Meghana_Nadig_Assignment6

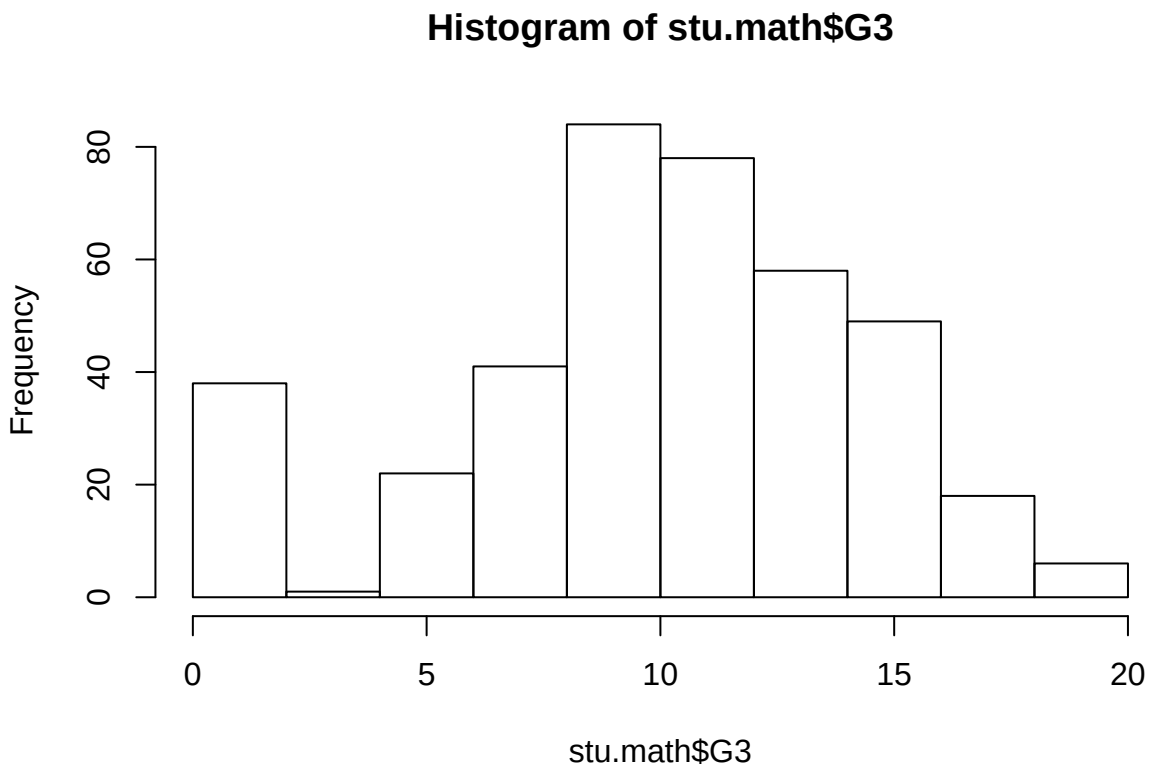
Problem 1:

```
# Importing Data

stu.math <- read.csv("C:/Users/Meghana Nadig/Downloads/student-mat.csv",sep=";",header=TRUE,stringsAsFa
str(stu.math)
```

```
## '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 ...
```

```
# Checking the distribution of G3
hist(stu.math$G3)
```

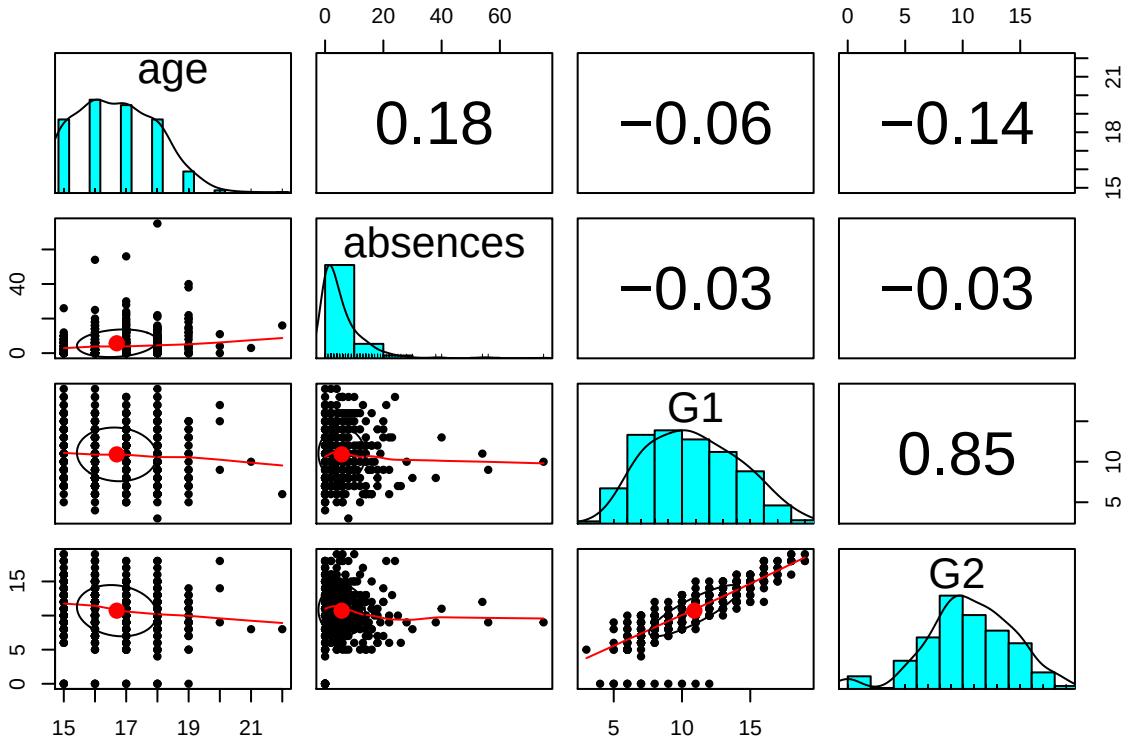



```
#install.packages("psych")

library(psych)
```

```
# Creating a Scatter Plot
# Selecting 4 continuous variables: "age","absences","G1","G2"

pairs.panels(stu.math[c("age", "absences", "G1", "G2")])
```




```
# Building a Regression Model
# Selecting 4 variables: "paid"(extra paid classes within the course subject),"age" (student's age),"G1

# Converting categorical variable to binary indicator (Dummy code)
stu.math$paid.bin <- ifelse(stu.math$paid == "yes", 1, 0)

stu.math$paid.bin
```

```
##   [1] 0 0 1 1 1 1 0 0 1 1 1 0 1 1 0 0 1 0 0 1 0 1 0 0 1 1 1 1 0 1 1 0 0 0 1
##  [36] 0 0 0 1 1 0 0 0 0 0 0 1 0 0 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0 1 0 0 0 1 1 0
##  [71] 1 0 0 0 1 1 0 1 0 0 1 1 1 1 0 1 0 0 1 0 1 1 0 1 0 1 0 1 0 1 1 0 0 1 1
## [106] 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
## [141] 0 0 1 0 0 1 0 1 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 1 1 1 0 1 1 0 1
## [176] 1 1 0 0 0 1 1 0 0 1 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 1 1 0 1 1 1 1 1 1
## [211] 1 1 1 1 1 1 1 1 1 1 0 0 0 1 0 0 0 1 1 0 0 1 0 1 1 0 1 0 0 0 0 1 0 0 1
## [246] 0 0 0 0 1 0 0 0 0 0 0 0 1 0 0 1 1 1 0 0 1 1 1 1 1 0 1 1 1 1 1 1 0 1 0 1
## [281] 1 0 1 0 0 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 0 1 1 1 0 1 0 1 0 0 0 0 0 1 0
## [316] 0 1 1 1 1 1 1 0 1 0 0 0 0 0 1 1 0 0 0 0 0 0 0 1 1 0 1 1 0 0 0 0 0 0 1 1 0
## [351] 0 1 0 0 1 0 1 0 0 0 0 0 0 0 1 0 1 1 1 1 1 1 0 1 0 0 0 0 1 1 1 1 1 0 0 0 1
## [386] 1 1 0 1 0 1 0 0 0 0
```

```
#install.packages("caTools")
library(caTools)

split <- sample.split(stu.math, SplitRatio = 0.8)

training <- subset(stu.math, split == TRUE)
```

```r
testing <- subset(stu.math, split == FALSE)
```

```r
# Training the model

m <- lm(G3 ~ paid.bin + age + G1 + G2, data = training)

summary(m)
```

```
##
## Call:
## lm(formula = G3 ~ paid.bin + age + G1 + G2, data = training)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3026 -0.3516  0.3175  1.1026  3.5827
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.29837    1.60270   0.186  0.85244
## paid.bin     0.05722    0.23528   0.243  0.80801
## age         -0.14078    0.09087  -1.549  0.12235
## G1           0.18344    0.06456   2.841  0.00479 **
## G2           0.97039    0.05671  17.110  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.045 on 310 degrees of freedom
## Multiple R-squared:  0.8097, Adjusted R-squared:  0.8072
## F-statistic: 329.7 on 4 and 310 DF,  p-value: < 2.2e-16
```

Backfitting (p-value)

```r
# Removing paid.bin (highest p-value) from the model

m1 <- lm(G3 ~ age + G1 + G2, data = training)

summary(m1)
```

```
##
## Call:
## lm(formula = G3 ~ age + G1 + G2, data = training)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.3263 -0.3460  0.3223  1.1195  3.5571
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.33389    1.59362   0.210  0.83418
## age         -0.14160    0.09067  -1.562  0.11940
## G1           0.18194    0.06417   2.835  0.00488 **
## G2           0.97217    0.05615  17.314  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 2.042 on 311 degrees of freedom
## Multiple R-squared:  0.8096, Adjusted R-squared:  0.8078
## F-statistic: 440.9 on 3 and 311 DF,  p-value: < 2.2e-16
```

```
# Removing age (second highest p-value) from the model

m2 <- lm(G3 ~ G1 + G2, data = training)

summary(m2)
```

```
##
## Call:
## lm(formula = G3 ~ G1 + G2, data = training)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -9.5074 -0.3159  0.3341  1.0313  3.8096
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -2.07773    0.39414  -5.272 2.53e-07 ***
## G1           0.17440    0.06414   2.719  0.00691 **
## G2           0.98412    0.05576  17.650  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.047 on 312 degrees of freedom
## Multiple R-squared:  0.8081, Adjusted R-squared:  0.8069
## F-statistic: 657.1 on 2 and 312 DF,  p-value: < 2.2e-16
```

Regression Equation = -1.98 + 0.18*G1 + 0.96*G2

The p-value backward elimination technique is used.

Predicting G3

```
G3_pred <- predict(m2,testing)
G3_pred
```

```
##         3         9        17        23        24        28        31
##  7.015993 18.426742 13.967082 15.299995 12.982966 16.284111 10.317139
##        37        43        51        57        58        62        65
## 16.284111 18.949938 12.808567 15.125597 15.125597  7.539189  9.507421
##        71        77        85        91        92        96        99
## 14.951198 10.665936  9.333022  6.031877 17.442626  8.984225 13.618284
##       105       111       119       125       126       130       133
## 18.426742 19.759656  6.380674  6.206275 12.982966 18.775540 12.459770
##       139       145       153       159       160       164       167
## 12.173248 -1.205734  9.507421 15.648792 11.475653  9.507421  9.507421
##       173       179       187       193       194       198       201
## 11.014733  7.539189 11.650052  7.015993  8.174508  8.348906 16.458510
##       207       213       221       227       228       232       235
##  6.031877 12.808567  4.873362 15.474394 10.840335 10.665936  6.380674
##       241       247       255       261       262       266       269
## 11.824451 11.824451 11.126856 18.601141  7.190391 17.617025  8.523305
##       275       281       289       295       296       300       303
##  9.507421  7.190391 14.315879 13.157364 12.173248 15.474394 12.347647
```

```
##       309       315       323       329       330       334       337
## 12.347647 13.331763 10.665936  8.523305 14.141480  7.190391 13.157364
##       343       349       357       363       364       368       371
## 15.474394 14.951198 12.808567 10.665936 15.474394  5.047760  6.031877
##       377       383       391
## 14.315879 10.665936  8.348906
```

95% Confidence Interval

```
# Residual Standard error is 2.023

# Finding 95% CI

G3_pred[1] - 1.96*2.023
```

```
##        3
## 3.050913
```

```
G3_pred[1] + 1.96*2.023
```

```
##        3
## 10.98107
```

Therefore, the 95% CI is between 3.06 and 11

RMSE

```
# Testing Model
sqerr_test <- (stu.math[33] - G3_pred)^2
msqerr_test <- mean(sqerr_test)
rmse_test <- sqrt(msqerr_test)
rmse_test
```

```
## [1] 5.963049
```

Therefore, the RMSE for testing model is 5.77

```
# Training Model
m3 <- lm(G3 ~ G1 + G2, data = testing)
G3_pred_train <- predict(m2,training)

sqerr_train <- (stu.math[33] - G3_pred_train)^2
msqerr_train <- mean(sqerr_train)
rmse_train <- sqrt(msqerr_train)
rmse_train
```

```
## [1] 5.969406
```

