  0.19692
## Fjobteacher      -0.27009    0.73824  -0.366  0.71480
## reasonhome       -0.41126    0.31857  -1.291  0.19799
## reasonother       0.06767    0.45323   0.149  0.88144
## reasonreputation  0.13478    0.34735   0.388  0.69834
## guardianmother   -0.05442    0.31663  -0.172  0.86369
## guardianother     0.01588    0.58375   0.027  0.97832
## traveltime       -0.02353    0.19540  -0.120  0.90427
## studytime        -0.04294    0.16910  -0.254  0.79979
## failures         -0.17219    0.19668  -0.875  0.38220
## schoolsupyes      0.20742    0.42358   0.490  0.62481
## famsupyes        -0.05329    0.27753  -0.192  0.84789
## paidyes           0.31311    0.28284   1.107  0.26941
## activitiesyes    -0.26104    0.26687  -0.978  0.32901
## nurseryyes       -0.05345    0.31236  -0.171  0.86428
## higheryes        -0.94298    0.74005  -1.274  0.20385
## internetyes      -0.15834    0.37029  -0.428  0.66932
## romanticyes      -0.30048    0.28115  -1.069  0.28627
## famrel            0.36601    0.14609   2.505  0.01291 *
## freetime          0.08386    0.14247   0.589  0.55668
## goout            -0.12457    0.13306  -0.936  0.35015
## Dalc             -0.16995    0.20659  -0.823  0.41153
## Walc              0.21053    0.14963   1.407  0.16074
## health            0.07805    0.09341   0.836  0.40426
## absences          0.09547    0.02382   4.008 8.24e-05 ***
## G1                0.14259    0.07892   1.807  0.07206 .
## G2                0.98859    0.06929  14.267  < 2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.962 on 235 degrees of freedom
## Multiple R-squared:  0.8456, Adjusted R-squared:  0.8187
## F-statistic: 31.39 on 41 and 235 DF,  p-value: < 2.2e-16
```

Hacer predicciones

```
predicciones <- predict(modelo, prueba)
cbind(predicciones)
```

```
##     predicciones
## 4     12.6825067
## 5      9.4336769
## 7     11.3123105
## 8      3.1015305
## 10    15.5646743
## 13    14.1903603
## 21    14.6014273
## 25     9.1914195
## 30    12.3525888
## 32    16.2922426
## 39    12.5533857
## 40    14.5733625
## 42    13.3614557
## 49    16.1217573
## 54     9.0446862
## 57    14.6141184
## 61     9.5080892
## 62     7.5710920
## 64     8.8472173
## 65     9.3670135
## 71    15.6454393
## 75    16.2834668
## 77    11.4850585
## 79     7.4548692
## 84    15.9082651
## 86     8.2599349
## 90     8.1169413
## 91     5.6803442
## 101    7.2175201
## 105   18.3876481
## 114   21.1555406
## 116   15.6866089
## 119    7.9292306
## 121   14.7037354
## 129    1.6560062
## 136   -0.5722479
## 144   14.0271825
## 149    5.4024220
## 154   -2.0734087
## 155   10.1102414
```

```
## 156    7.7569948
## 161    5.0096361
## 162    8.7189636
## 164   10.5773936
## 165    7.0152864
## 166   12.7184372
## 170   13.8328358
## 173   11.2291900
## 176    8.8874418
## 177   13.3031919
## 178    4.4005494
## 182   12.2344323
## 184   13.0264173
## 187   10.7573420
## 189    5.3686876
## 191   11.4796170
## 194    8.6959588
## 202   10.3285844
## 204    6.8413892
## 213   12.4947655
## 216   15.3468786
## 221    4.0232491
## 224   11.6067455
## 225   11.9760242
## 230    9.2289814
## 233    9.5256796
## 234   12.8037784
## 235    7.9882826
## 236    9.9725178
## 240    6.5821294
## 244   11.8428148
## 245   -1.7749205
## 249    3.0444624
## 252   10.7039279
## 260    7.0279845
## 261   18.9040910
## 262    7.1891059
## 263   11.5850336
## 277   14.5571565
## 278    8.8714461
## 279    6.5095023
## 283   11.5972085
## 291   11.5096672
## 292   14.1211742
## 294   18.7317433
## 295   13.8264957
## 300   13.6684550
## 301    8.5915447
## 302   10.4452654
## 307   17.5819281
## 308   10.1425016
## 309   10.5251082
## 312   13.3845674
## 313    9.7749903
```

```
## 316   12.6740505
## 323    9.4988405
## 329    8.7491969
## 330   13.9303183
## 333   -2.7955823
## 339   14.1194524
## 344    6.3146881
## 345    9.0314702
## 347   15.3609026
## 350   12.7714068
## 351    5.3986671
## 356    7.8086632
## 359    8.7936338
## 360   16.5560113
## 361   12.6281498
## 366    9.8751355
## 367   12.6217004
## 369    9.3349325
## 379   14.1602183
## 381   14.1312739
## 383    9.8146643
## 386    9.6851283
## 390    2.4493920
## 392   15.7868708
```

Resultados

