November 3, 2023

The results below are generated from an R script.

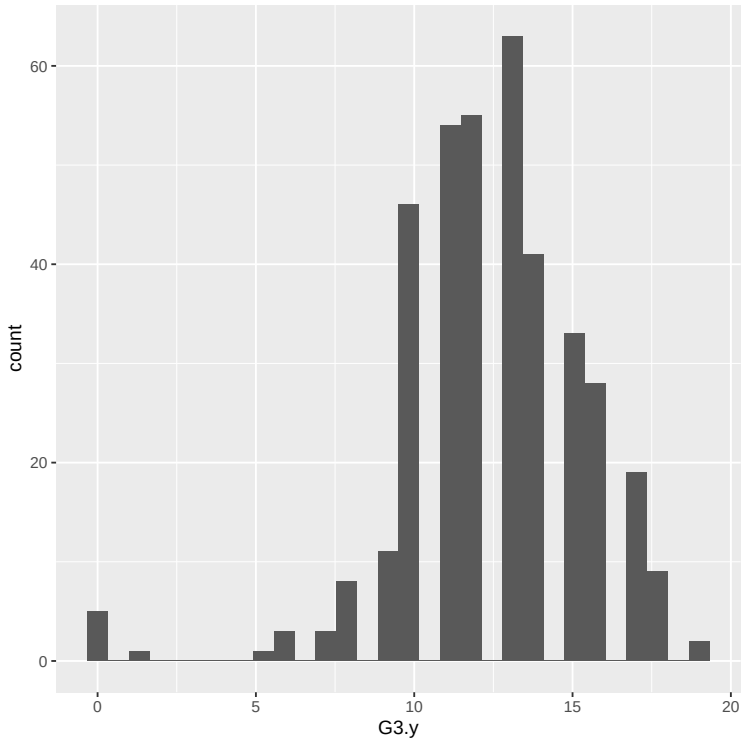
```
library(ggplot2)

df1=read.table("./datos/student-mat.csv",sep=";",header=TRUE)
df2=read.table("./datos/student-por.csv",sep=";",header=TRUE)

df3=merge(df1,df2,by=c("school","sex","age","address","famsize","Pstatus","Medu","Fedu","Mjob","Fjob","r
print(nrow(df3)) # 382 students

## [1] 382

# Limpieza de datos
# Resumen de datos
summary(df3)

##     school              sex                 age          address
##  Length:382         Length:382         Min.   :15.00   Length:382
##  Class :character   Class :character   1st Qu.:16.00   Class :character
##  Mode  :character   Mode  :character   Median :17.00   Mode  :character
##                                        Mean   :16.59
##                                        3rd Qu.:17.00
##                                        Max.   :22.00
##    famsize            Pstatus              Medu            Fedu           Mjob
##  Length:382         Length:382         Min.   :0.000   Min.   :0.000   Length:382
##  Class :character   Class :character   1st Qu.:2.000   1st Qu.:2.000   Class :character
##  Mode  :character   Mode  :character   Median :3.000   Median :3.000   Mode  :character
##                                        Mean   :2.806   Mean   :2.565
##                                        3rd Qu.:4.000   3rd Qu.:4.000
##                                        Max.   :4.000   Max.   :4.000
##      Fjob              reason            nursery            internet
##  Length:382         Length:382         Length:382         Length:382
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##   guardian.x         traveltime.x    studytime.x      failures.x     schoolsup.x
##  Length:382         Min.   :1.000   Min.   :1.000   Min.   :0.0000   Length:382
##  Class :character   1st Qu.:1.000   1st Qu.:1.000   1st Qu.:0.0000   Class :character
##  Mode  :character   Median :1.000   Median :2.000   Median :0.0000   Mode  :character
##                     Mean   :1.442   Mean   :2.034   Mean   :0.2906
##                     3rd Qu.:2.000   3rd Qu.:2.000   3rd Qu.:0.0000
##                     Max.   :4.000   Max.   :4.000   Max.   :3.0000
##    famsup.x           paid.x          activities.x         higher.x
##  Length:382         Length:382         Length:382         Length:382
```

```
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##   romantic.x           famrel.x      freetime.x       goout.x          Dalc.x