Therefore, the RMSE for training model is 6.22

Problem 2:

```
stu.math1 <- stu.math
# Adding new column
stu.math1$paid.bin <- NULL
stu.math1["PF"] <- NA
stu.math1$PF <- ifelse(stu.math1$G3 < 10, "F", "P")

stu.math1
```

```
##     school sex age address famsize Pstatus Medu Fedu     Mjob     Fjob
```

```
## 1       GP   F  18       U     GT3       A    4    4  at_home  teacher
## 2       GP   F  17       U     GT3       T    1    1  at_home    other
## 3       GP   F  15       U     LE3       T    1    1  at_home    other
## 4       GP   F  15       U     GT3       T    4    2   health services
## 5       GP   F  16       U     GT3       T    3    3    other    other
## 6       GP   M  16       U     LE3       T    4    3 services    other
## 7       GP   M  16       U     LE3       T    2    2    other    other
## 8       GP   F  17       U     GT3       A    4    4    other  teacher
## 9       GP   M  15       U     LE3       A    3    2 services    other
## 10      GP   M  15       U     GT3       T    3    4    other    other
## 11      GP   F  15       U     GT3       T    4    4  teacher   health
## 12      GP   F  15       U     GT3       T    2    1 services    other
## 13      GP   M  15       U     LE3       T    4    4   health services
## 14      GP   M  15       U     GT3       T    4    3  teacher    other
## 15      GP   M  15       U     GT3       A    2    2    other    other
## 16      GP   F  16       U     GT3       T    4    4   health    other
## 17      GP   F  16       U     GT3       T    4    4 services services
## 18      GP   F  16       U     GT3       T    3    3    other    other
## 19      GP   M  17       U     GT3       T    3    2 services services
## 20      GP   M  16       U     LE3       T    4    3   health    other
## 21      GP   M  15       U     GT3       T    4    3  teacher    other
## 22      GP   M  15       U     GT3       T    4    4   health   health
## 23      GP   M  16       U     LE3       T    4    2  teacher    other
## 24      GP   M  16       U     LE3       T    2    2    other    other
## 25      GP   F  15       R     GT3       T    2    4 services   health
## 26      GP   F  16       U     GT3       T    2    2 services services
## 27      GP   M  15       U     GT3       T    2    2    other    other
## 28      GP   M  15       U     GT3       T    4    2   health services
## 29      GP   M  16       U     LE3       A    3    4 services    other
## 30      GP   M  16       U     GT3       T    4    4  teacher  teacher
## 31      GP   M  15       U     GT3       T    4    4   health services
## 32      GP   M  15       U     GT3       T    4    4 services services
## 33      GP   M  15       R     GT3       T    4    3  teacher  at_home
## 34      GP   M  15       U     LE3       T    3    3    other    other
## 35      GP   M  16       U     GT3       T    3    2    other    other
## 36      GP   F  15       U     GT3       T    2    3    other    other
## 37      GP   M  15       U     LE3       T    4    3  teacher services
## 38      GP   M  16       R     GT3       A    4    4    other  teacher
## 39      GP   F  15       R     GT3       T    3    4 services   health
## 40      GP   F  15       R     GT3       T    2    2  at_home    other
## 41      GP   F  16       U     LE3       T    2    2    other    other
## 42      GP   M  15       U     LE3       T    4    4  teacher    other
## 43      GP   M  15       U     GT3       T    4    4 services  teacher
## 44      GP   M  15       U     GT3       T    2    2 services services
## 45      GP   F  16       U     LE3       T    2    2    other  at_home
## 46      GP   F  15       U     LE3       A    4    3    other    other
## 47      GP   F  16       U     LE3       A    3    3    other services
## 48      GP   M  16       U     GT3       T    4    3   health services
## 49      GP   M  15       U     GT3       T    4    2  teacher    other
## 50      GP   F  15       U     GT3       T    4    4 services  teacher
## 51      GP   F  16       U     LE3       T    2    2 services services
## 52      GP   F  15       U     LE3       T    4    2   health    other
## 53      GP   M  15       U     LE3       A    4    2   health   health
## 54      GP   F  15       U     GT3       T    4    4 services services
```

```
## 55      GP   F  15       U     LE3       A    3    3    other    other
## 56      GP   F  16       U     GT3       A    2    1    other    other
## 57      GP   F  15       U     GT3       A    4    3 services services
## 58      GP   M  15       U     GT3       T    4    4  teacher   health
## 59      GP   M  15       U     LE3       T    1    2    other  at_home
## 60      GP   F  16       U     GT3       T    4    2 services    other
## 61      GP   F  16       R     GT3       T    4    4   health  teacher
## 62      GP   F  16       U     GT3       T    1    1 services services
## 63      GP   F  16       U     LE3       T    1    2    other services
## 64      GP   F  16       U     GT3       T    4    3  teacher   health
## 65      GP   F  15       U     LE3       T    4    3 services services
## 66      GP   F  16       U     LE3       T    4    3  teacher services
## 67      GP   M  15       U     GT3       A    4    4    other services
## 68      GP   F  16       U     GT3       T    3    1 services    other
## 69      GP   F  15       R     LE3       T    2    2   health services
## 70      GP   F  15       R     LE3       T    3    1    other    other
## 71      GP   M  16       U     GT3       T    3    1    other    other
## 72      GP   M  15       U     GT3       T    4    2    other    other
## 73      GP   F  15       R     GT3       T    1    1    other    other
## 74      GP   M  16       U     GT3       T    3    1    other    other
## 75      GP   F  16       U     GT3       T    3    3    other services
## 76      GP   M  15       U     GT3       T    4    3  teacher    other
## 77      GP   M  15       U     GT3       T    4    0  teacher    other
## 78      GP   F  16       U     GT3       T    2    2    other    other
## 79      GP   M  17       U     GT3       T    2    1    other    other
## 80      GP   F  16       U     GT3       T    3    4  at_home    other
## 81      GP   M  15       U     GT3       T    2    3    other services
## 82      GP   M  15       U     GT3       T    2    3    other    other
## 83      GP   F  15       U     LE3       T    3    2 services    other
## 84      GP   M  15       U     LE3       T    2    2 services services
## 85      GP   F  15       U     GT3       T    1    1    other    other
## 86      GP   F  15       U     GT3       T    4    4 services services
## 87      GP   F  16       U     LE3       T    2    2  at_home    other
## 88      GP   F  15       U     GT3       T    4    2    other    other
## 89      GP   M  16       U     GT3       T    2    2 services    other
## 90      GP   M  16       U     LE3       A    4    4  teacher   health
## 91      GP   F  16       U     GT3       T    3    3    other    other
## 92      GP   F  15       U     GT3       T    4    3 services    other
## 93      GP   F  16       U     LE3       T    3    1    other    other
## 94      GP   F  16       U     GT3       T    4    2  teacher services
## 95      GP   M  15       U     LE3       T    2    2 services   health
## 96      GP   F  15       R     GT3       T    1    1  at_home    other
## 97      GP   M  16       R     GT3       T    4    3 services    other
## 98      GP   F  16       U     GT3       T    2    1    other    other
## 99      GP   F  16       U     GT3       T    4    4    other    other
## 100     GP   F  16       U     GT3       T    4    3    other  at_home
## 101     GP   M  16       U     GT3       T    4    4 services services
## 102     GP   M  16       U     GT3       T    4    4 services  teacher
## 103     GP   M  15       U     GT3       T    4    4 services    other
## 104     GP   F  15       U     GT3       T    3    2 services    other
## 105     GP   M  15       U     GT3       A    3    4 services    other
## 106     GP   F  15       U     GT3       A    3    3    other   health
## 107     GP   F  15       U     GT3       T    2    2    other    other
## 108     GP   M  16       U     GT3       T    3    3 services    other
```

```
## 109     GP   M  15       R     GT3       T    4    4    other    other
## 110     GP   F  16       U     LE3       T    4    4   health   health
## 111     GP   M  15       U     LE3       A    4    4  teacher  teacher
## 112     GP   F  16       R     GT3       T    3    3 services    other
## 113     GP   F  16       U     GT3       T    2    2  at_home    other
## 114     GP   M  15       U     LE3       T    4    2  teacher    other
## 115     GP   M  15       R     GT3       T    2    1   health services
## 116     GP   M  16       U     GT3       T    4    4  teacher  teacher
## 117     GP   M  15       U     GT3       T    4    4    other  teacher
## 118     GP   M  16       U     GT3       T    3    3    other services
## 119     GP   M  17       R     GT3       T    1    3    other    other
## 120     GP   M  15       U     GT3       T    3    4    other    other
## 121     GP   F  15       U     GT3       T    1    2  at_home services
## 122     GP   M  15       U     GT3       T    2    2 services services
## 123     GP   F  16       U     LE3       T    2    4    other   health
## 124     GP   M  16       U     GT3       T    4    4   health    other
## 125     GP   F  16       U     GT3       T    2    2    other    other
## 126     GP   M  15       U     GT3       T    3    4 services services
## 127     GP   F  15       U     LE3       A    3    4    other    other
## 128     GP   F  19       U     GT3       T    0    1  at_home    other
## 129     GP   M  18       R     GT3       T    2    2 services    other
## 130     GP   M  16       R     GT3       T    4    4  teacher  teacher
## 131     GP   F  15       R     GT3       T    3    4 services  teacher
## 132     GP   F  15       U     GT3       T    1    1  at_home    other
## 133     GP   F  17       U     LE3       T    2    2    other    other
## 134     GP   F  16       U     GT3       A    3    4 services    other
## 135     GP   M  15       R     GT3       T    3    4  at_home  teacher
## 136     GP   F  15       U     GT3       T    4    4 services  at_home
## 137     GP   M  17       R     GT3       T    3    4  at_home    other
## 138     GP   F  16       U     GT3       A    3    3    other    other
## 139     GP   M  16       U     LE3       T    1    1 services    other
## 140     GP   F  15       U     GT3       T    4    4  teacher  teacher
## 141     GP   M  15       U     GT3       T    4    3  teacher services
## 142     GP   M  16       U     LE3       T    2    2 services services
## 143     GP   F  15       U     GT3       T    4    4  teacher services
## 144     GP   F  16       U     LE3       T    1    1  at_home  at_home
## 145     GP   M  17       U     GT3       T    2    1    other    other
## 146     GP   F  15       U     GT3       T    1    1    other services
## 147     GP   F  15       U     GT3       T    3    2   health services
## 148     GP   F  15       U     GT3       T    1    2  at_home    other
## 149     GP   M  16       U     GT3       T    4    4  teacher  teacher
## 150     GP   M  15       U     LE3       A    2    1 services    other
## 151     GP   M  18       U     LE3       T    1    1    other    other
## 152     GP   M  16       U     LE3       T    2    1  at_home    other
## 153     GP   F  15       R     GT3       T    3    3 services services
## 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
## 157     GP   M  17       R     LE3       T    1    2    other    other
## 158     GP   F  18       R     GT3       T    1    1  at_home    other
## 159     GP   M  16       R     GT3       T    2    2  at_home    other
## 160     GP   M  16       U     GT3       T    3    3    other services
## 161     GP   M  17       R     LE3       T    2    1  at_home    other
## 162     GP   M  15       R     GT3       T    3    2    other    other
```

```
## 163     GP   M  16       U     LE3       T    1    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
## 167     GP   M  16       U     GT3       T    2    2    other    other
## 168     GP   F  16       U     GT3       T    4    2   health services
## 169     GP   F  16       U     GT3       T    2    2    other    other
## 170     GP   F  16       U     GT3       T    4    4   health   health
## 171     GP   M  16       U     GT3       T    3    4    other    other
## 172     GP   M  16       U     GT3       T    1    0    other    other
## 173     GP   M  17       U     LE3       T    4    4  teacher    other
## 174     GP   F  16       U     GT3       T    1    3  at_home services
## 175     GP   F  16       U     LE3       T    3    3    other    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
## 179     GP   M  16       R     GT3       T    4    2  teacher services
## 180     GP   M  17       U     GT3       T    4    3    other    other
## 181     GP   M  16       U     GT3       T    4    3  teacher    other
## 182     GP   M  16       U     GT3       T    3    3 services    other
## 183     GP   F  17       U     GT3       T    2    4 services services
## 184     GP   F  17       U     LE3       T    3    3    other    other
## 185     GP   F  16       U     GT3       T    3    2    other    other
## 186     GP   M  17       U     GT3       T    3    3 services services
## 187     GP   M  16       U     GT3       T    1    2 services services
## 188     GP   M  16       U     LE3       T    2    1    other    other
## 189     GP   F  17       U     GT3       A    3    3   health    other
## 190     GP   M  17       R     GT3       T    1    2  at_home    other
## 191     GP   F  16       U     GT3       T    2    3 services services
## 192     GP   F  17       U     GT3       T    1    1  at_home services
## 193     GP   M  17       U     GT3       T    1    2  at_home services
## 194     GP   M  16       R     GT3       T    3    3 services services
## 195     GP   M  16       U     GT3       T    2    3    other    other
## 196     GP   F  17       U     LE3       T    2    4 services services
## 197     GP   M  17       U     GT3       T    4    4 services  teacher
## 198     GP   M  16       R     LE3       T    3    3  teacher    other
## 199     GP   F  17       U     GT3       T    4    4 services  teacher
## 200     GP   F  16       U     LE3       T    4    4  teacher  teacher
## 201     GP   F  16       U     GT3       T    4    3   health    other
## 202     GP   F  16       U     GT3       T    2    3    other    other
## 203     GP   F  17       U     GT3       T    1    1    other    other
## 204     GP   F  17       R     GT3       T    2    2    other    other
## 205     GP   F  16       R     GT3       T    2    2 services services
## 206     GP   F  17       U     GT3       T    3    4  at_home services
## 207     GP   F  16       U     GT3       A    3    1 services    other
## 208     GP   F  16       U     GT3       T    4    3  teacher    other
## 209     GP   F  16       U     GT3       T    1    1  at_home    other
## 210     GP   F  17       R     GT3       T    4    3  teacher    other
## 211     GP   F  19       U     GT3       T    3    3    other    other
## 212     GP   M  17       U     LE3       T    4    4 services    other
## 213     GP   F  16       U     GT3       A    2    2    other    other
## 214     GP   M  18       U     GT3       T    2    2 services    other
## 215     GP   F  17       R     LE3       T    4    4 services    other
## 216     GP   F  17       U     LE3       T    3    2    other    other
```