```
resultados <- cbind(prueba, predicciones)
resultados
```

```
##     school sex age address famsize Pstatus Medu Fedu     Mjob     Fjob
## 4       GP   F  15       U     GT3       T    4    2   health services
## 5       GP   F  16       U     GT3       T    3    3    other    other
## 7       GP   M  16       U     LE3       T    2    2    other    other
## 8       GP   F  17       U     GT3       A    4    4    other  teacher
## 10      GP   M  15       U     GT3       T    3    4    other    other
## 13      GP   M  15       U     LE3       T    4    4   health services
## 21      GP   M  15       U     GT3       T    4    3  teacher    other
## 25      GP   F  15       R     GT3       T    2    4 services   health
## 30      GP   M  16       U     GT3       T    4    4  teacher  teacher
## 32      GP   M  15       U     GT3       T    4    4 services services
## 39      GP   F  15       R     GT3       T    3    4 services   health
## 40      GP   F  15       R     GT3       T    2    2  at_home    other
## 42      GP   M  15       U     LE3       T    4    4  teacher    other
## 49      GP   M  15       U     GT3       T    4    2  teacher    other
## 54      GP   F  15       U     GT3       T    4    4 services services
## 57      GP   F  15       U     GT3       A    4    3 services services
## 61      GP   F  16       R     GT3       T    4    4   health  teacher
## 62      GP   F  16       U     GT3       T    1    1 services services
## 64      GP   F  16       U     GT3       T    4    3  teacher   health
## 65      GP   F  15       U     LE3       T    4    3 services services
## 71      GP   M  16       U     GT3       T    3    1    other    other
## 75      GP   F  16       U     GT3       T    3    3    other services
```

```
## 77     GP   M  15       U     GT3       T    4    0  teacher    other
## 79     GP   M  17       U     GT3       T    2    1    other    other
## 84     GP   M  15       U     LE3       T    2    2 services services
## 86     GP   F  15       U     GT3       T    4    4 services services
## 90     GP   M  16       U     LE3       A    4    4  teacher   health
## 91     GP   F  16       U     GT3       T    3    3    other    other
## 101    GP   M  16       U     GT3       T    4    4 services services
## 105    GP   M  15       U     GT3       A    3    4 services    other
## 114    GP   M  15       U     LE3       T    4    2  teacher    other
## 116    GP   M  16       U     GT3       T    4    4  teacher  teacher
## 119    GP   M  17       R     GT3       T    1    3    other    other
## 121    GP   F  15       U     GT3       T    1    2  at_home services
## 129    GP   M  18       R     GT3       T    2    2 services    other
## 136    GP   F  15       U     GT3       T    4    4 services  at_home
## 144    GP   F  16       U     LE3       T    1    1  at_home  at_home
## 149    GP   M  16       U     GT3       T    4    4  teacher  teacher
## 154    GP   M  19       U     GT3       T    3    2 services  at_home
## 155    GP   F  17       U     GT3       T    4    4    other  teacher
## 156    GP   M  15       R     GT3       T    2    3  at_home services
## 161    GP   M  17       R     LE3       T    2    1  at_home    other
## 162    GP   M  15       R     GT3       T    3    2    other    other
## 164    GP   M  17       U     GT3       T    1    3  at_home services
## 165    GP   M  17       R     LE3       T    1    1    other services
## 166    GP   M  16       U     GT3       T    3    2 services services
## 170    GP   F  16       U     GT3       T    4    4   health   health
## 173    GP   M  17       U     LE3       T    4    4  teacher    other
## 176    GP   M  17       U     LE3       T    4    3  teacher    other
## 177    GP   F  16       U     GT3       T    2    2 services    other
## 178    GP   M  17       U     GT3       T    3    3    other    other
## 182    GP   M  16       U     GT3       T    3    3 services    other
## 184    GP   F  17       U     LE3       T    3    3    other    other
## 187    GP   M  16       U     GT3       T    1    2 services services
## 189    GP   F  17       U     GT3       A    3    3   health    other
## 191    GP   F  16       U     GT3       T    2    3 services services
## 194    GP   M  16       R     GT3       T    3    3 services services
## 202    GP   F  16       U     GT3       T    2    3    other    other
## 204    GP   F  17       R     GT3       T    2    2    other    other
## 213    GP   F  16       U     GT3       A    2    2    other    other
## 216    GP   F  17       U     LE3       T    3    2    other    other
## 221    GP   F  17       R     GT3       T    2    1  at_home services
## 224    GP   M  18       U     GT3       T    2    2    other    other
## 225    GP   F  16       U     GT3       T    4    4  teacher services
## 230    GP   F  17       U     GT3       A    2    1    other    other
## 233    GP   M  17       U     GT3       T    4    4  teacher  teacher
## 234    GP   M  16       U     GT3       T    4    4   health    other
## 235    GP   M  16       U     LE3       T    1    1    other    other
## 236    GP   M  16       U     GT3       T    3    2  at_home    other
## 240    GP   M  18       U     GT3       T    2    2    other services
## 244    GP   M  16       U     GT3       T    4    4 services services
## 245    GP   F  18       U     GT3       T    2    1    other    other
## 249    GP   M  18       R     LE3       T    3    3    other services
## 252    GP   M  16       U     GT3       T    3    3  at_home    other
## 260    GP   F  17       U     LE3       T    2    2 services services
## 261    GP   F  18       U     GT3       T    4    3 services    other
```