##  Length:382         Min.   :1.00   Min.   :1.000   Min.   :1.000   Min.   :1.000
##  Class :character   1st Qu.:4.00   1st Qu.:3.000   1st Qu.:2.000   1st Qu.:1.000
##  Mode  :character   Median :4.00   Median :3.000   Median :3.000   Median :1.000
##                     Mean   :3.94   Mean   :3.223   Mean   :3.113   Mean   :1.474
##                     3rd Qu.:5.00   3rd Qu.:4.000   3rd Qu.:4.000   3rd Qu.:2.000
##                     Max.   :5.00   Max.   :5.000   Max.   :5.000   Max.   :5.000
##      Walc.x        health.x       absences.x          G1.x            G2.x
##  Min.   :1.00   Min.   :1.000   Min.   : 0.000   Min.   : 3.00   Min.   : 0.00
##  1st Qu.:1.00   1st Qu.:3.000   1st Qu.: 0.000   1st Qu.: 8.00   1st Qu.: 8.25
##  Median :2.00   Median :4.000   Median : 3.000   Median :10.50   Median :11.00
##  Mean   :2.28   Mean   :3.579   Mean   : 5.319   Mean   :10.86   Mean   :10.71
##  3rd Qu.:3.00   3rd Qu.:5.000   3rd Qu.: 8.000   3rd Qu.:13.00   3rd Qu.:13.00
##  Max.   :5.00   Max.   :5.000   Max.   :75.000   Max.   :19.00   Max.   :19.00
##       G3.x        guardian.y         traveltime.y    studytime.y      failures.y
##  Min.   : 0.00   Length:382         Min.   :1.000   Min.   :1.000   Min.   :0.0000
##  1st Qu.: 8.00   Class :character   1st Qu.:1.000   1st Qu.:1.000   1st Qu.:0.0000
##  Median :11.00   Mode  :character   Median :1.000   Median :2.000   Median :0.0000
##  Mean   :10.39                      Mean   :1.445   Mean   :2.039   Mean   :0.1414
##  3rd Qu.:14.00                      3rd Qu.:2.000   3rd Qu.:2.000   3rd Qu.:0.0000
##  Max.   :20.00                      Max.   :4.000   Max.   :4.000   Max.   :3.0000
##  schoolsup.y          famsup.y           paid.y          activities.y
##  Length:382         Length:382         Length:382         Length:382
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
##    higher.y          romantic.y           famrel.y       freetime.y      goout.y
##  Length:382         Length:382         Min.   :1.000   Min.   :1.00   Min.   :1.000
##  Class :character   Class :character   1st Qu.:4.000   1st Qu.:3.00   1st Qu.:2.000
##  Mode  :character   Mode  :character   Median :4.000   Median :3.00   Median :3.000
##                                        Mean   :3.942   Mean   :3.23   Mean   :3.118
##                                        3rd Qu.:5.000   3rd Qu.:4.00   3rd Qu.:4.000
##                                        Max.   :5.000   Max.   :5.00   Max.   :5.000
##      Dalc.y          Walc.y         health.y       absences.y          G1.y
##  Min.   :1.000   Min.   :1.000   Min.   :1.000   Min.   : 0.000   Min.   : 0.00
##  1st Qu.:1.000   1st Qu.:1.000   1st Qu.:3.000   1st Qu.: 0.000   1st Qu.:10.00
##  Median :1.000   Median :2.000   Median :4.000   Median : 2.000   Median :12.00
##  Mean   :1.476   Mean   :2.291   Mean   :3.576   Mean   : 3.673   Mean   :12.11
##  3rd Qu.:2.000   3rd Qu.:3.000   3rd Qu.:5.000   3rd Qu.: 6.000   3rd Qu.:14.00
##  Max.   :5.000   Max.   :5.000   Max.   :5.000   Max.   :32.000   Max.   :19.00
##       G2.y            G3.y
##  Min.   : 5.00   Min.   : 0.00
##  1st Qu.:11.00   1st Qu.:11.00
##  Median :12.00   Median :13.00
##  Mean   :12.24   Mean   :12.52
##  3rd Qu.:14.00   3rd Qu.:14.00
##  Max.   :19.00   Max.   :19.00
```

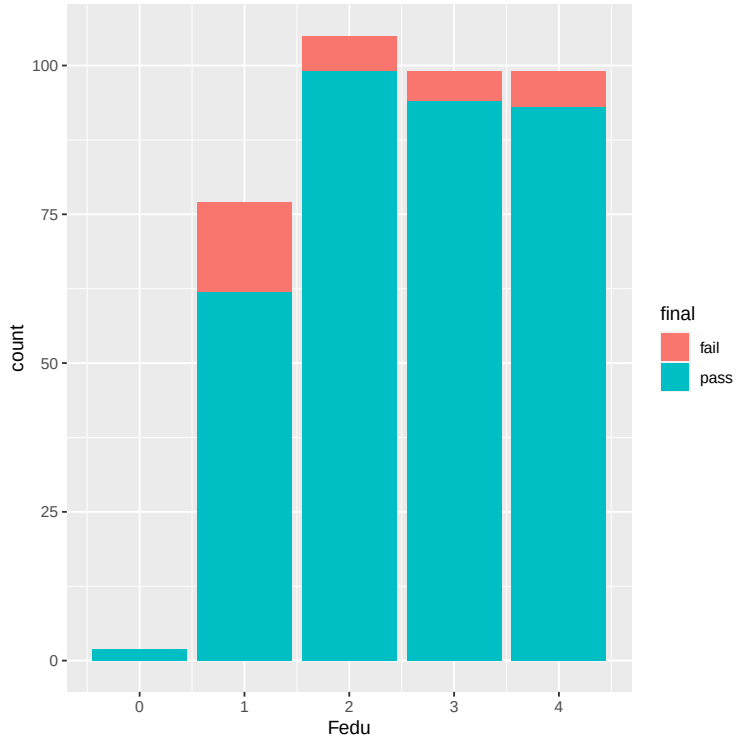
```
str(df3)
```