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## 217     GP   F  17       U     GT3       T    4    3    other    other
## 218     GP   M  18       U     LE3       T    3    3 services   health
## 219     GP   F  17       U     GT3       T    2    3  at_home    other
## 220     GP   F  17       U     GT3       T    2    2  at_home  at_home
## 221     GP   F  17       R     GT3       T    2    1  at_home services
## 222     GP   F  17       U     GT3       T    1    1  at_home    other
## 223     GP   F  16       U     GT3       T    2    3 services  teacher
## 224     GP   M  18       U     GT3       T    2    2    other    other
## 225     GP   F  16       U     GT3       T    4    4  teacher services
## 226     GP   F  18       R     GT3       T    3    1    other    other
## 227     GP   F  17       U     GT3       T    3    2    other    other
## 228     GP   M  17       U     LE3       T    2    3 services services
## 229     GP   M  18       U     LE3       T    2    1  at_home    other
## 230     GP   F  17       U     GT3       A    2    1    other    other
## 231     GP   F  17       U     LE3       T    4    3   health    other
## 232     GP   M  17       R     GT3       T    2    2    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
## 237     GP   M  17       U     LE3       T    2    2    other    other
## 238     GP   F  16       U     GT3       T    2    1    other    other
## 239     GP   F  17       R     GT3       T    2    1  at_home services
## 240     GP   M  18       U     GT3       T    2    2    other services
## 241     GP   M  17       U     LE3       T    4    3   health    other
## 242     GP   M  17       R     LE3       A    4    4  teacher    other
## 243     GP   M  16       U     LE3       T    4    3  teacher    other
## 244     GP   M  16       U     GT3       T    4    4 services services
## 245     GP   F  18       U     GT3       T    2    1    other    other
## 246     GP   M  16       U     GT3       T    2    1    other    other
## 247     GP   M  17       U     GT3       T    2    3    other    other
## 248     GP   M  22       U     GT3       T    3    1 services services
## 249     GP   M  18       R     LE3       T    3    3    other services
## 250     GP   M  16       U     GT3       T    0    2    other    other
## 251     GP   M  18       U     GT3       T    3    2 services    other
## 252     GP   M  16       U     GT3       T    3    3  at_home    other
## 253     GP   M  18       U     GT3       T    2    1 services services
## 254     GP   M  16       R     GT3       T    2    1    other    other
## 255     GP   M  17       R     GT3       T    2    1    other    other
## 256     GP   M  17       U     LE3       T    1    1   health    other
## 257     GP   F  17       U     LE3       T    4    2  teacher services
## 258     GP   M  19       U     LE3       A    4    3 services  at_home
## 259     GP   M  18       U     GT3       T    2    1    other    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
## 264     GP   F  17       U     GT3       T    3    3    other    other
## 265     GP   F  18       U     GT3       T    2    2  at_home services
## 266     GP   M  18       R     LE3       A    3    4    other    other
## 267     GP   M  17       U     GT3       T    3    1 services    other
## 268     GP   F  18       R     GT3       T    4    4  teacher    other
## 269     GP   M  18       U     GT3       T    4    2   health    other
## 270     GP   F  18       R     GT3       T    2    1    other    other
```

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## 271     GP   F  19       U     GT3       T    3    3    other services
## 272     GP   F  18       U     GT3       T    2    3    other services
## 273     GP   F  18       U     LE3       T    1    1    other    other
## 274     GP   M  17       R     GT3       T    1    2  at_home  at_home
## 275     GP   F  17       U     GT3       T    2    4  at_home   health
## 276     GP   F  17       U     LE3       T    2    2 services    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
## 280     GP   M  18       U     LE3       T    4    3  teacher services
## 281     GP   M  17       U     LE3       A    4    1 services    other
## 282     GP   M  17       U     LE3       A    3    2  teacher services
## 283     GP   F  18       R     LE3       T    1    1  at_home    other
## 284     GP   F  18       U     GT3       T    1    1    other    other
## 285     GP   F  17       U     GT3       T    2    2    other    other
## 286     GP   M  17       U     GT3       T    1    1    other    other
## 287     GP   F  18       U     GT3       T    2    2  at_home  at_home
## 288     GP   F  17       U     GT3       T    1    1 services  teacher
## 289     GP   M  18       U     GT3       T    2    1 services services
## 290     GP   M  18       U     LE3       A    4    4  teacher  teacher
## 291     GP   M  18       U     GT3       T    4    2  teacher    other
## 292     GP   F  17       U     GT3       T    4    3   health services
## 293     GP   F  18       U     LE3       T    2    1 services  at_home
## 294     GP   F  17       R     LE3       T    3    1 services    other
## 295     GP   M  18       R     LE3       T    3    2 services    other
## 296     GP   M  17       U     GT3       T    3    3   health    other
## 297     GP   F  19       U     GT3       T    4    4   health    other
## 298     GP   F  18       U     LE3       T    4    3    other    other
## 299     GP   F  18       U     GT3       T    4    3    other    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
## 303     GP   F  17       U     GT3       T    4    2    other    other
## 304     GP   F  17       U     GT3       T    3    2   health   health
## 305     GP   M  19       U     GT3       T    3    3    other    other
## 306     GP   F  18       U     GT3       T    2    4 services  at_home
## 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
## 310     GP   F  19       U     LE3       T    1    1  at_home    other
## 311     GP   F  19       U     LE3       T    1    2 services services
## 312     GP   F  19       U     GT3       T    2    1  at_home    other
## 313     GP   M  19       U     GT3       T    1    2    other services
## 314     GP   F  19       U     LE3       T    3    2 services    other
## 315     GP   F  19       U     GT3       T    1    1  at_home   health
## 316     GP   F  19       R     GT3       T    2    3    other    other
## 317     GP   F  18       U     GT3       T    2    1 services    other
## 318     GP   F  18       U     GT3       T    4    3    other    other
## 319     GP   F  17       R     GT3       T    3    4  at_home services
## 320     GP   F  18       U     GT3       T    4    4  teacher    other
## 321     GP   F  17       U     GT3       A    4    3 services services
## 322     GP   F  17       U     GT3       T    2    2    other    other
## 323     GP   F  17       R     LE3       T    2    2 services services
## 324     GP   F  17       U     GT3       T    3    1 services services
```

```
## 325     GP   F  17       U     LE3       T    0    2  at_home  at_home
## 326     GP   M  18       U     GT3       T    4    4    other    other
## 327     GP   M  17       U     GT3       T    3    3    other services
## 328     GP   M  17       R     GT3       T    2    2 services    other
## 329     GP   F  17       U     GT3       T    4    4  teacher services
## 330     GP   F  17       U     GT3       T    4    4  teacher  teacher
## 331     GP   M  18       U     LE3       T    2    2    other    other
## 332     GP   F  17       R     GT3       T    2    4  at_home    other
## 333     GP   F  18       U     GT3       T    3    3 services services
## 334     GP   F  18       U     LE3       T    2    2    other    other
## 335     GP   F  18       R     GT3       T    2    2  at_home    other
## 336     GP   F  17       U     GT3       T    3    4 services    other
## 337     GP   F  19       R     GT3       A    3    1 services  at_home
## 338     GP   F  17       U     GT3       T    3    2    other    other
## 339     GP   F  18       U     LE3       T    3    3 services services
## 340     GP   F  17       R     GT3       A    3    2    other    other
## 341     GP   F  19       U     GT3       T    2    1 services services
## 342     GP   M  18       U     GT3       T    4    4  teacher services
## 343     GP   M  18       U     LE3       T    3    4 services    other
## 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
## 346     GP   F  18       U     GT3       T    3    2    other services
## 347     GP   M  18       R     GT3       T    4    3  teacher services
## 348     GP   M  18       U     GT3       T    4    3  teacher    other
## 349     GP   F  17       U     GT3       T    4    3   health    other
## 350     MS   M  18       R     GT3       T    3    2    other    other
## 351     MS   M  19       R     GT3       T    1    1    other services
## 352     MS   M  17       U     GT3       T    3    3   health    other
## 353     MS   M  18       U     LE3       T    1    3  at_home services
## 354     MS   M  19       R     GT3       T    1    1    other    other
## 355     MS   M  17       R     GT3       T    4    3 services    other
## 356     MS   F  18       U     GT3       T    3    3 services services
## 357     MS   F  17       R     GT3       T    4    4  teacher services
## 358     MS   F  17       U     LE3       A    3    2 services    other
## 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
## 362     MS   M  18       R     LE3       T    1    1  at_home    other
## 363     MS   F  18       U     GT3       T    3    3 services services
## 364     MS   F  17       U     LE3       T    4    4  at_home  at_home
## 365     MS   F  17       R     GT3       T    1    2    other services
## 366     MS   M  18       R     GT3       T    1    3  at_home    other
## 367     MS   M  18       U     LE3       T    4    4  teacher services
## 368     MS   F  17       R     GT3       T    1    1    other services
## 369     MS   F  18       U     GT3       T    2    3  at_home services
## 370     MS   F  18       R     GT3       T    4    4    other  teacher
## 371     MS   F  19       U     LE3       T    3    2 services services
## 372     MS   M  18       R     LE3       T    1    2  at_home services
## 373     MS   F  17       U     GT3       T    2    2    other  at_home
## 374     MS   F  17       R     GT3       T    1    2    other    other
## 375     MS   F  18       R     LE3       T    4    4    other    other
## 376     MS   F  18       R     GT3       T    1    1    other    other
## 377     MS   F  20       U     GT3       T    4    2   health    other
## 378     MS   F  18       R     LE3       T    4    4  teacher services
```

```
## 379     MS   F  18       U     GT3       T    3    3    other    other
## 380     MS   F  17       R     GT3       T    3    1  at_home    other
## 381     MS   M  18       U     GT3       T    4    4  teacher  teacher
## 382     MS   M  18       R     GT3       T    2    1    other    other
## 383     MS   M  17       U     GT3       T    2    3    other services
## 384     MS   M  19       R     GT3       T    1    1    other services
## 385     MS   M  18       R     GT3       T    4    2    other    other
## 386     MS   F  18       R     GT3       T    2    2  at_home    other
## 387     MS   F  18       R     GT3       T    4    4  teacher  at_home
## 388     MS   F  19       R     GT3       T    2    3 services    other
## 389     MS   F  18       U     LE3       T    3    1  teacher services
## 390     MS   F  18       U     GT3       T    1    1    other    other
## 391     MS   M  20       U     LE3       A    2    2 services services
## 392     MS   M  17       U     LE3       T    3    1 services services
## 393     MS   M  21       R     GT3       T    1    1    other    other
## 394     MS   M  18       R     LE3       T    3    2 services    other
## 395     MS   M  19       U     LE3       T    1    1    other  at_home
##         reason guardian traveltime studytime failures schoolsup famsup
## 1       course   mother          2         2        0       yes     no
## 2       course   father          1         2        0        no    yes
## 3        other   mother          1         2        3       yes     no
## 4         home   mother          1         3        0        no    yes
## 5         home   father          1         2        0        no    yes
## 6   reputation   mother          1         2        0        no    yes
## 7         home   mother          1         2        0        no     no
## 8         home   mother          2         2        0       yes    yes
## 9         home   mother          1         2        0        no    yes
## 10        home   mother          1         2        0        no    yes
## 11  reputation   mother          1         2        0        no    yes
## 12  reputation   father          3         3        0        no    yes
## 13      course   father          1         1        0        no    yes
## 14      course   mother          2         2        0        no    yes
## 15        home    other          1         3        0        no    yes
## 16        home   mother          1         1        0        no    yes
## 17  reputation   mother          1         3        0        no    yes
## 18  reputation   mother          3         2        0       yes    yes
## 19      course   mother          1         1        3        no    yes
## 20        home   father          1         1        0        no     no
## 21  reputation   mother          1         2        0        no     no
## 22       other   father          1         1        0        no    yes
## 23      course   mother          1         2        0        no     no
## 24  reputation   mother          2         2        0        no    yes
## 25      course   mother          1         3        0       yes    yes
## 26        home   mother          1         1        2        no    yes
## 27        home   mother          1         1        0        no    yes
## 28       other   mother          1         1        0        no     no
## 29        home   mother          1         2        0       yes    yes
## 30        home   mother          1         2        0        no    yes
## 31        home   mother          1         2        0        no    yes
## 32  reputation   mother          2         2        0        no    yes
## 33      course   mother          1         2        0        no    yes
## 34      course   mother          1         2        0        no     no
## 35        home   mother          1         1        0        no    yes
## 36       other   father          2         1        0        no    yes
```

```
## 37        home   mother          1         3         0        no    yes
## 38  reputation   mother          2         3         0        no    yes
## 39      course   mother          1         3         0       yes    yes
## 40  reputation   mother          1         1         0       yes    yes
## 41        home   mother          2         2         1        no    yes
## 42        home    other          1         1         0        no    yes
## 43      course   father          1         2         0        no    yes
## 44      course   father          1         1         0       yes    yes
## 45      course   father          2         2         1       yes     no
## 46      course   mother          1         2         0       yes    yes
## 47        home   mother          1         2         0        no    yes
## 48  reputation   mother          1         4         0        no     no
## 49        home   mother          1         2         0        no    yes
## 50       other   father          1         2         1       yes    yes
## 51      course   mother          3         2         0        no    yes
## 52       other   mother          1         2         0        no    yes
## 53       other   father          2         1         1        no     no
## 54      course   mother          1         1         0       yes    yes
## 55       other   mother          1         1         0        no     no
## 56       other   mother          1         2         0        no     no
## 57  reputation   mother          1         2         0        no    yes
## 58  reputation   mother          1         2         0        no    yes
## 59        home   father          1         2         0       yes    yes
## 60      course   mother          1         2         0        no    yes
## 61       other   mother          1         2         0        no    yes
## 62      course   father          4         1         0       yes    yes
## 63  reputation   father          1         2         0       yes     no
## 64        home   mother          1         3         0       yes    yes
## 65  reputation   father          1         2         0       yes     no
## 66      course   mother          3         2         0        no    yes
## 67  reputation   mother          1         4         0        no    yes
## 68      course   mother          1         4         0       yes    yes
## 69  reputation   mother          2         2         0       yes    yes
## 70  reputation   father          2         4         0        no    yes
## 71  reputation   father          2         4         0        no    yes
## 72      course   mother          1         4         0        no     no
## 73  reputation   mother          1         2         2       yes    yes
## 74  reputation   mother          1         1         0        no     no
## 75        home   mother          1         2         0       yes    yes
## 76        home   mother          1         2         0        no    yes
## 77      course   mother          2         4         0        no     no
## 78  reputation   mother          1         4         0        no     no
## 79        home   mother          2         1         3       yes    yes
## 80      course   mother          1         2         0        no    yes
## 81      course   father          1         1         0       yes    yes
## 82        home   mother          1         3         0       yes     no
## 83  reputation   mother          1         2         0        no    yes
## 84        home   mother          2         2         0        no     no
## 85        home   father          1         2         0        no    yes
## 86  reputation   father          2         2         2        no     no
## 87      course   mother          1         2         0        no    yes
## 88  reputation   mother          1         3         0        no    yes
## 89  reputation   father          2         2         1        no     no
## 90  reputation   mother          1         2         0        no    yes
```

```
## 91        home   mother          1         3         0        no    yes
## 92  reputation   mother          1         1         0        no     no
## 93        home   father          1         2         0       yes    yes
## 94        home   mother          2         2         0        no    yes
## 95  reputation   mother          1         4         0        no    yes
## 96        home   mother          2         4         1       yes    yes
## 97  reputation   mother          2         1         0       yes    yes
## 98      course   mother          1         2         0        no    yes
## 99  reputation   mother          1         1         0        no     no
## 100     course   mother          1         3         0       yes    yes
## 101      other   mother          1         1         0       yes    yes
## 102      other   father          1         3         0        no    yes
## 103     course   mother          1         1         0        no    yes
## 104       home   mother          2         2         0       yes    yes
## 105     course   mother          1         2         0        no    yes
## 106 reputation   father          1         4         0       yes     no
## 107     course   mother          1         4         0       yes    yes
## 108       home   father          1         3         0        no    yes
## 109       home   father          4         4         0        no    yes
## 110      other   mother          1         3         0        no    yes
## 111     course   mother          1         1         0        no     no
## 112 reputation   father          1         3         1       yes    yes
## 113       home   mother          1         2         1       yes     no
## 114     course   mother          1         1         0        no     no
## 115 reputation   mother          1         2         0        no     no
## 116     course   father          1         2         0        no    yes
## 117 reputation   father          2         2         0        no    yes
## 118       home   father          2         1         0        no     no
## 119     course   father          3         2         1        no    yes
## 120 reputation   father          1         1         0        no     no
## 121     course   mother          1         2         0        no     no
## 122       home   father          1         4         0        no    yes
## 123     course   father          2         2         0        no    yes
## 124     course   mother          1         1         0        no    yes
## 125       home   mother          1         2         0        no     no
## 126       home   father          1         1         0       yes     no
## 127       home   mother          1         2         0       yes     no
## 128     course    other          1         2         3        no    yes
## 129 reputation   mother          1         1         2        no    yes
## 130     course   mother          1         1         0        no     no
## 131     course   father          2         3         2        no    yes
## 132     course   mother          3         1         0        no    yes
## 133     course   father          1         1         0        no    yes
## 134     course   father          1         1         0        no     no
## 135     course   mother          4         2         0        no    yes
## 136     course   mother          1         3         0        no    yes
## 137     course   mother          3         2         0        no     no
## 138     course    other          2         1         2        no    yes
## 139     course   mother          1         2         1        no     no
## 140     course   mother          2         1         0        no     no
## 141     course   father          2         4         0       yes    yes
## 142 reputation   father          2         1         2        no    yes
## 143     course   mother          1         3         0        no    yes
## 144     course   mother          1         1         0        no     no
```

```
## 145       home   mother          1          1          3         no    yes
## 146     course   father          1          2          0         no    yes
## 147       home   father          1          2          3         no    yes
## 148     course   mother          1          2          0         no    yes
## 149     course   mother          1          1          0         no    yes
## 150     course   mother          4          1          3         no     no
## 151     course   mother          1          1          3         no     no
## 152     course   mother          1          1          1         no     no
## 153 reputation    other          2          3          2         no    yes
## 154       home   mother          1          1          3         no    yes
## 155     course   mother          1          1          0        yes    yes
## 156     course   mother          1          2          0        yes     no
## 157 reputation   mother          1          1          0         no     no
## 158     course   mother          3          1          3         no    yes
## 159     course   mother          3          1          0         no     no
## 160     course   father          1          2          1         no    yes
## 161     course   mother          2          1          2         no     no
## 162     course   mother          2          2          2        yes    yes
## 163     course   mother          2          1          1         no     no
## 164     course   father          1          1          0         no     no
## 165     course   mother          4          2          3         no     no
## 166     course   mother          2          1          1         no    yes
## 167     course   father          1          2          0         no     no
## 168       home   father          1          2          0         no     no
## 169       home   mother          1          2          0         no    yes
## 170 reputation   mother          1          2          0         no    yes
## 171     course   father          3          1          2         no    yes
## 172 reputation   mother          2          2          0         no    yes
## 173 reputation   mother          1          2          0         no    yes
## 174       home   mother          1          2          3         no     no
## 175 reputation   mother          2          2          0         no    yes
## 176     course   mother          2          2          0         no     no
## 177 reputation   mother          2          2          0         no     no
## 178 reputation   father          1          2          0         no     no
## 179      other   mother          1          1          0         no    yes
## 180     course   mother          1          2          0         no    yes
## 181       home   mother          1          2          0         no    yes
## 182       home   mother          1          2          0         no     no
## 183 reputation   father          1          2          0         no    yes
## 184 reputation   mother          1          2          0         no    yes
## 185 reputation   mother          1          2          0         no    yes
## 186      other   mother          1          2          0         no    yes
## 187      other   mother          1          1          0         no    yes
## 188     course   mother          1          2          0         no     no
## 189 reputation   mother          1          2          0         no    yes
## 190       home   mother          1          2          0         no     no
## 191     course   mother          1          2          0         no     no
## 192     course   mother          1          2          0         no     no
## 193      other    other          2          2          0         no     no
## 194 reputation   mother          1          1          0         no    yes
## 195       home   father          2          1          0         no     no
## 196     course   father          1          2          0         no     no
## 197       home   mother          1          1          0         no     no
## 198       home   father          3          1          0         no    yes
```

```
## 199       home   mother          2         1         1         no    yes
## 200 reputation   mother          1         2         0         no    yes
## 201       home   mother          1         2         0         no    yes
## 202 reputation   mother          1         2         0        yes    yes
## 203     course   mother          1         2         0         no    yes
## 204 reputation   mother          1         1         0         no    yes
## 205 reputation   mother          2         4         0         no    yes
## 206       home   mother          1         3         1         no    yes
## 207     course   mother          1         2         3         no    yes
## 208      other   mother          1         2         0         no     no
## 209       home   mother          2         1         0         no    yes
## 210 reputation   mother          2         3         0         no    yes
## 211 reputation    other          1         4         0         no    yes
## 212       home   mother          1         2         0         no    yes
## 213 reputation   mother          1         2         0        yes    yes
## 214       home   mother          1         2         1         no    yes
## 215      other   mother          1         1         0         no    yes
## 216 reputation   mother          2         2         0         no     no
## 217 reputation   mother          1         2         2         no     no
## 218       home   father          1         2         1         no    yes
## 219       home   father          2         1         0         no    yes
## 220     course   mother          1         3         0         no    yes
## 221 reputation   mother          2         2         0         no    yes
## 222 reputation   mother          1         3         1         no    yes
## 223      other   mother          1         2         0        yes     no
## 224       home   mother          2         2         0         no    yes
## 225       home   mother          1         3         0         no    yes
## 226 reputation   mother          1         2         1         no     no
## 227     course   mother          1         2         0         no     no
## 228 reputation   father          1         2         0         no    yes
## 229     course   mother          4         2         0        yes    yes
## 230     course   mother          2         3         0         no     no
## 231 reputation   father          1         2         0         no     no
## 232     course   father          2         2         0         no    yes
## 233 reputation   mother          1         2         0        yes    yes
## 234 reputation   father          1         2         0         no    yes
## 235       home   mother          2         2         0         no    yes
## 236 reputation   mother          2         3         0         no     no
## 237       home   father          1         2         0         no     no
## 238       home   mother          1         1         0         no     no
## 239     course   mother          3         2         0         no     no
## 240 reputation   father          1         2         1         no     no
## 241     course   mother          2         2         0         no     no
## 242     course   mother          2         2         0         no    yes
## 243     course   mother          1         1         0         no     no
## 244     course   mother          1         1         0         no     no
## 245     course    other          2         3         0         no    yes
## 246     course   mother          3         1         0         no     no
## 247     course   father          2         1         0         no     no
## 248      other   mother          1         1         3         no     no
## 249     course   mother          1         2         1         no    yes
## 250      other   mother          1         1         0         no     no
## 251     course   mother          2         1         1         no     no
## 252 reputation    other          3         2         0        yes    yes
```

```
## 253      other   mother          1          1          1         no      no
## 254     course   mother          2          1          0         no      no
## 255     course   mother          1          1          0         no      no
## 256     course   mother          2          1          1         no     yes
## 257 reputation   mother          1          4          0         no     yes
## 258 reputation   mother          1          2          0         no     yes
## 259       home   mother          1          2          0         no      no
## 260     course   father          1          4          0         no      no
## 261       home   father          1          2          0         no     yes
## 262     course   mother          1          2          0         no     yes
## 263     course   mother          1          3          0         no      no
## 264       home   mother          1          3          0         no      no
## 265       home   mother          1          3          0         no     yes
## 266 reputation   mother          2          2          0         no     yes
## 267      other   mother          1          2          0         no      no
## 268 reputation   mother          2          2          0         no      no
## 269 reputation   father          1          2          0         no     yes
## 270 reputation   mother          2          2          0         no     yes
## 271       home    other          1          2          2         no     yes
## 272 reputation   father          1          4          0         no     yes
## 273       home   mother          2          2          0         no     yes
## 274       home   mother          1          2          0         no     yes
## 275 reputation   mother          2          2          0         no     yes
## 276     course   mother          2          2          0        yes     yes
## 277       home   mother          2          2          0         no      no
## 278       home   mother          2          1          0         no      no
## 279 reputation   father          1          2          1        yes     yes
## 280     course   mother          2          1          0         no      no
## 281       home   mother          2          1          0         no      no
## 282       home   mother          1          1          1         no      no
## 283 reputation   mother          2          4          0         no     yes
## 284       home   mother          2          2          0        yes      no
## 285     course   mother          1          2          0         no     yes
## 286 reputation   father          1          2          0         no      no
## 287      other   mother          1          3          0         no     yes
## 288 reputation   mother          1          3          0         no     yes
## 289 reputation   mother          1          3          0         no      no
## 290 reputation   mother          1          2          0         no     yes
## 291       home   mother          1          2          0         no     yes
## 292 reputation   mother          1          3          0         no     yes
## 293 reputation   mother          1          2          1         no      no
## 294 reputation   mother          2          4          0         no     yes
## 295 reputation   mother          2          3          0         no     yes
## 296       home   mother          1          1          0         no     yes
## 297 reputation    other          2          2          0         no     yes
## 298       home    other          2          2          0         no     yes
## 299 reputation   father          1          4          0         no     yes
## 300       home   mother          1          1          0         no     yes
## 301       home   mother          1          2          0         no     yes
## 302       home   father          2          1          0         no      no
## 303 reputation   mother          2          3          0         no     yes
## 304 reputation   father          1          4          0         no     yes
## 305       home    other          1          2          1         no     yes
## 306 reputation    other          1          2          1         no     yes
```

```
## 307     course    other          1         1         0        no     no
## 308 reputation    other          2         1         1        no    yes
## 309 reputation   father          1         2         1        no     no
## 310 reputation    other          1         2         1       yes    yes
## 311       home    other          1         2         1        no     no
## 312      other    other          3         2         0        no    yes
## 313     course    other          1         2         1        no     no
## 314 reputation    other          2         2         1        no    yes
## 315       home    other          1         3         2        no     no
## 316 reputation    other          1         3         1        no     no
## 317     course   mother          2         2         0        no    yes
## 318     course   mother          1         3         0        no    yes
## 319     course   father          1         3         0        no    yes
## 320     course   mother          1         2         0        no    yes
## 321     course   mother          1         2         0        no    yes
## 322     course   mother          1         2         0        no    yes
## 323     course   mother          1         3         0        no    yes
## 324     course   father          1         3         0        no    yes
## 325       home   father          2         3         0        no     no
## 326     course   mother          1         3         0        no     no
## 327 reputation   mother          1         1         0        no     no
## 328     course   mother          4         1         0        no    yes
## 329     course   mother          1         3         0        no    yes
## 330     course   mother          2         3         0        no    yes
## 331     course   mother          1         4         0        no    yes
## 332     course   father          1         3         0        no    yes
## 333       home   mother          1         2         0        no     no
## 334       home    other          1         2         0        no     no
## 335     course   mother          2         4         0        no     no
## 336     course   mother          1         3         0        no     no
## 337       home    other          1         3         1        no     no
## 338       home   mother          1         2         0        no    yes
## 339       home   mother          1         4         0        no    yes
## 340       home   mother          1         2         0        no    yes
## 341       home    other          1         3         1        no     no
## 342       home   father          1         2         1        no    yes
## 343       home   mother          1         2         0        no     no
## 344       home   father          1         2         1        no    yes
## 345     course   mother          1         3         0        no    yes
## 346      other   mother          1         3         0        no     no
## 347     course   mother          1         3         0        no     no
## 348     course   mother          1         3         0        no    yes
## 349 reputation   mother          1         3         0        no    yes
## 350     course   mother          2         1         1        no    yes
## 351       home    other          3         2         3        no     no
## 352     course   mother          2         2         0        no    yes
## 353     course   mother          1         1         1        no     no
## 354       home    other          3         1         1        no    yes
## 355       home   mother          2         2         0        no    yes
## 356     course   father          1         2         0        no    yes
## 357      other   father          2         2         0        no    yes
## 358 reputation   mother          2         2         0        no     no
## 359       home   father          2         1         0        no     no
## 360     course   father          2         3         0        no     no
```

```
## 361     course   mother          3         2        0        no     no
## 362      other   mother          2         2        1        no     no
## 363      other   mother          2         2        0        no    yes
## 364     course   mother          1         2        0        no    yes
## 365     course   father          2         2        0        no     no
## 366     course   mother          2         2        0        no    yes
## 367      other   mother          2         3        0        no     no
## 368 reputation   mother          3         1        1        no    yes
## 369     course   father          2         1        0        no    yes
## 370      other   father          3         2        0        no    yes
## 371       home    other          2         2        2        no     no
## 372      other   father          3         1        0        no    yes
## 373       home   mother          1         3        0        no     no
## 374     course   mother          1         1        0        no     no
## 375 reputation   mother          2         3        0        no     no
## 376       home   mother          4         3        0        no     no
## 377     course    other          2         3        2        no    yes
## 378     course   mother          1         2        0        no     no
## 379       home   mother          1         2        0        no     no
## 380 reputation   mother          1         2        0        no    yes
## 381       home   father          1         2        0        no     no
## 382      other   mother          2         1        0        no     no
## 383       home   father          2         2        0        no     no
## 384      other   mother          2         1        1        no     no
## 385       home   father          2         1        1        no     no
## 386      other   mother          2         3        0        no     no
## 387 reputation   mother          3         1        0        no    yes
## 388     course   mother          1         3        1        no     no
## 389     course   mother          1         2        0        no    yes
## 390     course   mother          2         2        1        no     no
## 391     course    other          1         2        2        no    yes
## 392     course   mother          2         1        0        no     no
## 393     course    other          1         1        3        no     no
## 394     course   mother          3         1        0        no     no
## 395     course   father          1         1        0        no     no
##     paid activities nursery higher internet romantic famrel freetime goout
## 1     no         no     yes    yes       no       no      4        3     4
## 2     no         no      no    yes      yes       no      5        3     3
## 3    yes         no     yes    yes      yes       no      4        3     2
## 4    yes        yes     yes    yes      yes      yes      3        2     2
## 5    yes         no     yes    yes       no       no      4        3     2
## 6    yes        yes     yes    yes      yes       no      5        4     2
## 7     no         no     yes    yes      yes       no      4        4     4
## 8     no         no     yes    yes       no       no      4        1     4
## 9    yes         no     yes    yes      yes       no      4        2     2
## 10   yes        yes     yes    yes      yes       no      5        5     1
## 11   yes         no     yes    yes      yes       no      3        3     3
## 12    no        yes     yes    yes      yes       no      5        2     2
## 13   yes        yes     yes    yes      yes       no      4        3     3
## 14   yes         no     yes    yes      yes       no      5        4     3
## 15    no         no     yes    yes      yes      yes      4        5     2
## 16    no         no     yes    yes      yes       no      4        4     4
## 17   yes        yes     yes    yes      yes       no      3        2     3
## 18    no        yes     yes    yes       no       no      5        3     2
```

```
## 19    no        yes     yes     yes      yes       no      5       5     5
## 20   yes        yes     yes     yes      yes       no      3       1     3
## 21    no         no     yes     yes      yes       no      4       4     1
## 22   yes         no     yes     yes      yes       no      5       4     2
## 23    no        yes     yes     yes      yes       no      4       5     1
## 24    no        yes     yes     yes      yes       no      5       4     4
## 25   yes        yes     yes     yes      yes       no      4       3     2
## 26   yes         no      no     yes      yes       no      1       2     2
## 27   yes         no     yes     yes      yes       no      4       2     2
## 28   yes         no     yes     yes      yes       no      2       2     4
## 29    no        yes     yes     yes      yes       no      5       3     3
## 30   yes        yes     yes     yes      yes      yes      4       4     5
## 31   yes         no      no     yes      yes       no      5       4     2
## 32    no        yes     yes     yes      yes       no      4       3     1
## 33    no        yes     yes     yes      yes      yes      4       5     2
## 34    no        yes      no     yes      yes       no      5       3     2
## 35   yes         no      no     yes      yes       no      5       4     3
## 36    no        yes     yes     yes       no       no      3       5     1
## 37    no        yes     yes     yes      yes       no      5       4     3
## 38    no        yes     yes     yes      yes      yes      2       4     3
## 39   yes        yes     yes     yes      yes       no      4       3     2
## 40   yes        yes     yes     yes       no       no      4       3     1
## 41    no        yes      no     yes      yes      yes      3       3     3
## 42    no         no      no     yes      yes      yes      5       4     3
## 43    no        yes     yes     yes      yes       no      4       3     3
## 44    no         no     yes     yes      yes       no      5       4     1
## 45    no        yes     yes     yes      yes       no      4       3     3
## 46   yes        yes     yes     yes      yes      yes      5       2     2
## 47    no         no     yes     yes      yes       no      2       3     5
## 48    no        yes     yes     yes      yes       no      4       2     2
## 49   yes         no     yes     yes       no       no      4       3     3
## 50    no        yes      no     yes      yes       no      4       4     4
## 51   yes         no     yes     yes      yes       no      4       3     3
## 52   yes         no     yes     yes      yes       no      4       3     3
## 53    no         no     yes     yes       no       no      5       5     5
## 54   yes         no     yes     yes      yes       no      3       3     4
## 55   yes         no     yes     yes      yes       no      5       3     4
## 56   yes        yes     yes     yes      yes      yes      5       3     4
## 57   yes        yes     yes     yes      yes       no      4       3     2
## 58    no        yes     yes     yes       no       no      3       2     2
## 59    no        yes     yes     yes      yes       no      4       3     2
## 60    no         no     yes     yes      yes       no      4       2     3
## 61    no        yes     yes     yes       no       no      2       4     4
## 62    no        yes      no     yes      yes      yes      5       5     5
## 63    no        yes     yes     yes      yes       no      4       4     3
## 64   yes        yes     yes     yes      yes       no      3       4     4
## 65    no        yes     yes     yes      yes      yes      4       4     4
## 66    no        yes     yes     yes      yes       no      5       4     3
## 67    no        yes      no     yes      yes      yes      1       3     3
## 68   yes         no     yes     yes      yes       no      4       3     3
## 69   yes         no     yes     yes      yes       no      4       1     3
## 70    no         no      no     yes      yes       no      4       4     2
## 71   yes         no     yes     yes      yes       no      4       3     2
## 72    no         no     yes     yes      yes       no      3       3     3
```

```
## 73    no         no      no    yes       yes      yes      3        3     4
## 74    no        yes     yes    yes        no       no      5        3     2
## 75   yes        yes     yes    yes       yes       no      4        3     3
## 76   yes        yes     yes    yes       yes       no      4        3     3
## 77    no        yes     yes    yes       yes       no      3        4     3
## 78   yes         no     yes    yes       yes      yes      5        2     3
## 79    no        yes     yes     no       yes       no      4        5     1
## 80    no         no     yes    yes       yes       no      2        4     3
## 81   yes        yes      no    yes       yes      yes      3        2     2
## 82   yes         no      no    yes       yes       no      5        3     2
## 83   yes         no     yes    yes       yes       no      4        4     4
## 84   yes        yes     yes    yes       yes       no      5        3     3
## 85    no        yes      no    yes       yes       no      4        3     2
## 86   yes         no     yes    yes       yes      yes      4        4     4
## 87    no         no     yes    yes        no       no      4        3     4
## 88    no        yes     yes    yes       yes       no      5        3     3
## 89   yes        yes      no    yes       yes       no      4        4     2
## 90    no         no     yes    yes        no       no      4        1     3
## 91   yes         no     yes    yes       yes      yes      4        3     3
## 92   yes        yes     yes    yes       yes       no      4        5     5
## 93    no         no     yes    yes        no       no      3        3     3
## 94   yes        yes     yes    yes       yes       no      5        3     3
## 95    no        yes     yes    yes       yes       no      4        3     4
## 96   yes        yes     yes    yes       yes       no      3        1     2
## 97    no        yes      no    yes       yes       no      3        3     3
## 98   yes         no     yes    yes        no      yes      4        3     5
## 99    no        yes      no    yes       yes       no      5        3     4
## 100  yes         no     yes    yes       yes       no      5        3     5
## 101  yes        yes     yes    yes       yes       no      4        5     5
## 102   no        yes     yes    yes       yes      yes      4        4     3
## 103   no        yes      no    yes       yes       no      5        3     3
## 104  yes         no     yes    yes       yes       no      4        3     5
## 105  yes        yes     yes    yes       yes       no      5        4     4
## 106   no         no     yes    yes        no       no      4        3     3
## 107  yes         no     yes    yes       yes       no      5        1     2
## 108   no        yes     yes    yes       yes       no      5        3     3
## 109  yes        yes     yes    yes       yes      yes      1        3     5
## 110  yes        yes     yes    yes       yes      yes      5        4     5
## 111   no        yes     yes    yes       yes       no      5        5     3
## 112   no        yes     yes    yes       yes       no      4        1     2
## 113   no        yes     yes    yes       yes       no      3        1     2
## 114   no         no     yes    yes       yes       no      3        5     2
## 115   no        yes     yes    yes       yes      yes      5        4     2
## 116   no        yes     yes    yes       yes       no      5        4     4
## 117   no        yes     yes    yes        no       no      4        4     3
## 118   no        yes     yes    yes       yes       no      5        4     2
## 119   no        yes     yes    yes       yes       no      5        2     4
## 120   no         no     yes    yes       yes       no      3        4     3
## 121   no         no      no    yes       yes       no      3        2     3
## 122  yes        yes     yes    yes       yes       no      5        5     4
## 123  yes        yes     yes    yes       yes      yes      4        2     2
## 124   no        yes     yes    yes       yes       no      3        4     4
## 125  yes         no     yes    yes       yes      yes      5        4     4
## 126   no         no     yes    yes       yes       no      5        5     5
```

```
## 127   no        yes     yes     yes      yes      yes      5        3      2
## 128   no         no      no      no       no       no      3        4      2
## 129   no        yes     yes     yes      yes       no      3        3      3
## 130  yes        yes     yes     yes      yes       no      3        5      5
## 131   no         no     yes     yes      yes      yes      4        2      2
## 132   no        yes      no     yes      yes      yes      4        3      3
## 133   no         no     yes     yes      yes      yes      3        4      4
## 134   no         no     yes     yes      yes       no      3        2      1
## 135   no         no     yes     yes       no      yes      5        3      3
## 136   no        yes     yes     yes      yes      yes      4        3      3
## 137   no         no     yes     yes       no       no      5        4      5
## 138   no        yes      no     yes      yes      yes      4        3      2
## 139   no         no     yes     yes       no      yes      4        4      4
## 140   no        yes     yes     yes      yes       no      4        3      2
## 141   no         no     yes     yes      yes       no      2        2      2
## 142   no        yes     yes     yes      yes       no      2        3      3
## 143  yes        yes     yes     yes      yes       no      4        2      2
## 144   no         no     yes     yes      yes       no      3        4      4
## 145   no         no     yes     yes      yes       no      5        4      5
## 146  yes         no     yes     yes      yes       no      4        4      2
## 147   no         no     yes     yes      yes       no      3        3      2
## 148  yes         no      no     yes      yes       no      4        3      2
## 149   no         no     yes      no      yes      yes      3        3      2
## 150   no         no     yes     yes      yes       no      4        5      5
## 151   no         no     yes      no      yes      yes      2        3      5
## 152   no        yes     yes     yes       no      yes      4        4      4
## 153  yes        yes     yes     yes      yes      yes      4        2      1
## 154   no         no     yes      no      yes      yes      4        5      4
## 155   no         no     yes     yes       no      yes      4        2      1
## 156  yes        yes     yes     yes       no       no      4        4      4
## 157   no         no     yes     yes       no       no      2        2      2
## 158   no        yes      no     yes       no       no      5        2      5
## 159   no         no      no     yes       no       no      4        2      2
## 160  yes         no     yes     yes      yes      yes      4        5      5
## 161   no        yes     yes      no      yes      yes      3        3      2
## 162   no         no     yes     yes      yes      yes      4        4      4
## 163   no        yes     yes     yes       no       no      4        4      4
## 164   no         no     yes      no      yes       no      5        3      3
## 165   no        yes     yes      no       no      yes      5        3      5
## 166   no        yes      no      no       no       no      4        5      2
## 167   no         no     yes      no      yes       no      4        3      5
## 168  yes         no     yes     yes      yes      yes      4        2      3
## 169  yes         no      no     yes      yes       no      5        1      5
## 170  yes         no     yes     yes      yes      yes      4        4      2
## 171   no        yes      no     yes      yes       no      3        4      5
## 172  yes        yes     yes     yes      yes      yes      4        3      2
## 173  yes        yes     yes     yes      yes       no      4        4      4
## 174   no        yes      no     yes      yes      yes      4        3      5
## 175  yes        yes     yes     yes      yes       no      4        4      5
## 176  yes        yes     yes     yes      yes       no      4        4      4
## 177  yes        yes      no     yes      yes       no      3        4      4
## 178   no        yes      no     yes      yes       no      4        3      4
## 179   no        yes     yes     yes      yes      yes      4        3      3
## 180   no        yes     yes     yes      yes      yes      5        2      3
```