```
## 262     GP   M  18       U     GT3       T    4    3  teacher    other
## 263     GP   M  18       R     GT3       T    3    2    other    other
## 277     GP   F  18       R     GT3       A    3    2    other services
## 278     GP   M  18       U     GT3       T    4    4  teacher services
## 279     GP   F  18       U     GT3       T    4    4   health   health
## 283     GP   F  18       R     LE3       T    1    1  at_home    other
## 291     GP   M  18       U     GT3       T    4    2  teacher    other
## 292     GP   F  17       U     GT3       T    4    3   health services
## 294     GP   F  17       R     LE3       T    3    1 services    other
## 295     GP   M  18       R     LE3       T    3    2 services    other
## 300     GP   M  18       U     LE3       T    4    4  teacher  teacher
## 301     GP   F  18       U     LE3       A    4    4   health    other
## 302     GP   M  17       U     LE3       T    4    4    other  teacher
## 307     GP   M  20       U     GT3       A    3    2 services    other
## 308     GP   M  19       U     GT3       T    4    4  teacher services
## 309     GP   M  19       R     GT3       T    3    3    other services
## 312     GP   F  19       U     GT3       T    2    1  at_home    other
## 313     GP   M  19       U     GT3       T    1    2    other services
## 316     GP   F  19       R     GT3       T    2    3    other    other
## 323     GP   F  17       R     LE3       T    2    2 services services
## 329     GP   F  17       U     GT3       T    4    4  teacher services
## 330     GP   F  17       U     GT3       T    4    4  teacher  teacher
## 333     GP   F  18       U     GT3       T    3    3 services services
## 339     GP   F  18       U     LE3       T    3    3 services services
## 344     GP   F  17       U     GT3       A    2    2  at_home  at_home
## 345     GP   F  18       U     GT3       T    2    3  at_home    other
## 347     GP   M  18       R     GT3       T    4    3  teacher services
## 350     MS   M  18       R     GT3       T    3    2    other    other
## 351     MS   M  19       R     GT3       T    1    1    other services
## 356     MS   F  18       U     GT3       T    3    3 services services
## 359     MS   M  18       U     LE3       T    1    1    other services
## 360     MS   F  18       U     LE3       T    1    1  at_home services
## 361     MS   F  18       R     LE3       A    1    4  at_home    other
## 366     MS   M  18       R     GT3       T    1    3  at_home    other
## 367     MS   M  18       U     LE3       T    4    4  teacher services
## 369     MS   F  18       U     GT3       T    2    3  at_home services
## 379     MS   F  18       U     GT3       T    3    3    other    other
## 381     MS   M  18       U     GT3       T    4    4  teacher  teacher
## 383     MS   M  17       U     GT3       T    2    3    other services
## 386     MS   F  18       R     GT3       T    2    2  at_home    other
## 390     MS   F  18       U     GT3       T    1    1    other    other
## 392     MS   M  17       U     LE3       T    3    1 services services
##         reason guardian traveltime studytime failures schoolsup famsup paid
## 4         home   mother          1         3        0        no    yes  yes
## 5         home   father          1         2        0        no    yes  yes
## 7         home   mother          1         2        0        no     no   no
## 8         home   mother          2         2        0       yes    yes   no
## 10        home   mother          1         2        0        no    yes  yes
## 13      course   father          1         1        0        no    yes  yes
## 21  reputation   mother          1         2        0        no     no   no
## 25      course   mother          1         3        0       yes    yes  yes
## 30        home   mother          1         2        0        no    yes  yes
## 32  reputation   mother          2         2        0        no    yes   no
## 39      course   mother          1         3        0       yes    yes  yes
```

```
## 40  reputation   mother          1          1          0       yes    yes  yes
## 42         home    other          1          1          0        no    yes   no
## 49         home   mother          1          2          0        no    yes  yes
## 54       course   mother          1          1          0       yes    yes  yes
## 57  reputation   mother          1          2          0        no    yes  yes
## 61        other   mother          1          2          0        no    yes   no
## 62       course   father          4          1          0       yes    yes   no
## 64         home   mother          1          3          0       yes    yes  yes
## 65  reputation   father          1          2          0       yes     no   no
## 71  reputation   father          2          4          0        no    yes  yes
## 75         home   mother          1          2          0       yes    yes  yes
## 77       course   mother          2          4          0        no     no   no
## 79         home   mother          2          1          3       yes    yes   no
## 84         home   mother          2          2          0        no     no  yes
## 86  reputation   father          2          2          2        no     no  yes
## 90  reputation   mother          1          2          0        no    yes   no
## 91         home   mother          1          3          0        no    yes  yes
## 101       other   mother          1          1          0       yes    yes  yes
## 105      course   mother          1          2          0        no    yes  yes
## 114      course   mother          1          1          0        no     no   no
## 116      course   father          1          2          0        no    yes   no
## 119      course   father          3          2          1        no    yes   no
## 121      course   mother          1          2          0        no     no   no
## 129 reputation   mother          1          1          2        no    yes   no
## 136      course   mother          1          3          0        no    yes   no
## 144      course   mother          1          1          0        no     no   no
## 149      course   mother          1          1          0        no    yes   no
## 154        home   mother          1          1          3        no    yes   no
## 155      course   mother          1          1          0       yes    yes   no
## 156      course   mother          1          2          0       yes     no  yes
## 161      course   mother          2          1          2        no     no   no
## 162      course   mother          2          2          2       yes    yes   no
## 164      course   father          1          1          0        no     no   no
## 165      course   mother          4          2          3        no     no   no
## 166      course   mother          2          1          1        no    yes   no
## 170 reputation   mother          1          2          0        no    yes  yes
## 173 reputation   mother          1          2          0        no    yes  yes
## 176      course   mother          2          2          0        no     no  yes
## 177 reputation   mother          2          2          0        no     no  yes
## 178 reputation   father          1          2          0        no     no   no
## 182        home   mother          1          2          0        no     no  yes
## 184 reputation   mother          1          2          0        no    yes   no
## 187       other   mother          1          1          0        no    yes  yes
## 189 reputation   mother          1          2          0        no    yes   no
## 191      course   mother          1          2          0        no     no   no
## 194 reputation   mother          1          1          0        no    yes   no
## 202 reputation   mother          1          2          0       yes    yes  yes
## 204 reputation   mother          1          1          0        no    yes   no
## 213 reputation   mother          1          2          0       yes    yes  yes
## 216 reputation   mother          2          2          0        no     no  yes
## 221 reputation   mother          2          2          0        no    yes   no
## 224        home   mother          2          2          0        no    yes  yes
## 225        home   mother          1          3          0        no    yes   no
## 230      course   mother          2          3          0        no     no   no
```

```
## 233 reputation   mother          1         2         0       yes    yes   no
## 234 reputation   father          1         2         0        no    yes  yes
## 235       home   mother          2         2         0        no    yes  yes
## 236 reputation   mother          2         3         0        no     no   no
## 240 reputation   father          1         2         1        no     no   no
## 244     course   mother          1         1         0        no     no   no
## 245     course    other          2         3         0        no    yes  yes
## 249     course   mother          1         2         1        no    yes   no
## 252 reputation    other          3         2         0       yes    yes   no
## 260     course   father          1         4         0        no     no  yes
## 261       home   father          1         2         0        no    yes  yes
## 262     course   mother          1         2         0        no    yes  yes
## 263     course   mother          1         3         0        no     no   no
## 277       home   mother          2         2         0        no     no   no
## 278       home   mother          2         1         0        no     no  yes
## 279 reputation   father          1         2         1       yes    yes   no
## 283 reputation   mother          2         4         0        no    yes  yes
## 291       home   mother          1         2         0        no    yes  yes
## 292 reputation   mother          1         3         0        no    yes  yes
## 294 reputation   mother          2         4         0        no    yes  yes
## 295 reputation   mother          2         3         0        no    yes  yes
## 300       home   mother          1         1         0        no    yes  yes
## 301       home   mother          1         2         0        no    yes   no
## 302       home   father          2         1         0        no     no  yes
## 307     course    other          1         1         0        no     no   no
## 308 reputation    other          2         1         1        no    yes  yes
## 309 reputation   father          1         2         1        no     no   no
## 312      other    other          3         2         0        no    yes   no
## 313     course    other          1         2         1        no     no   no
## 316 reputation    other          1         3         1        no     no   no
## 323     course   mother          1         3         0        no    yes  yes
## 329     course   mother          1         3         0        no    yes  yes
## 330     course   mother          2         3         0        no    yes  yes
## 333       home   mother          1         2         0        no     no   no
## 339       home   mother          1         4         0        no    yes   no
## 344       home   father          1         2         1        no    yes   no
## 345     course   mother          1         3         0        no    yes   no
## 347     course   mother          1         3         0        no     no   no
## 350     course   mother          2         1         1        no    yes   no
## 351       home    other          3         2         3        no     no   no
## 356     course   father          1         2         0        no    yes   no
## 359       home   father          2         1         0        no     no   no
## 360     course   father          2         3         0        no     no   no
## 361     course   mother          3         2         0        no     no   no
## 366     course   mother          2         2         0        no    yes  yes
## 367      other   mother          2         3         0        no     no  yes
## 369     course   father          2         1         0        no    yes  yes
## 379       home   mother          1         2         0        no     no  yes
## 381       home   father          1         2         0        no     no  yes
## 383       home   father          2         2         0        no     no   no
## 386      other   mother          2         3         0        no     no  yes
## 390     course   mother          2         2         1        no     no   no
## 392     course   mother          2         1         0        no     no   no
##     activities nursery higher internet romantic famrel freetime goout Dalc Walc
```