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## 181  yes        yes     yes    yes      yes       no      3        4     3
## 182  yes        yes     yes    yes      yes      yes      4        2     3
## 183   no        yes     yes    yes       no       no      5        4     2
## 184   no        yes     yes    yes      yes      yes      5        3     3
## 185  yes         no     yes    yes      yes       no      1        2     2
## 186   no        yes     yes    yes      yes      yes      4        3     4
## 187  yes        yes     yes    yes      yes      yes      3        3     3
## 188  yes        yes     yes    yes      yes      yes      4        2     3
## 189   no         no      no    yes      yes      yes      3        3     3
## 190   no         no     yes    yes       no       no      3        1     3
## 191   no         no     yes    yes      yes       no      4        3     3
## 192   no        yes     yes    yes      yes       no      5        3     3
## 193  yes        yes      no    yes      yes       no      4        4     4
## 194   no        yes     yes    yes      yes       no      4        3     2
## 195   no         no     yes    yes      yes       no      5        3     3
## 196   no        yes     yes    yes      yes      yes      4        3     2
## 197   no         no     yes    yes      yes       no      5        2     3
## 198  yes        yes     yes    yes      yes       no      3        3     4
## 199   no         no     yes    yes      yes       no      4        2     4
## 200  yes         no     yes    yes      yes       no      4        5     2
## 201   no        yes     yes    yes      yes       no      4        3     5
## 202  yes        yes     yes    yes       no       no      4        4     3
## 203  yes         no      no    yes       no       no      4        4     4
## 204   no         no     yes    yes      yes       no      5        3     2
## 205  yes        yes      no    yes      yes       no      5        3     5
## 206  yes         no     yes    yes      yes      yes      4        4     3
## 207  yes         no     yes    yes      yes       no      2        3     3
## 208  yes        yes     yes    yes      yes      yes      1        3     2
## 209  yes         no     yes    yes       no       no      4        3     2
## 210  yes        yes     yes    yes      yes      yes      4        4     2
## 211  yes        yes     yes    yes      yes       no      4        3     3
## 212  yes         no     yes    yes      yes      yes      5        3     5
## 213  yes         no     yes    yes      yes       no      3        3     4
## 214  yes        yes     yes    yes      yes       no      4        4     4
## 215  yes         no     yes    yes       no       no      5        2     1
## 216  yes         no     yes    yes      yes       no      4        4     4
## 217  yes         no     yes    yes      yes      yes      3        4     5
## 218  yes         no     yes    yes      yes       no      3        2     4
## 219  yes         no     yes    yes       no       no      3        3     3
## 220  yes        yes     yes    yes      yes       no      4        3     3
## 221   no        yes     yes    yes      yes       no      4        2     5
## 222   no        yes     yes    yes       no      yes      4        3     4
## 223   no         no     yes    yes      yes       no      2        3     1
## 224  yes         no     yes    yes      yes       no      3        3     3
## 225   no        yes      no    yes      yes       no      5        3     2
## 226   no        yes     yes    yes      yes      yes      5        3     3
## 227   no        yes      no    yes      yes       no      5        3     4
## 228  yes         no      no    yes      yes       no      5        3     3
## 229  yes        yes     yes    yes      yes      yes      4        3     2
## 230   no        yes     yes    yes      yes      yes      3        2     3
## 231   no        yes     yes    yes      yes      yes      3        2     3
## 232  yes        yes     yes    yes      yes       no      4        5     2
## 233   no        yes     yes    yes      yes      yes      4        5     5
## 234  yes        yes     yes    yes      yes       no      4        2     4
```

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## 235  yes         no     yes    yes      yes       no      3        4     2
## 236   no        yes     yes    yes      yes      yes      5        3     3
## 237  yes        yes      no    yes      yes      yes      4        4     2
## 238   no         no     yes    yes      yes      yes      4        5     2
## 239   no        yes     yes    yes       no       no      2        1     1
## 240   no         no     yes     no      yes       no      5        5     4
## 241   no        yes     yes    yes      yes      yes      2        5     5
## 242  yes         no     yes    yes      yes       no      3        3     3
## 243   no        yes      no    yes      yes       no      5        4     5
## 244   no        yes     yes    yes      yes       no      5        3     2
## 245  yes         no      no    yes      yes      yes      4        4     4
## 246   no         no     yes    yes      yes       no      4        3     3
## 247   no         no     yes    yes      yes       no      5        2     2
## 248   no         no      no     no      yes      yes      5        4     5
## 249   no         no     yes    yes      yes      yes      4        3     3
## 250  yes         no      no    yes      yes       no      4        3     2
## 251   no         no     yes     no      yes       no      4        4     5
## 252   no         no      no    yes      yes       no      5        3     3
## 253   no         no      no     no      yes       no      3        2     5
## 254   no        yes      no    yes       no       no      3        3     2
## 255   no         no      no    yes      yes       no      4        4     2
## 256   no        yes     yes    yes      yes       no      4        4     4
## 257  yes        yes     yes    yes      yes       no      4        2     3
## 258   no         no     yes    yes      yes       no      4        3     1
## 259   no        yes     yes    yes      yes       no      5        2     4
## 260  yes        yes     yes    yes      yes      yes      3        4     1
## 261  yes         no     yes    yes      yes      yes      3        1     2
## 262  yes         no      no    yes      yes       no      4        3     2
## 263   no        yes      no    yes       no       no      5        3     2
## 264   no        yes      no    yes       no       no      3        2     3
## 265  yes        yes     yes    yes      yes      yes      4        3     3
## 266  yes        yes     yes    yes      yes       no      4        2     5
## 267  yes        yes     yes    yes      yes      yes      5        4     4
## 268  yes        yes     yes    yes      yes       no      4        3     4
## 269  yes        yes     yes    yes      yes      yes      5        4     5
## 270   no         no     yes     no      yes      yes      4        3     5
## 271  yes        yes     yes    yes      yes       no      4        3     5
## 272  yes        yes     yes    yes      yes      yes      4        5     5
## 273  yes         no      no    yes       no       no      4        4     3
## 274  yes        yes      no    yes       no      yes      3        5     2
## 275  yes         no     yes    yes      yes      yes      4        3     3
## 276  yes         no     yes    yes      yes      yes      4        4     4
## 277   no         no      no     no      yes      yes      4        1     1
## 278  yes        yes     yes    yes      yes       no      3        2     4
## 279   no        yes     yes    yes      yes      yes      2        4     4
## 280  yes        yes     yes    yes      yes       no      4        2     3
## 281  yes        yes     yes    yes      yes      yes      4        5     4
## 282   no         no     yes    yes      yes       no      4        4     4
## 283  yes        yes     yes    yes       no       no      5        2     2
## 284   no        yes     yes    yes      yes       no      5        4     4
## 285   no         no      no    yes      yes       no      5        4     5
## 286  yes         no      no    yes      yes       no      4        3     3
## 287  yes         no     yes    yes      yes       no      4        3     3
## 288  yes         no     yes    yes      yes       no      4        3     3
```

```
## 289  yes        yes     yes    yes      yes       no      4        2     4
## 290  yes        yes     yes    yes      yes       no      5        4     3
## 291  yes        yes     yes    yes      yes      yes      4        3     2
## 292  yes         no     yes    yes      yes       no      4        2     2
## 293   no         no     yes    yes      yes      yes      5        4     3
## 294  yes         no     yes    yes       no       no      3        1     2
## 295  yes        yes     yes    yes      yes       no      5        4     2
## 296  yes         no     yes    yes      yes       no      4        4     3
## 297  yes        yes     yes    yes      yes       no      2        3     4
## 298  yes         no     yes    yes      yes      yes      4        4     5
## 299  yes         no     yes    yes      yes       no      4        3     3
## 300  yes         no     yes    yes      yes      yes      1        4     2
## 301   no         no     yes    yes      yes      yes      4        2     4
## 302  yes         no     yes    yes      yes       no      4        1     1
## 303  yes         no     yes    yes      yes       no      4        3     3
## 304  yes        yes      no    yes      yes       no      5        2     2
## 305   no        yes     yes    yes      yes      yes      4        4     4
## 306  yes        yes     yes    yes      yes       no      4        4     3
## 307   no        yes     yes    yes       no       no      5        5     3
## 308  yes         no     yes    yes      yes      yes      4        3     4
## 309   no        yes     yes    yes       no      yes      4        5     3
## 310   no        yes      no    yes      yes       no      4        4     3
## 311   no        yes      no    yes       no      yes      4        2     4
## 312   no         no     yes     no      yes      yes      3        4     1
## 313   no         no      no    yes      yes       no      4        5     2
## 314  yes         no      no    yes      yes      yes      4        2     2
## 315   no         no      no    yes      yes      yes      4        1     2
## 316   no         no     yes    yes      yes      yes      4        1     2
## 317  yes        yes     yes    yes      yes       no      5        3     3
## 318  yes        yes     yes    yes      yes      yes      4        3     4
## 319  yes        yes      no    yes      yes       no      4        3     4
## 320  yes         no     yes    yes      yes       no      4        4     4
## 321  yes         no     yes    yes      yes      yes      5        2     2
## 322   no         no     yes    yes       no      yes      4        2     2
## 323  yes        yes     yes    yes      yes       no      3        3     2
## 324   no         no      no    yes      yes       no      3        4     3
## 325   no         no     yes    yes      yes       no      3        3     3
## 326   no        yes     yes    yes      yes       no      4        3     3
## 327   no        yes      no    yes      yes       no      4        3     5
## 328   no         no     yes    yes      yes       no      4        4     5
## 329  yes        yes     yes    yes      yes       no      5        4     4
## 330  yes         no      no    yes      yes      yes      4        3     3
## 331   no        yes     yes    yes      yes       no      4        5     5
## 332   no         no     yes    yes      yes      yes      4        4     3
## 333   no        yes     yes    yes      yes       no      5        3     4
## 334   no        yes      no    yes      yes      yes      4        3     3
## 335   no        yes     yes    yes       no       no      4        4     4
## 336   no         no     yes    yes      yes       no      4        4     5
## 337  yes         no     yes    yes       no       no      5        4     3
## 338  yes         no     yes    yes      yes      yes      4        3     2
## 339   no         no     yes    yes      yes       no      5        3     3
## 340  yes         no     yes    yes      yes       no      4        3     3
## 341  yes        yes     yes    yes      yes      yes      4        3     4
## 342   no        yes     yes    yes      yes       no      4        3     3
```