```
## 4          yes     yes    yes      yes      yes      3        2     2     1     1
## 5           no     yes    yes       no       no      4        3     2     1     2
## 7           no     yes    yes      yes       no      4        4     4     1     1
## 8           no     yes    yes       no       no      4        1     4     1     1
## 10         yes     yes    yes      yes       no      5        5     1     1     1
## 13         yes     yes    yes      yes       no      4        3     3     1     3
## 21          no     yes    yes      yes       no      4        4     1     1     1
## 25         yes     yes    yes      yes       no      4        3     2     1     1
## 30         yes     yes    yes      yes      yes      4        4     5     5     5
## 32         yes     yes    yes      yes       no      4        3     1     1     1
## 39         yes     yes    yes      yes       no      4        3     2     1     1
## 40         yes     yes    yes       no       no      4        3     1     1     1
## 42          no      no    yes      yes      yes      5        4     3     2     4
## 49          no     yes    yes       no       no      4        3     3     2     2
## 54          no     yes    yes      yes       no      3        3     4     2     3
## 57         yes     yes    yes      yes       no      4        3     2     1     1
## 61         yes     yes    yes       no       no      2        4     4     2     3
## 62         yes      no    yes      yes      yes      5        5     5     5     5
## 64         yes     yes    yes      yes       no      3        4     4     2     4
## 65         yes     yes    yes      yes      yes      4        4     4     2     4
## 71          no     yes    yes      yes       no      4        3     2     1     1
## 75         yes     yes    yes      yes       no      4        3     3     2     4
## 77         yes     yes    yes      yes       no      3        4     3     1     1
## 79         yes     yes     no      yes       no      4        5     1     1     1
## 84         yes     yes    yes      yes       no      5        3     3     1     3
## 86          no     yes    yes      yes      yes      4        4     4     2     3
## 90          no     yes    yes       no       no      4        1     3     3     5
## 91          no     yes    yes      yes      yes      4        3     3     1     3
## 101        yes     yes    yes      yes       no      4        5     5     5     5
## 105        yes     yes    yes      yes       no      5        4     4     1     1
## 114         no     yes    yes      yes       no      3        5     2     1     1
## 116        yes     yes    yes      yes       no      5        4     4     1     2
## 119        yes     yes    yes      yes       no      5        2     4     1     4
## 121         no      no    yes      yes       no      3        2     3     1     2
## 129        yes     yes    yes      yes       no      3        3     3     1     2
## 136        yes     yes    yes      yes      yes      4        3     3     1     1
## 144         no     yes    yes      yes       no      3        4     4     3     3
## 149         no     yes     no      yes      yes      3        3     2     2     1
## 154         no     yes     no      yes      yes      4        5     4     1     1
## 155         no     yes    yes       no      yes      4        2     1     1     1
## 156        yes     yes    yes       no       no      4        4     4     1     1
## 161        yes     yes     no      yes      yes      3        3     2     2     2
## 162         no     yes    yes      yes      yes      4        4     4     1     4
## 164         no     yes     no      yes       no      5        3     3     1     4
## 165        yes     yes     no       no      yes      5        3     5     1     5
## 166        yes      no     no       no       no      4        5     2     1     1
## 170         no     yes    yes      yes      yes      4        4     2     1     1
## 173        yes     yes    yes      yes       no      4        4     4     1     3
## 176        yes     yes    yes      yes       no      4        4     4     4     4
## 177        yes      no    yes      yes       no      3        4     4     1     4
## 178        yes      no    yes      yes       no      4        3     4     1     4
## 182        yes     yes    yes      yes      yes      4        2     3     1     2
## 184        yes     yes    yes      yes      yes      5        3     3     2     3
## 187        yes     yes    yes      yes      yes      3        3     3     1     2
```

```
## 189        no      no    yes      yes      yes      3        3     3    1    3
## 191        no     yes    yes      yes       no      4        3     3    1    1
## 194       yes     yes    yes      yes       no      4        3     2    3    4
## 202       yes     yes    yes       no       no      4        4     3    1    3
## 204        no     yes    yes      yes       no      5        3     2    1    2
## 213        no     yes    yes      yes       no      3        3     4    1    1
## 216        no     yes    yes      yes       no      4        4     4    1    3
## 221       yes     yes    yes      yes       no      4        2     5    1    2
## 224        no     yes    yes      yes       no      3        3     3    5    5
## 225       yes      no    yes      yes       no      5        3     2    1    1
## 230       yes     yes    yes      yes      yes      3        2     3    1    2
## 233       yes     yes    yes      yes      yes      4        5     5    1    3
## 234       yes     yes    yes      yes       no      4        2     4    2    4
## 235        no     yes    yes      yes       no      3        4     2    1    1
## 236       yes     yes    yes      yes      yes      5        3     3    1    3
## 240        no     yes     no      yes       no      5        5     4    3    5
## 244       yes     yes    yes      yes       no      5        3     2    1    2
## 245        no      no    yes      yes      yes      4        4     4    1    1
## 249        no     yes    yes      yes      yes      4        3     3    1    3
## 252        no      no    yes      yes       no      5        3     3    1    3
## 260       yes     yes    yes      yes      yes      3        4     1    1    1
## 261        no     yes    yes      yes      yes      3        1     2    1    3
## 262        no      no    yes      yes       no      4        3     2    1    1
## 263       yes      no    yes       no       no      5        3     2    1    1
## 277        no      no     no      yes      yes      4        1     1    1    1
## 278       yes     yes    yes      yes       no      3        2     4    1    4
## 279       yes     yes    yes      yes      yes      2        4     4    1    1
## 283       yes     yes    yes       no       no      5        2     2    1    1
## 291       yes     yes    yes      yes      yes      4        3     2    1    4
## 292        no     yes    yes      yes       no      4        2     2    1    2
## 294        no     yes    yes       no       no      3        1     2    1    1
## 295       yes     yes    yes      yes       no      5        4     2    1    1
## 300        no     yes    yes      yes      yes      1        4     2    2    2
## 301        no     yes    yes      yes      yes      4        2     4    1    1
## 302        no     yes    yes      yes       no      4        1     1    2    2
## 307       yes     yes    yes       no       no      5        5     3    1    1
## 308        no     yes    yes      yes      yes      4        3     4    1    1
## 309       yes     yes    yes       no      yes      4        5     3    1    2
## 312        no     yes     no      yes      yes      3        4     1    1    1
## 313        no      no    yes      yes       no      4        5     2    2    2
## 316        no     yes    yes      yes      yes      4        1     2    1    1
## 323       yes     yes    yes      yes       no      3        3     2    2    2
## 329       yes     yes    yes      yes       no      5        4     4    1    3
## 330        no      no    yes      yes      yes      4        3     3    1    2
## 333       yes     yes    yes      yes       no      5        3     4    1    1
## 339        no     yes    yes      yes       no      5        3     3    1    1
## 344        no     yes    yes      yes      yes      3        3     1    1    2
## 345        no     yes    yes      yes       no      4        3     3    1    2
## 347        no     yes    yes      yes      yes      5        3     2    1    2
## 350        no      no    yes      yes       no      2        5     5    5    5
## 351        no     yes    yes      yes       no      5        4     4    3    3
## 356        no     yes    yes       no      yes      5        3     4    1    1
## 359        no      no    yes      yes      yes      3        3     2    1    2
## 360        no     yes    yes      yes       no      5        3     2    1    1
```