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## 343   no        yes     yes    yes      yes      yes      4        3     3
## 344   no         no     yes    yes      yes      yes      3        3     1
## 345   no         no     yes    yes      yes       no      4        3     3
## 346   no         no     yes    yes      yes      yes      5        4     3
## 347   no         no     yes    yes      yes      yes      5        3     2
## 348  yes         no     yes    yes      yes      yes      5        4     5
## 349  yes        yes     yes    yes      yes      yes      4        4     3
## 350   no         no      no    yes      yes       no      2        5     5
## 351   no         no     yes    yes      yes       no      5        4     4
## 352  yes         no     yes    yes      yes       no      4        5     4
## 353   no         no     yes     no      yes      yes      4        3     3
## 354   no         no     yes    yes      yes       no      4        4     4
## 355  yes        yes      no    yes      yes      yes      4        5     5
## 356   no         no     yes    yes       no      yes      5        3     4
## 357  yes        yes     yes    yes      yes       no      4        3     3
## 358   no         no     yes    yes       no      yes      1        2     3
## 359   no         no      no    yes      yes      yes      3        3     2
## 360   no         no     yes    yes      yes       no      5        3     2
## 361   no         no     yes    yes       no      yes      4        3     4
## 362   no        yes      no     no       no       no      4        4     3
## 363   no         no     yes    yes      yes      yes      4        3     2
## 364  yes        yes     yes    yes      yes      yes      2        3     4
## 365   no         no      no    yes       no       no      3        2     2
## 366  yes         no     yes    yes       no       no      3        3     4
## 367  yes         no     yes    yes      yes      yes      4        2     2
## 368  yes         no     yes    yes      yes      yes      5        2     1
## 369  yes         no     yes    yes      yes      yes      5        2     3
## 370  yes         no      no    yes      yes      yes      3        2     2
## 371   no        yes     yes    yes       no      yes      3        2     2
## 372  yes        yes     yes     no      yes      yes      4        3     3
## 373   no        yes     yes    yes       no      yes      3        4     3
## 374   no        yes     yes    yes      yes       no      3        5     5
## 375   no         no     yes    yes      yes       no      5        4     4
## 376   no         no     yes    yes      yes       no      4        3     2
## 377  yes         no      no    yes      yes      yes      5        4     3
## 378  yes        yes     yes    yes      yes       no      5        4     3
## 379  yes         no     yes    yes      yes      yes      4        1     3
## 380  yes        yes      no    yes      yes       no      4        5     4
## 381  yes        yes      no    yes      yes       no      3        2     4
## 382   no        yes      no    yes      yes      yes      4        4     3
## 383   no        yes     yes    yes      yes       no      4        4     3
## 384   no         no     yes    yes       no       no      4        3     2
## 385  yes         no     yes    yes       no       no      5        4     3
## 386  yes         no     yes    yes       no       no      5        3     3
## 387  yes        yes     yes    yes      yes      yes      4        4     3
## 388   no        yes      no    yes      yes       no      5        4     2
## 389  yes         no     yes    yes      yes       no      4        3     4
## 390   no        yes     yes    yes       no       no      1        1     1
## 391  yes         no     yes    yes       no       no      5        5     4
## 392   no         no      no    yes      yes       no      2        4     5
## 393   no         no      no    yes       no       no      5        5     3
## 394   no         no      no    yes      yes       no      4        4     1
## 395   no         no     yes    yes      yes       no      3        2     3
##     Dalc Walc health absences G1 G2 G3 PF
```

```
## 1      1    1      3        6  5  6  6  F
## 2      1    1      3        4  5  5  6  F
## 3      2    3      3       10  7  8 10  P
## 4      1    1      5        2 15 14 15  P
## 5      1    2      5        4  6 10 10  P
## 6      1    2      5       10 15 15 15  P
## 7      1    1      3        0 12 12 11  P
## 8      1    1      1        6  6  5  6  F
## 9      1    1      1        0 16 18 19  P
## 10     1    1      5        0 14 15 15  P
## 11     1    2      2        0 10  8  9  F
## 12     1    1      4        4 10 12 12  P
## 13     1    3      5        2 14 14 14  P
## 14     1    2      3        2 10 10 11  P
## 15     1    1      3        0 14 16 16  P
## 16     1    2      2        4 14 14 14  P
## 17     1    2      2        6 13 14 14  P
## 18     1    1      4        4  8 10 10  P
## 19     2    4      5       16  6  5  5  F
## 20     1    3      5        4  8 10 10  P
## 21     1    1      1        0 13 14 15  P
## 22     1    1      5        0 12 15 15  P
## 23     1    3      5        2 15 15 16  P
## 24     2    4      5        0 13 13 12  P
## 25     1    1      5        2 10  9  8  F
## 26     1    3      5       14  6  9  8  F
## 27     1    2      5        2 12 12 11  P
## 28     2    4      1        4 15 16 15  P
## 29     1    1      5        4 11 11 11  P
## 30     5    5      5       16 10 12 11  P
## 31     3    4      5        0  9 11 12  P
## 32     1    1      5        0 17 16 17  P
## 33     1    1      5        0 17 16 16  P
## 34     1    1      2        0  8 10 12  P
## 35     1    1      5        0 12 14 15  P
## 36     1    1      5        0  8  7  6  F
## 37     1    1      4        2 15 16 18  P
## 38     1    1      5        7 15 16 15  P
## 39     1    1      5        2 12 12 11  P
## 40     1    1      2        8 14 13 13  P
## 41     1    2      3       25  7 10 11  P
## 42     2    4      5        8 12 12 12  P
## 43     1    1      5        2 19 18 18  P
## 44     1    1      1        0  8  8 11  P
## 45     2    2      5       14 10 10  9  F
## 46     1    1      5        8  8  8  6  F
## 47     1    4      3       12 11 12 11  P
## 48     1    1      2        4 19 19 20  P
## 49     2    2      5        2 15 15 14  P
## 50     1    1      3        2  7  7  7  F
## 51     2    3      4        2 12 13 13  P
## 52     1    1      5        2 11 13 13  P
## 53     3    4      5        6 11 11 10  P
## 54     2    3      5        0  8 10 11  P
```

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## 55     4    4      1        6 10 13 13  P
## 56     1    1      2        8  8  9 10  P
## 57     1    1      1        0 14 15 15  P
## 58     1    1      5        4 14 15 15  P
## 59     1    1      5        2  9 10  9  F
## 60     1    1      5        2 15 16 16  P
## 61     2    3      4        6 10 11 11  P
## 62     5    5      5        6 10  8 11  P
## 63     1    1      1        4  8 10  9  F
## 64     2    4      4        2 10  9  9  F
## 65     2    4      2        0 10 10 10  P
## 66     1    2      1        2 16 15 15  P
## 67     5    5      3        4 13 13 12  P
## 68     1    2      5        4  7  7  6  F
## 69     1    3      4        2  8  9  8  F
## 70     2    3      3       12 16 16 16  P
## 71     1    1      5        0 13 15 15  P
## 72     1    1      3        0 10 10 10  P
## 73     2    4      5        2  8  6  5  F
## 74     2    2      5        2 12 12 14  P
## 75     2    4      5       54 11 12 11  P
## 76     2    3      5        6  9  9 10  P
## 77     1    1      1        8 11 11 10  P
## 78     1    3      3        0 11 11 11  P
## 79     1    1      3        2  8  8 10  P
## 80     1    2      3       12  5  5  5  F
## 81     1    3      3        2 10 12 12  P
## 82     1    2      5        4 11 10 11  P
## 83     1    1      5       10  7  6  6  F
## 84     1    3      4        4 15 15 15  P
## 85     2    3      4        2  9 10 10  P
## 86     2    3      5        6  7  9  8  F
## 87     1    2      2        4  8  7  6  F
## 88     1    3      1        4 13 14 14  P
## 89     1    1      3       12 11 10 10  P
## 90     3    5      5       18  8  6  7  F
## 91     1    3      4        0  7  7  8  F
## 92     1    3      1        4 16 17 18  P
## 93     2    3      2        4  7  6  6  F
## 94     1    1      1        0 11 10 10  P
## 95     1    1      4        6 11 13 14  P
## 96     1    1      1        2  7 10 10  P
## 97     1    1      4        2 11 15 15  P
## 98     1    1      5        2  8  9 10  P
## 99     1    2      1        6 11 14 14  P
## 100    1    1      3        0  7  9  8  F
## 101    5    5      4       14  7  7  5  F
## 102    1    1      4        0 16 17 17  P
## 103    1    1      5        4 10 13 14  P
## 104    1    1      2       26  7  6  6  F
## 105    1    1      1        0 16 18 18  P
## 106    1    1      4       10 10 11 11  P
## 107    1    1      3        8  7  8  8  F
## 108    1    1      5        2 16 18 18  P
```

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## 109    3    5      1        6 10 13 13  P
## 110    1    1      4        4 14 15 16  P
## 111    1    1      4        6 18 19 19  P
## 112    1    1      2        0  7 10 10  P
## 113    1    1      5        6 10 13 13  P
## 114    1    1      3       10 18 19 19  P
## 115    1    1      5        8  9  9  9  F
## 116    1    2      5        2 15 15 16  P
## 117    1    1      2        2 11 13 14  P
## 118    1    1      5        0 13 14 13  P
## 119    1    4      5       20  9  7  8  F
## 120    1    2      4        6 14 13 13  P
## 121    1    2      1        2 16 15 15  P
## 122    1    2      5        6 16 14 15  P
## 123    1    2      5        2 13 13 13  P
## 124    1    4      5       18 14 11 13  P
## 125    1    1      5        0  8  7  8  F
## 126    3    2      5        0 13 13 12  P
## 127    1    1      1        0  7 10 11  P
## 128    1    1      5        2  7  8  9  F
## 129    1    2      4        0  7  4  0  F
## 130    2    5      4        8 18 18 18  P
## 131    2    2      5        0 12  0  0  F
## 132    1    2      4        0  8  0  0  F
## 133    1    3      5       12 10 13 12  P
## 134    1    4      5       16 12 11 11  P
## 135    1    1      5        0  9  0  0  F
## 136    1    1      5        0 11  0  0  F
## 137    2    4      5        0 10  0  0  F
## 138    1    1      5        0  4  0  0  F
## 139    1    3      5        0 14 12 12  P
## 140    1    1      5        0 16 16 15  P
## 141    1    1      3        0  7  9  0  F
## 142    2    2      2        8  9  9  9  F
## 143    1    1      5        2  9 11 11  P
## 144    3    3      1        2 14 14 13  P
## 145    1    2      5        0  5  0  0  F
## 146    1    2      5        0  8 11 11  P
## 147    1    1      3        0  6  7  0  F
## 148    1    1      5        2 10 11 11  P
## 149    2    1      5        0  7  6  0  F
## 150    2    5      5        0  8  9 10  P
## 151    2    5      4        0  6  5  0  F
## 152    3    5      5        6 12 13 14  P
## 153    2    3      3        8 10 10 10  P
## 154    1    1      4        0  5  0  0  F
## 155    1    1      4        0 11 11 12  P
## 156    1    1      1        2 11  8  8  F
## 157    3    3      5        8 16 12 13  P
## 158    1    5      4        6  9  8 10  P
## 159    1    2      3        2 17 15 15  P
## 160    4    4      5        4 10 12 12  P
## 161    2    2      5        0  7  6  0  F
## 162    1    4      3        6  5  9  7  F
```

```
## 163    2    4      5        0  7  0  0  F
## 164    1    4      2        2 10 10 10  P
## 165    1    5      5        0  5  8  7  F
## 166    1    1      2       16 12 11 12  P
## 167    2    4      4        4 10 10 10  P
## 168    1    1      3        0 14 15 16  P
## 169    1    1      4        0  6  7  0  F
## 170    1    1      3        0 14 14 14  P
## 171    2    4      2        0  6  5  0  F
## 172    1    1      3        2 13 15 16  P
## 173    1    3      5        0 13 11 10  P
## 174    1    1      3        0  8  7  0  F
## 175    1    1      4        4 10 11  9  F
## 176    4    4      4        4 10  9  9  F
## 177    1    4      5        2 13 13 11  P
## 178    1    4      4        4  6  5  6  F
## 179    3    4      3       10 10  8  9  F
## 180    1    1      2        4 10 10 11  P
## 181    2    3      3       10  9  8  8  F
## 182    1    2      3        2 12 13 12  P
## 183    2    3      5        0 16 17 17  P
## 184    2    3      1       56  9  9  8  F
## 185    1    2      1       14 12 13 12  P
## 186    2    3      4       12 12 12 11  P
## 187    1    2      3        2 11 12 11  P
## 188    1    2      5        0 15 15 15  P
## 189    1    3      3        6  8  7  9  F
## 190    1    5      3        4  8  9 10  P
## 191    1    1      2       10 11 12 13  P
## 192    1    1      3        0  8  8  9  F
## 193    4    5      5       12  7  8  8  F
## 194    3    4      5        8  8  9 10  P
## 195    1    1      3        0 13 14 14  P
## 196    1    1      5        0 14 15 15  P
## 197    1    2      5        4 17 15 16  P
## 198    3    5      3        8  9  9 10  P
## 199    2    3      2       24 18 18 18  P
## 200    1    2      3        0  9  9 10  P
## 201    1    5      2        2 16 16 16  P
## 202    1    3      4        6  8 10 10  P
## 203    1    3      1        4  9  9 10  P
## 204    1    2      3       18  7  6  6  F
## 205    1    1      5        6 10 10 11  P
## 206    3    4      5       28 10  9  9  F
## 207    2    2      4        5  7  7  7  F
## 208    1    1      1       10 11 12 13  P
## 209    1    4      5        6  9  9 10  P
## 210    1    1      4        6  7  7  7  F
## 211    1    2      3       10  8  8  8  F
## 212    4    5      3       13 12 12 13  P
## 213    1    1      4        0 12 13 14  P
## 214    2    4      5       15  6  7  8  F
## 215    1    2      3       12  8 10 10  P
## 216    1    3      1        2 14 15 15  P
```

```
## 217    2    4      1       22  6  6  4  F
## 218    2    4      4       13  6  6  8  F
## 219    1    4      3        3  7  7  8  F
## 220    1    1      4        4  9 10 10  P
## 221    1    2      5        2  6  6  6  F
## 222    1    1      5        0  6  5  0  F
## 223    1    1      3        2 16 16 17  P
## 224    5    5      4        0 12 13 13  P
## 225    1    1      5        0 13 13 14  P
## 226    1    1      4       16  9  8  7  F
## 227    1    3      3       10 16 15 15  P
## 228    1    3      3        2 12 11 12  P
## 229    4    5      3       14 10  8  9  F
## 230    1    2      3       10 12 10 12  P
## 231    1    2      3       14 13 13 14  P
## 232    1    1      1        4 11 11 11  P
## 233    1    3      2       14 11  9  9  F
## 234    2    4      1        2 14 13 13  P
## 235    1    1      5       18  9  7  6  F
## 236    1    3      2       10 11  9 10  P
## 237    5    5      4        4 14 13 13  P
## 238    1    1      5       20 13 12 12  P
## 239    1    1      3        2 13 11 11  P
## 240    3    5      2        0  7  7  0  F
## 241    1    4      5       14 12 12 12  P
## 242    2    3      4        2 10 11 12  P
## 243    1    1      3        0  6  0  0  F
## 244    1    2      5        0 13 12 12  P
## 245    1    1      3        0  7  0  0  F
## 246    1    1      4        6 18 18 18  P
## 247    1    1      2        4 12 12 13  P
## 248    5    5      1       16  6  8  8  F
## 249    1    3      5        8  3  5  5  F
## 250    2    4      5        0 13 15 15  P
## 251    2    4      5        0  6  8  8  F
## 252    1    3      2        6  7 10 10  P
## 253    2    5      5        4  6  9  8  F
## 254    1    3      3        0  8  9  8  F
## 255    2    4      5        0  8 12 12  P
## 256    1    2      5        2  7  9  8  F
## 257    1    1      4        6 14 12 13  P
## 258    1    1      1       12 11 11 11  P
## 259    1    2      4        8 15 14 14  P
## 260    1    1      2        0 10  9  0  F
## 261    1    3      2       21 17 18 18  P
## 262    1    1      3        2  8  8  8  F
## 263    1    1      3        1 13 12 12  P
## 264    1    1      4        4 10  9  9  F
## 265    1    1      3        0  9 10  0  F
## 266    3    4      1       13 17 17 17  P
## 267    3    4      5        2  9  9 10  P
## 268    2    2      4        8 12 10 11  P
## 269    1    3      5       10 10  9 10  P
## 270    1    2      3        0  6  0  0  F
```