```
## 361         no     yes    yes       no      yes      4        3     4    1    4
## 366         no     yes    yes       no       no      3        3     4    2    4
## 367         no     yes    yes      yes      yes      4        2     2    2    2
## 369         no     yes    yes      yes      yes      5        2     3    1    2
## 379         no     yes    yes      yes      yes      4        1     3    1    2
## 381        yes      no    yes      yes       no      3        2     4    1    4
## 383        yes     yes    yes      yes       no      4        4     3    1    1
## 386         no     yes    yes       no       no      5        3     3    1    3
## 390        yes     yes    yes       no       no      1        1     1    1    1
## 392         no      no    yes      yes       no      2        4     5    3    4
##     health absences G1 G2 G3 predicciones
## 4        5        2 15 14 15   12.6825067
## 5        5        4  6 10 10    9.4336769
## 7        3        0 12 12 11   11.3123105
## 8        1        6  6  5  6    3.1015305
## 10       5        0 14 15 15   15.5646743
## 13       5        2 14 14 14   14.1903603
## 21       1        0 13 14 15   14.6014273
## 25       5        2 10  9  8    9.1914195
## 30       5       16 10 12 11   12.3525888
## 32       5        0 17 16 17   16.2922426
## 39       5        2 12 12 11   12.5533857
## 40       2        8 14 13 13   14.5733625
## 42       5        8 12 12 12   13.3614557
## 49       5        2 15 15 14   16.1217573
## 54       5        0  8 10 11    9.0446862
## 57       1        0 14 15 15   14.6141184
## 61       4        6 10 11 11    9.5080892
## 62       5        6 10  8 11    7.5710920
## 64       4        2 10  9  9    8.8472173
## 65       2        0 10 10 10    9.3670135
## 71       5        0 13 15 15   15.6454393
## 75       5       54 11 12 11   16.2834668
## 77       1        8 11 11 10   11.4850585
## 79       3        2  8  8 10    7.4548692
## 84       4        4 15 15 15   15.9082651
## 86       5        6  7  9  8    8.2599349
## 90       5       18  8  6  7    8.1169413
## 91       4        0  7  7  8    5.6803442
## 101      4       14  7  7  5    7.2175201
## 105      1        0 16 18 18   18.3876481
## 114      3       10 18 19 19   21.1555406
## 116      5        2 15 15 16   15.6866089
## 119      5       20  9  7  8    7.9292306
## 121      1        2 16 15 15   14.7037354
## 129      4        0  7  4  0    1.6560062
## 136      5        0 11  0  0   -0.5722479
## 144      1        2 14 14 13   14.0271825
## 149      5        0  7  6  0    5.4024220
## 154      4        0  5  0  0   -2.0734087
## 155      4        0 11 11 12   10.1102414
## 156      1        2 11  8  8    7.7569948
## 161      5        0  7  6  0    5.0096361
## 162      3        6  5  9  7    8.7189636
```

```
## 164      2        2 10 10 10   10.5773936
## 165      5        0  5  8  7    7.0152864
## 166      2       16 12 11 12   12.7184372
## 170      3        0 14 14 14   13.8328358
## 173      5        0 13 11 10   11.2291900
## 176      4        4 10  9  9    8.8874418
## 177      5        2 13 13 11   13.3031919
## 178      4        4  6  5  6    4.4005494
## 182      3        2 12 13 12   12.2344323
## 184      1       56  9  9  8   13.0264173
## 187      3        2 11 12 11   10.7573420
## 189      3        6  8  7  9    5.3686876
## 191      2       10 11 12 13   11.4796170
## 194      5        8  8  9 10    8.6959588
## 202      4        6  8 10 10   10.3285844
## 204      3       18  7  6  6    6.8413892
## 213      4        0 12 13 14   12.4947655
## 216      1        2 14 15 15   15.3468786
## 221      5        2  6  6  6    4.0232491
## 224      4        0 12 13 13   11.6067455
## 225      5        0 13 13 14   11.9760242
## 230      3       10 12 10 12    9.2289814
## 233      2       14 11  9  9    9.5256796
## 234      1        2 14 13 13   12.8037784
## 235      5       18  9  7  6    7.9882826
## 236      2       10 11  9 10    9.9725178
## 240      2        0  7  7  0    6.5821294
## 244      5        0 13 12 12   11.8428148
## 245      3        0  7  0  0   -1.7749205
## 249      5        8  3  5  5    3.0444624
## 252      2        6  7 10 10   10.7039279
## 260      2        0 10  9  0    7.0279845
## 261      2       21 17 18 18   18.9040910
## 262      3        2  8  8  8    7.1891059
## 263      3        1 13 12 12   11.5850336
## 277      5       75 10  9  9   14.5571565
## 278      3       22  9  9  9    8.8714461
## 279      4       15  9  8  8    6.5095023
## 283      3        1 12 12 12   11.5972085
## 291      5       11 12 11 11   11.5096672
## 292      3        0 15 15 15   14.1211742
## 294      3        6 18 18 18   18.7317433
## 295      4        8 14 13 14   13.8264957
## 300      1        5 16 15 16   13.6684550
## 301      4       14 12 10 11    8.5915447
## 302      5        0 11 11 10   10.4452654
## 307      5        0 17 18 18   17.5819281
## 308      4       38  8  9  8   10.1425016
## 309      5        0 15 12 12   10.5251082
## 312      2       20 14 12 13   13.3845674
## 313      4        3 13 11 11    9.7749903
## 316      3       40 13 11 11   12.6740505
## 323      3        3 11 11 11    9.4988405
## 329      4        7 10  9  9    8.7491969
```

```
## 330      4        4 14 14 14   13.9303183
## 333      4        0  7  0  0   -2.7955823
## 339      1        7 16 15 17   14.1194524
## 344      4        0  9  8  0    6.3146881
## 345      3        4 11 10 10    9.0314702
## 347      4        9 16 15 16   15.3609026
## 350      5       10 11 13 13   12.7714068
## 351      2        8  8  7  8    5.3986671
## 356      5        0 10  9  9    7.8086632
## 359      3        4 10 10 10    8.7936338
## 360      4        0 18 16 16   16.5560113
## 361      5        0 13 13 13   12.6281498
## 366      3        4 10 10 10    9.8751355
## 367      5        0 13 13 13   12.6217004
## 369      4        0 11 10 10    9.3349325
## 379      1        0 15 15 15   14.1602183
## 381      2        4 15 14 14   14.1312739
## 383      3        2 11 11 10    9.8146643
## 386      4        2 10  9 10    9.6851283
## 390      5        0  6  5  0    2.4493920
## 392      2        3 14 16 16   15.7868708
```

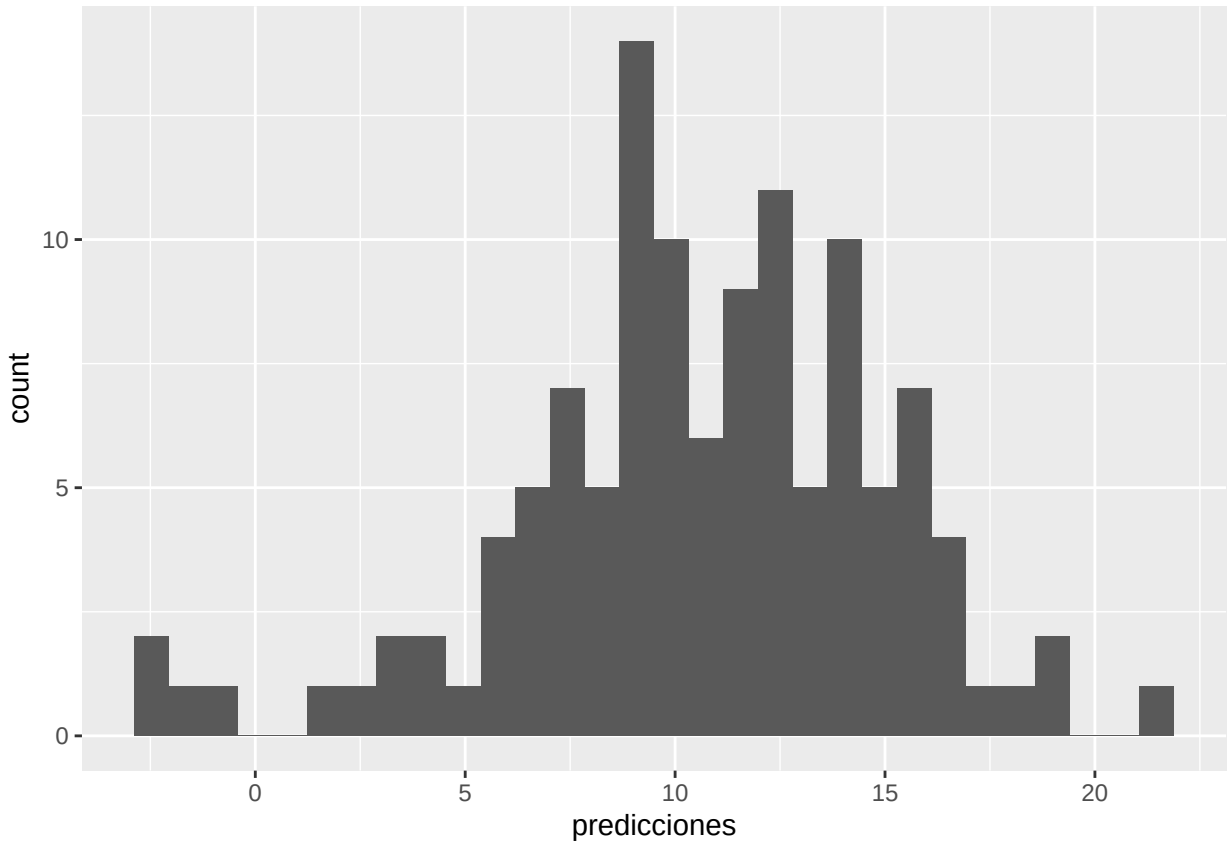
```
class(resultados)
```

```
## [1] "data.frame"
```

Gráfico

```
ggplot(resultados, aes(x=predicciones))+geom_histogram()
```

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



Construir una función que convierta valores negativos a cero

```
convertir_cero <- function(x){
  if(x<0){
    return(0)
    }
  else{
    return(x)
  }
}
```

Convertir valores a cero con función