```
## 271    3    3      5       15  9  9  9  F
## 272    1    3      2        4 15 14 14  P
## 273    1    1      3        2 11 11 11  P
## 274    2    2      1        2 15 14 14  P
## 275    1    1      1        2 10 10 10  P
## 276    2    3      5        6 12 12 12  P
## 277    1    1      5       75 10  9  9  F
## 278    1    4      3       22  9  9  9  F
## 279    1    1      4       15  9  8  8  F
## 280    1    2      1        8 10 11 10  P
## 281    2    4      5       30  8  8  8  F
## 282    3    4      3       19 11  9 10  P
## 283    1    1      3        1 12 12 12  P
## 284    1    1      4        4  8  9 10  P
## 285    1    2      5        4 10  9 11  P
## 286    1    2      4        2 12 10 11  P
## 287    1    2      2        5 18 18 19  P
## 288    1    1      3        6 13 12 12  P
## 289    1    3      2        6 15 14 14  P
## 290    1    1      2        9 15 13 15  P
## 291    1    4      5       11 12 11 11  P
## 292    1    2      3        0 15 15 15  P
## 293    1    1      5       12 12 12 13  P
## 294    1    1      3        6 18 18 18  P
## 295    1    1      4        8 14 13 14  P
## 296    1    3      5        4 14 12 11  P
## 297    2    3      2        0 10  9  0  F
## 298    1    2      2       10 10  8  8  F
## 299    1    1      3        0 14 13 14  P
## 300    2    2      1        5 16 15 16  P
## 301    1    1      4       14 12 10 11  P
## 302    2    2      5        0 11 11 10  P
## 303    1    1      3        0 15 12 14  P
## 304    1    2      5        0 17 17 18  P
## 305    1    1      3       20 15 14 13  P
## 306    1    1      3        8 14 12 12  P
## 307    1    1      5        0 17 18 18  P
## 308    1    1      4       38  8  9  8  F
## 309    1    2      5        0 15 12 12  P
## 310    1    3      3       18 12 10 10  P
## 311    2    2      3        0  9  9  0  F
## 312    1    1      2       20 14 12 13  P
## 313    2    2      4        3 13 11 11  P
## 314    1    2      1       22 13 10 11  P
## 315    1    1      3       14 15 13 13  P
## 316    1    1      3       40 13 11 11  P
## 317    1    2      1        0  8  8  0  F
## 318    1    1      5        9  9 10  9  F
## 319    2    5      5        0 11 11 10  P
## 320    3    3      5        2 11 11 11  P
## 321    1    2      5       23 13 13 13  P
## 322    1    1      3       12 11  9  9  F
## 323    2    2      3        3 11 11 11  P
## 324    2    3      5        1 12 14 15  P
```

```
## 325    2    3      2        0 16 15 15  P
## 326    2    2      3        3  9 12 11  P
## 327    3    5      5        3 14 15 16  P
## 328    5    5      4        8 11 10 10  P
## 329    1    3      4        7 10  9  9  F
## 330    1    2      4        4 14 14 14  P
## 331    2    4      5        2  9  8  8  F
## 332    1    1      5        7 12 14 14  P
## 333    1    1      4        0  7  0  0  F
## 334    1    1      2        0  8  8  0  F
## 335    1    1      4        0 10  9  0  F
## 336    1    3      5       16 16 15 15  P
## 337    1    2      5       12 14 13 13  P
## 338    2    3      2        0  7  8  0  F
## 339    1    1      1        7 16 15 17  P
## 340    2    3      2        4  9 10 10  P
## 341    1    3      3        4 11 12 11  P
## 342    2    2      2        0 10 10  0  F
## 343    1    3      5       11 16 15 15  P
## 344    1    2      4        0  9  8  0  F
## 345    1    2      3        4 11 10 10  P
## 346    2    3      1        7 13 13 14  P
## 347    1    2      4        9 16 15 16  P
## 348    2    3      5        0 10 10  9  F
## 349    1    3      4        0 13 15 15  P
## 350    5    5      5       10 11 13 13  P
## 351    3    3      2        8  8  7  8  F
## 352    2    3      3        2 13 13 13  P
## 353    2    3      3        7  8  7  8  F
## 354    3    3      5        4  8  8  8  F
## 355    1    3      2        4 13 11 11  P
## 356    1    1      5        0 10  9  9  F
## 357    1    2      5        4 12 13 13  P
## 358    1    2      5        2 12 12 11  P
## 359    1    2      3        4 10 10 10  P
## 360    1    1      4        0 18 16 16  P
## 361    1    4      5        0 13 13 13  P
## 362    2    3      5        2 13 12 12  P
## 363    1    3      3        0 11 11 10  P
## 364    1    1      1        0 16 15 15  P
## 365    1    2      3        0 12 11 12  P
## 366    2    4      3        4 10 10 10  P
## 367    2    2      5        0 13 13 13  P
## 368    1    2      1        0  7  6  0  F
## 369    1    2      4        0 11 10 10  P
## 370    4    2      5       10 14 12 11  P
## 371    1    1      3        4  7  7  9  F
## 372    2    3      3        3 14 12 12  P
## 373    1    1      3        8 13 11 11  P
## 374    1    3      1       14  6  5  5  F
## 375    1    1      1        0 19 18 19  P
## 376    1    2      4        2  8  8 10  P
## 377    1    1      3        4 15 14 15  P
## 378    3    4      2        4  8  9 10  P
```

```
## 379    1    2      1        0 15 15 15  P
## 380    2    3      1       17 10 10 10  P
## 381    1    4      2        4 15 14 14  P
## 382    1    3      5        5  7  6  7  F
## 383    1    1      3        2 11 11 10  P
## 384    1    3      5        0  6  5  0  F
## 385    4    3      3       14  6  5  5  F
## 386    1    3      4        2 10  9 10  P
## 387    2    2      5        7  6  5  6  F
## 388    1    2      5        0  7  5  0  F
## 389    1    1      1        0  7  9  8  F
## 390    1    1      5        0  6  5  0  F
## 391    4    5      4       11  9  9  9  F
## 392    3    4      2        3 14 16 16  P
## 393    3    3      3        3 10  8  7  F
## 394    3    4      5        0 11 12 10  P
## 395    3    3      5        5  8  9  9  F
```

```
# Dummy code

stu.math1$PF.dv <- ifelse(stu.math1$PF == "P", 1, 0)

stu.math1$PF.dv
```

```
##   [1] 0 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 1 1 0 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1
##  [36] 0 1 1 1 1 1 1 1 1 1 0 0 1 1 1 0 1 1 1 1 1 1 1 1 0 1 1 1 0 0 1 1 1 0 0 1
##  [71] 1 1 0 1 1 1 1 1 1 1 0 1 1 0 1 1 0 0 1 1 0 0 1 0 1 1 1 1 1 1 0 0 1 1 0 1
## [106] 1 0 1 1 1 1 1 1 1 1 0 1 1 1 0 1 1 1 1 1 0 1 1 0 0 1 0 0 1 1 0 0 0 0 1 1
## [141] 0 0 1 1 0 1 0 1 0 1 0 1 1 0 1 0 1 1 1 1 0 0 0 1 0 1 1 1 0 1 0 1 1 0 0
## [176] 0 1 0 0 1 0 1 1 0 1 1 1 1 1 0 1 1 0 0 1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 1 0
## [211] 0 1 1 0 1 1 0 0 0 1 0 0 1 1 1 0 1 1 0 1 1 1 0 1 0 1 1 1 1 0 1 1 0 1 0
## [246] 1 1 0 0 1 0 1 0 0 1 0 1 1 1 0 1 0 1 0 0 1 1 1 1 0 0 1 1 1 1 1 0 0 0 1
## [281] 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 0 1 1 1 1 1 1 1 1 1 0 1 1 0 1 1 1 1
## [316] 1 0 0 1 1 1 0 1 1 1 1 1 1 0 1 0 1 0 0 0 1 1 0 1 1 1 0 1 0 1 1 1 0 1 1
## [351] 0 1 0 0 1 0 1 1 1 1 1 1 1 1 1 1 1 0 1 1 0 1 1 0 1 1 1 1 1 1 1 0 1 0 0
## [386] 1 0 0 0 0 0 1 0 1 0
```

```
# Converting categorical variable to binary indicator (Dummy code)
stu.math1$paid.dv <- ifelse(stu.math1$paid == "yes", 1, 0)

stu.math1$paid.dv
```

```
##   [1] 0 0 1 1 1 1 0 0 1 1 1 0 1 1 0 0 1 0 0 1 0 1 0 0 1 1 1 1 0 1 1 0 0 0 1
##  [36] 0 0 0 1 1 0 0 0 0 0 0 1 0 0 1 0 1 1 0 1 1 1 1 0 0 0 0 0 0 1 0 0 0 1 1 0
##  [71] 1 0 0 0 1 1 0 1 0 0 1 1 1 1 0 1 0 0 1 0 1 1 0 1 0 1 0 1 0 1 1 0 0 1 1
## [106] 0 1 0 1 1 0 0 0 0 0 0 0 0 0 0 0 1 1 0 1 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0
## [141] 0 0 1 0 0 1 0 1 0 0 0 0 1 0 0 1 0 0 0 1 0 0 0 0 0 0 0 1 1 1 0 1 1 0 1
## [176] 1 1 0 0 0 1 1 0 0 1 0 1 1 0 0 0 0 1 0 0 0 0 1 0 1 0 1 1 0 1 1 1 1 1 1
## [211] 1 1 1 1 1 1 1 1 1 1 0 0 0 1 0 0 0 1 1 0 0 1 0 1 1 0 1 0 0 0 0 1 0 0 1
## [246] 0 0 0 0 1 0 0 0 0 0 0 1 0 0 1 1 1 0 0 1 1 1 1 1 0 1 1 1 1 1 1 0 1 0 1
## [281] 1 0 1 0 0 1 1 1 1 1 1 1 1 0 1 1 1 1 1 1 1 0 1 1 1 0 1 0 1 0 0 0 0 0 1 0
## [316] 0 1 1 1 1 1 0 1 0 0 0 0 0 1 1 0 0 0 0 0 0 1 1 0 1 1 0 0 0 0 0 0 1 1 0
## [351] 0 1 0 0 1 0 1 0 0 0 0 0 0 1 0 1 1 1 1 1 0 1 0 0 0 0 1 1 1 1 1 0 0 0 1
## [386] 1 1 0 1 0 1 0 0 0 0
```

```r
# Splitting the data

split_data <- sample.split(stu.math1, SplitRatio = 0.8)

train <- subset(stu.math1, split == TRUE)

test <- subset(stu.math1, split == FALSE)
```

```r
# Training the model

model <- glm(PF.dv ~ paid.dv + age + G1 + G2, data = train, family = binomial)

summary(model)
```

```
##
## Call:
## glm(formula = PF.dv ~ paid.dv + age + G1 + G2, family = binomial,
##     data = train)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.60033  -0.08259   0.00665   0.13992   2.31790
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -13.10930    3.98027  -3.294 0.000989 ***
## paid.dv      -0.07451    0.45224  -0.165 0.869137
## age          -0.26583    0.19080  -1.393 0.163532
## G1            0.22458    0.15746   1.426 0.153805
## G2            1.68524    0.29520   5.709 1.14e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 412.34  on 314  degrees of freedom
## Residual deviance: 124.22  on 310  degrees of freedom
## AIC: 134.22
##
## Number of Fisher Scoring iterations: 8
```

Backfitting (p-value)

```r
# Removing paid.dv (highest p-value) from the model

model2 <- glm(PF.dv ~ age + G1 + G2, data = train, family = binomial)

summary(model2)
```

```
##
## Call:
## glm(formula = PF.dv ~ age + G1 + G2, family = binomial, data = train)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
```

```
## -2.61203  -0.08120   0.00657   0.13995   2.33155
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -13.1589     3.9673  -3.317  0.00091 ***
## age          -0.2641     0.1904  -1.387  0.16556
## G1            0.2240     0.1573   1.424  0.15447
## G2            1.6838     0.2949   5.709 1.14e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 412.34  on 314  degrees of freedom
## Residual deviance: 124.25  on 311  degrees of freedom
## AIC: 132.25
##
## Number of Fisher Scoring iterations: 8
```

```
# Removing age (second highest p-value) from the model

model3 <- glm(PF.dv ~ G1 + G2, data = train, family = binomial)

summary(model3)
```

```
##
## Call:
## glm(formula = PF.dv ~ G1 + G2, family = binomial, data = train)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.55447  -0.06986   0.00668   0.11728   2.20993
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -17.6393     2.6210  -6.730 1.70e-11 ***
## G1            0.1587     0.1492   1.063    0.288
## G2            1.7524     0.2939   5.963 2.48e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 412.34  on 314  degrees of freedom
## Residual deviance: 126.25  on 312  degrees of freedom
## AIC: 132.25
##
## Number of Fisher Scoring iterations: 8
```

```
# Removing G1 from the model

model4 <- glm(PF.dv ~ G2, data = train, family = binomial)

summary(model4)
```

```
##
## Call:
## glm(formula = PF.dv ~ G2, family = binomial, data = train)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.57761  -0.06740   0.00644   0.10703   2.20446
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -17.3321     2.5563  -6.780  1.2e-11 ***
## G2            1.8743     0.2737   6.848  7.5e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 412.34  on 314  degrees of freedom
## Residual deviance: 127.40  on 313  degrees of freedom
## AIC: 131.4
##
## Number of Fisher Scoring iterations: 8
```

The p-value backward elimination technique is used.

Predicting pass or fail

```
PF_pred <- predict(model4, test, type = "response")
PF_pred
```

```
##           3           9          17          23          24
## 8.805336e-02 9.999999e-01 9.998647e-01 9.999792e-01 9.991193e-01
##          28          31          37          43          51
## 9.999968e-01 9.639204e-01 9.999968e-01 9.999999e-01 9.991193e-01
##          57          58          62          65          71
## 9.999792e-01 9.999792e-01 8.805336e-02 8.039196e-01 9.999792e-01
##          77          85          91          92          96
## 9.639204e-01 8.039196e-01 1.460116e-02 9.999995e-01 8.039196e-01
##          99         105         111         119         125
## 9.998647e-01 9.999999e-01 1.000000e+00 1.460116e-02 1.460116e-02
##         126         130         133         139         145
## 9.991193e-01 9.999999e-01 9.991193e-01 9.942887e-01 2.970080e-08
##         153         159         160         164         167
## 8.039196e-01 9.999792e-01 9.942887e-01 8.039196e-01 8.039196e-01
##         173         179         187         193         194
## 9.639204e-01 8.805336e-02 9.942887e-01 8.805336e-02 3.861957e-01
##         198         201         207         213         221
## 3.861957e-01 9.999968e-01 1.460116e-02 9.991193e-01 2.268757e-03
##         227         228         232         235         241
## 9.999792e-01 9.639204e-01 9.639204e-01 1.460116e-02 9.942887e-01
##         247         255         261         262         266
## 9.942887e-01 9.942887e-01 9.999999e-01 8.805336e-02 9.999995e-01
##         269         275         281         289         295
## 3.861957e-01 8.039196e-01 8.805336e-02 9.998647e-01 9.991193e-01
##         296         300         303         309         315
## 9.942887e-01 9.999792e-01 9.942887e-01 9.942887e-01 9.991193e-01
```