```
resultados$predicciones <- sapply(resultados$predicciones, convertir_cero)
```

Correr la evaluación con RMSE

```
mse <- mean((resultados$G3 - resultados$predicciones)^2)
mse
```

```
## [1] 3.991675
```

Raíz cuadrada del error medio

```
rmse <- sqrt(mse)
rmse
```

```
## [1] 1.997918
```

Usar el modelo que construimos

```
uso <- read.csv("student-mat - uso.csv")
predicciones_uso <- predict(modelo, uso)
resultados_uso <- cbind(uso, predicciones_uso)
resultados_uso
```

```
##    school sex age address famsize Pstatus Medu Fedu     Mjob     Fjob
## 1      GP   F  15       U     GT3       A    3    4  at_home  teacher
## 2      GP   F  16       U     GT3       T    2    2   health  at_home
## 3      GP   F  15       U     LE3       T    1    3  at_home services
## 4      GP   F  18       U     GT3       T    3    4   health services
## 5      GP   F  15       U     GT3       T    3    2  at_home    other
## 6      GP   M  14       U     LE3       T    3    2 services  at_home
## 7      GP   M  16       U     LE3       T    4    4    other services
## 8      GP   F  17       U     GT3       A    4    2 services  teacher
## 9      GP   M  15       U     LE3       A    3    3 services    other
## 10     GP   M  15       U     GT3       T    4    4  teacher  at_home
## 11     GP   F  17       U     GT3       T    3    4  teacher   health
## 12     GP   F  18       U     GT3       T    4    2 services    other
## 13     GP   M  18       U     LE3       T    3    3    other services
## 14     GP   M  15       U     GT3       T    3    3  teacher    other
## 15     GP   M  15       U     GT3       A    4    2    other  at_home
## 16     GP   F  17       U     GT3       T    2    3  at_home services
## 17     GP   F  15       U     GT3       T    2    4 services services
## 18     GP   F  16       U     GT3       T    1    4  at_home    other
## 19     GP   M  17       U     GT3       T    4    2 services services
##         reason guardian traveltime studytime failures schoolsup famsup paid
## 1       course   mother          2         2        0       yes     no   no
## 2       course   father          1         2        0        no    yes   no
## 3        other   mother          1         2        3       yes     no  yes
## 4       course   mother          1         3        0        no    yes  yes
## 5         home   father          1         2        0        no     no  yes
## 6   reputation   mother          1         2        0        no    yes  yes
## 7         home   mother          1         2        0        no     no   no
## 8   reputation   mother          2         2        0       yes    yes   no
## 9         home   mother          1         2        0        no    yes  yes
## 10  reputation   mother          1         2        0        no    yes  yes
## 11      course   mother          1         2        0        no     no  yes
## 12  reputation   father          3         3        0        no     no   no
## 13      course   father          1         1        0        no    yes  yes
## 14      course   mother          2         2        0        no    yes  yes
## 15        home    other          1         3        0        no     no   no
## 16        home   mother          1         1        0        no    yes   no
## 17  reputation   mother          1         3        0        no    yes  yes
## 18        home   mother          3         2        0       yes    yes   no
```

```
## 19     course   mother          1         1       3        no     no   no
##    activities nursery higher internet romantic famrel freetime goout Dalc Walc
## 1          no     yes    yes       no       no      4        3     4    1    1
## 2          no      no    yes      yes       no      5        3     3    1    1
## 3          no     yes    yes      yes       no      4        3     2    2    3
## 4         yes     yes    yes      yes      yes      3        2     2    1    1
## 5          no     yes    yes       no       no      4        3     2    1    2
## 6         yes     yes    yes      yes       no      5        4     2    1    2
## 7          no     yes    yes      yes       no      4        4     4    1    1
## 8          no     yes    yes       no       no      4        1     4    1    1
## 9          no     yes    yes      yes       no      4        2     2    1    1
## 10        yes     yes    yes      yes       no      5        5     1    1    1
## 11         no     yes    yes      yes       no      3        3     3    1    2
## 12        yes     yes    yes      yes       no      5        2     2    1    1
## 13        yes     yes    yes      yes       no      4        3     3    1    3
## 14         no     yes    yes      yes       no      5        4     3    1    2
## 15         no     yes    yes      yes      yes      4        5     2    1    1
## 16         no     yes    yes      yes       no      4        4     4    1    2
## 17        yes     yes    yes      yes       no      3        2     3    1    2
## 18        yes     yes    yes       no       no      5        3     2    1    1
## 19        yes     yes    yes      yes       no      5        5     5    2    4
##    health absences G1 G2 predicciones_uso
## 1       3        6  5  6         5.505448
## 2       3        4  5  5         4.081891
## 3       3       10  7  8         8.011783
## 4       5        2 15 14        11.570405
## 5       5        4  6 10        10.169630
## 6       5       10 15 15        18.315595
## 7       3        0 12 12        10.732801
## 8       1        6  6  5         3.973612
## 9       1        0 16 18        18.238781
## 10      5        0 14 15        16.625306
## 11      2        0 10  8         7.225938
## 12      4        4 10 12        11.301711
## 13      5        2 14 14        13.640829
## 14      3        2 10 10        10.884219
## 15      3        0 14 16        16.300679
## 16      2        4 14 14        12.857057
## 17      2        6 13 14        13.409283
## 18      4        4  8 10         9.099661
## 19      5       16  6  5         4.946424
```