```
##          323          329          330          334          337
## 9.639204e-01 3.861957e-01 9.998647e-01 8.805336e-02 9.991193e-01
##          343          349          357          363          364
## 9.999792e-01 9.999792e-01 9.991193e-01 9.639204e-01 9.999792e-01
##          368          371          377          383          391
## 2.268757e-03 1.460116e-02 9.998647e-01 9.639204e-01 3.861957e-01
```

Regression Equation

P(Pass) = 1/(1 + e-(-17.6 + 1.9*G2))

```
# For age = 15 and G2 = 10, P(Pass) = 80%

new <- data.frame(G2=10)
res <- predict(model4,new,type = "response")
res
```

```
##         1
## 0.8039196
```

Accuracy of the model

```
# Creating Confusion Matrix

(table(ActualValue=test$PF.dv, PredictedValue=PF_pred>0.5))
```

```
##            PredictedValue
## ActualValue FALSE TRUE
##           0    16    0
##           1     5   59
```

Therefore, accuracy of model is (22+55)/(22+55+5+0) = 93.9%

Problem 3:

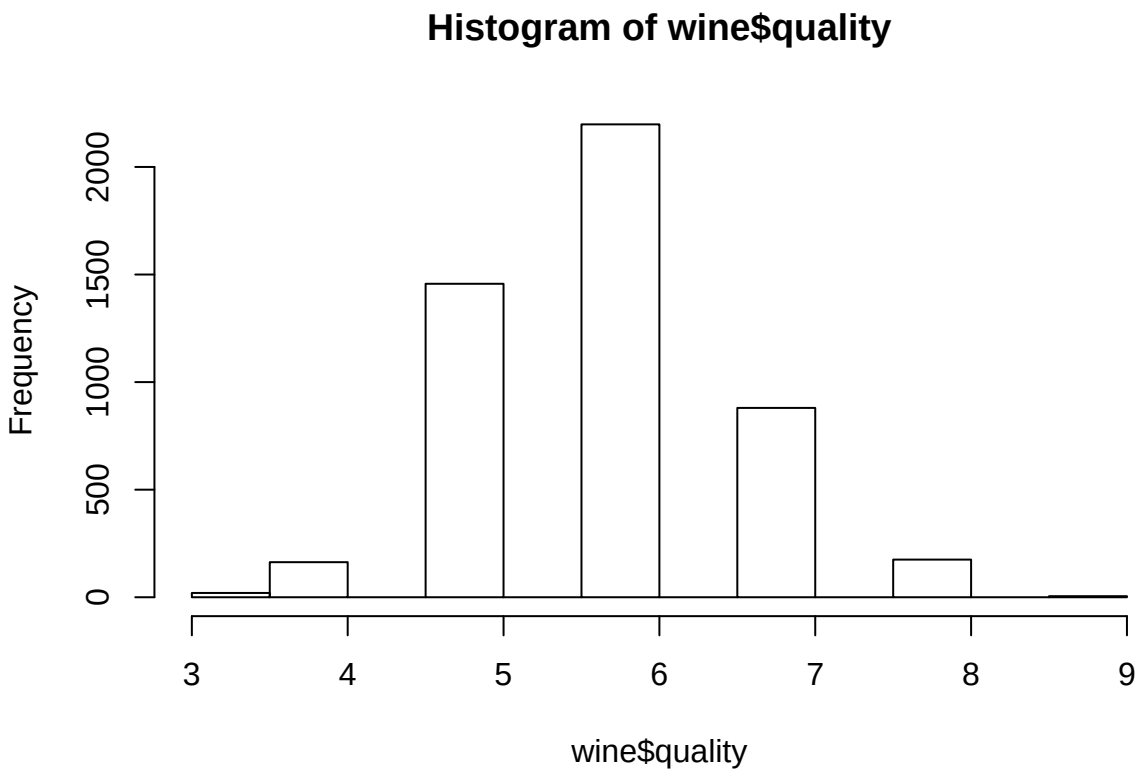
Collecting and Exploring the data

```
wine <- read.csv("C:/Users/Meghana Nadig/Downloads/whitewines.csv")

str(wine)
```

```
## 'data.frame':    4898 obs. of  12 variables:
##  $ fixed.acidity       : num  7 6.3 8.1 7.2 7.2 8.1 6.2 7 6.3 8.1 ...
##  $ volatile.acidity    : num  0.27 0.3 0.28 0.23 0.23 0.28 0.32 0.27 0.3 0.22 ...
##  $ citric.acid         : num  0.36 0.34 0.4 0.32 0.32 0.4 0.16 0.36 0.34 0.43 ...
##  $ residual.sugar      : num  20.7 1.6 6.9 8.5 8.5 6.9 7 20.7 1.6 1.5 ...
##  $ chlorides           : num  0.045 0.049 0.05 0.058 0.058 0.05 0.045 0.045 0.049 0.044 ...
##  $ free.sulfur.dioxide : num  45 14 30 47 47 30 30 45 14 28 ...
##  $ total.sulfur.dioxide: num  170 132 97 186 186 97 136 170 132 129 ...
##  $ density             : num  1.001 0.994 0.995 0.996 0.996 ...
##  $ pH                  : num  3 3.3 3.26 3.19 3.19 3.26 3.18 3 3.3 3.22 ...
##  $ sulphates           : num  0.45 0.49 0.44 0.4 0.4 0.44 0.47 0.45 0.49 0.45 ...
##  $ alcohol             : num  8.8 9.5 10.1 9.9 9.9 10.1 9.6 8.8 9.5 11 ...
##  $ quality             : int  6 6 6 6 6 6 6 6 6 6 ...
```

```
hist(wine$quality)
```




```
# Splitting data into training and testing dataset

wine_train <- wine[1:3750, ]

wine_test <- wine[3751:4898, ]
```

Training model on data

```
#install.packages("rpart")
library(rpart)
```

```
m.rpart <- rpart(quality ~ ., data = wine_train)

m.rpart
```

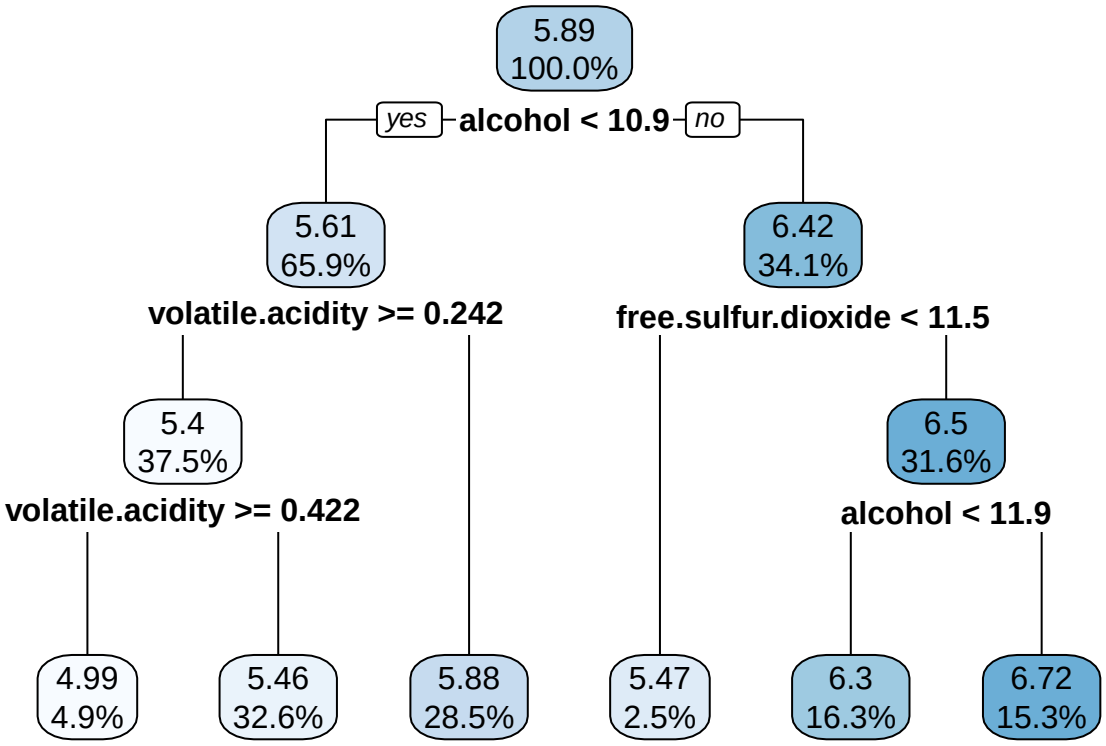
```
## n= 3750
##
## node), split, n, deviance, yval
##       * denotes terminal node
##
##  1) root 3750 3140.06000 5.886933
##    2) alcohol< 10.85 2473 1510.66200 5.609381
##      4) volatile.acidity>=0.2425 1406  740.15080 5.402560
##        8) volatile.acidity>=0.4225 182   92.99451 4.994505 *
##        9) volatile.acidity< 0.4225 1224  612.34560 5.463235 *
##      5) volatile.acidity< 0.2425 1067  631.12090 5.881912 *
##    3) alcohol>=10.85 1277 1069.95800 6.424432
```

```
##       6) free.sulfur.dioxide< 11.5 93   99.18280 5.473118 *
##       7) free.sulfur.dioxide>=11.5 1184  879.99920 6.499155
##        14) alcohol< 11.85 611  447.38130 6.296236 *
##        15) alcohol>=11.85 573  380.63180 6.715532 *
```

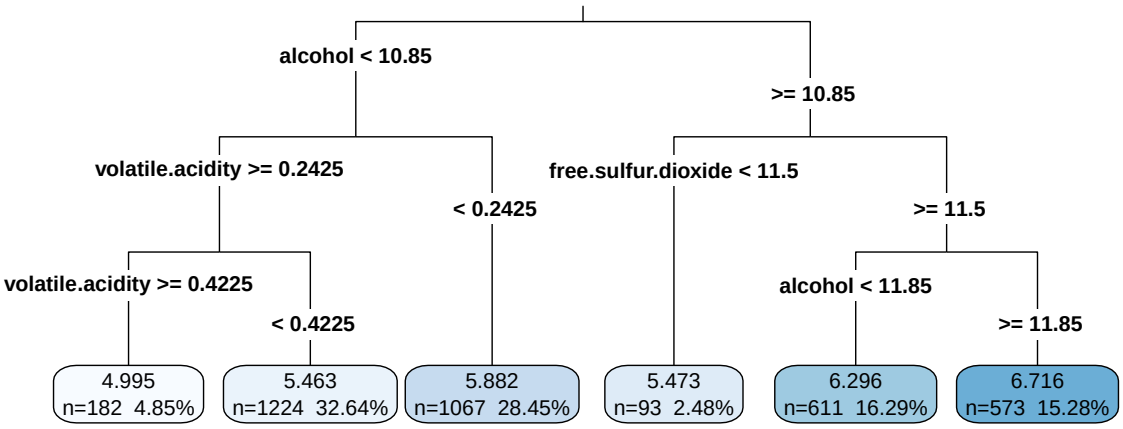
Visualizing decision trees

```
#install.packages("rpart.plot")
library(rpart.plot)

rpart.plot(m.rpart, digits = 3)
```




```
rpart.plot(m.rpart, digits = 4, fallen.leaves = TRUE,
           type = 3, extra = 101)
```



Evaluating model performance

```
p.rpart <- predict(m.rpart, wine_test)

summary(p.rpart)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   4.995   5.463   5.882   5.999   6.296   6.716
```

```
summary(wine_test$quality)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   3.000   5.000   6.000   5.848   6.000   8.000
```

```
cor(p.rpart, wine_test$quality)
```

```
## [1] 0.4931608
```

Measuring performance with mean absolute error

```
MAE <- function(actual, predicted) {
mean(abs(actual - predicted))
}

MAE(p.rpart, wine_test$quality)
```

```
## [1] 0.5732104
```

```
# Mean quality rating in the training data
```

```
mean(wine_train$quality)
```

```
## [1] 5.886933
```

```
# Mean quality rating in the testing data

MAE(5.87, wine_test$quality)
```

```
## [1] 0.5815679
```

Improving model performance

```
library(RWeka)
```

```
##
## Attaching package: 'RWeka'
```

```
## The following object is masked from 'package:caTools':
##
##     LogitBoost
```

```
m.m5p <- M5P(quality ~ ., data = wine_train)

m.m5p
```

```
## M5 pruned model tree:
## (using smoothed linear models)
##
## alcohol <= 10.85 : LM1 (2473/77.476%)
## alcohol >  10.85 :
## |   free.sulfur.dioxide <= 20.5 :
## |   |   free.sulfur.dioxide <= 10.5 : LM2 (81/104.574%)
## |   |   free.sulfur.dioxide >  10.5 : LM3 (224/87.002%)
## |   free.sulfur.dioxide >  20.5 : LM4 (972/84.073%)
##
## LM num: 1
## quality =
##  0.0777 * fixed.acidity
##  - 2.3087 * volatile.acidity
##  + 0.0732 * residual.sugar
##  + 0.0022 * free.sulfur.dioxide
##  - 155.0175 * density
##  + 0.6462 * pH
##  + 0.7923 * sulphates
##  + 0.0758 * alcohol
##  + 156.2102
##
## LM num: 2
## quality =
##  -0.0314 * fixed.acidity
##  - 0.3415 * volatile.acidity
##  + 1.7929 * citric.acid
##  + 0.1316 * residual.sugar
##  - 0.2456 * chlorides
##  + 0.1212 * free.sulfur.dioxide
##  - 178.6281 * density
##  + 0.054 * pH
```

```
##  + 0.1392 * sulphates
##  + 0.0108 * alcohol
##  + 180.6069
##
## LM num: 3
## quality =
##  -0.2019 * fixed.acidity
##  - 2.3804 * volatile.acidity
##  - 1.0851 * citric.acid
##  + 0.0905 * residual.sugar
##  - 0.2456 * chlorides
##  + 0.0041 * free.sulfur.dioxide
##  - 177.078 * density
##  + 0.054 * pH
##  + 0.0868 * sulphates
##  + 0.0108 * alcohol
##  + 183.5076
##
## LM num: 4
## quality =
##  0.0004 * fixed.acidity
##  - 0.0325 * volatile.acidity
##  + 0.0957 * residual.sugar
##  - 5.9702 * chlorides
##  + 0.0002 * free.sulfur.dioxide
##  - 172.3931 * density
##  + 1.0123 * pH
##  + 1.1653 * sulphates
##  + 0.1542 * alcohol
##  + 171.6842
##
## Number of Rules : 4
```

```
summary(m.m5p)
```

```
##
## === Summary ===
##
## Correlation coefficient                  0.5932
## Mean absolute error                      0.5804
## Root mean squared error                  0.7367
## Relative absolute error                 83.3671 %
## Root relative squared error             80.507  %
## Total Number of Instances             3750
```

```
p.m5p <- predict(m.m5p, wine_test)

summary(p.m5p)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   4.170   5.646   6.032   6.079   6.501   7.913
```

```
# Finding corelation
cor(p.m5p, wine_test$quality)
```

```
## [1] 0.531723
```

```r
# Mean absolute error
MAE(wine_test$quality, p.m5p)
```

```
## [1] 0.5660352
```

RSME of the model

```r
RSME <- function(actual, predicted) {
sqrt(mean((actual - predicted)^2))
}

RSME(wine_test$quality,p.m5p)
```

```
## [1] 0.7191548
```

```r
RSME
```

```
## function(actual, predicted) {
## sqrt(mean((actual - predicted)^2))
## }
```

Therefore, the RSME of the model is 0.72