```
## 'data.frame': 382 obs. of  53 variables:
##  $ school      : chr  "GP" "GP" "GP" "GP" ...
##  $ sex         : chr  "F" "F" "F" "F" ...
##  $ age         : int  15 15 15 15 15 15 15 15 15 15 ...
##  $ address     : chr  "R" "R" "R" "R" ...
##  $ famsize     : chr  "GT3" "GT3" "GT3" "GT3" ...
##  $ Pstatus     : chr  "T" "T" "T" "T" ...
##  $ Medu        : int  1 1 2 2 3 3 3 2 3 3 ...
##  $ Fedu        : int  1 1 2 4 3 4 4 2 1 3 ...
##  $ Mjob        : chr  "at_home" "other" "at_home" "services" ...
##  $ Fjob        : chr  "other" "other" "other" "health" ...
##  $ reason      : chr  "home" "reputation" "reputation" "course" ...
##  $ nursery     : chr  "yes" "no" "yes" "yes" ...
##  $ internet    : chr  "yes" "yes" "no" "yes" ...
##  $ guardian.x  : chr  "mother" "mother" "mother" "mother" ...
##  $ traveltime.x: int  2 1 1 1 2 1 2 2 2 1 ...
##  $ studytime.x : int  4 2 1 3 3 3 3 2 4 4 ...
##  $ failures.x  : int  1 2 0 0 2 0 2 0 0 0 ...
##  $ schoolsup.x : chr  "yes" "yes" "yes" "yes" ...
##  $ famsup.x    : chr  "yes" "yes" "yes" "yes" ...
##  $ paid.x      : chr  "yes" "no" "yes" "yes" ...
##  $ activities.x: chr  "yes" "no" "yes" "yes" ...
##  $ higher.x    : chr  "yes" "yes" "yes" "yes" ...
##  $ romantic.x  : chr  "no" "yes" "no" "no" ...
##  $ famrel.x    : int  3 3 4 4 4 4 4 4 4 4 ...
##  $ freetime.x  : int  1 3 3 3 2 3 2 1 4 3 ...
##  $ goout.x     : int  2 4 1 2 1 2 2 3 2 3 ...
##  $ Dalc.x      : int  1 2 1 1 2 1 2 1 2 1 ...
##  $ Walc.x      : int  1 4 1 1 3 1 2 3 3 1 ...
##  $ health.x    : int  1 5 2 5 3 5 5 4 3 4 ...
##  $ absences.x  : int  2 2 8 2 8 2 0 2 12 10 ...
##  $ G1.x        : int  7 8 14 10 10 12 12 8 16 10 ...
##  $ G2.x        : int  10 6 13 9 10 12 0 9 16 11 ...
##  $ G3.x        : int  10 5 13 8 10 11 0 8 16 11 ...
##  $ guardian.y  : chr  "mother" "mother" "mother" "mother" ...
##  $ traveltime.y: int  2 1 1 1 2 1 2 2 2 1 ...
##  $ studytime.y : int  4 2 1 3 3 3 3 2 4 4 ...
##  $ failures.y  : int  0 0 0 0 0 0 0 0 0 0 ...
##  $ schoolsup.y : chr  "yes" "yes" "yes" "yes" ...
##  $ famsup.y    : chr  "yes" "yes" "yes" "yes" ...
##  $ paid.y      : chr  "yes" "no" "no" "no" ...
##  $ activities.y: chr  "yes" "no" "yes" "yes" ...
##  $ higher.y    : chr  "yes" "yes" "yes" "yes" ...
##  $ romantic.y  : chr  "no" "yes" "no" "no" ...
##  $ famrel.y    : int  3 3 4 4 4 4 4 4 4 4 ...
##  $ freetime.y  : int  1 3 3 3 2 3 2 1 4 3 ...
##  $ goout.y     : int  2 4 1 2 1 2 2 3 2 3 ...
##  $ Dalc.y      : int  1 2 1 1 2 1 2 1 2 1 ...
##  $ Walc.y      : int  1 4 1 1 3 1 2 3 3 1 ...
##  $ health.y    : int  1 5 2 5 3 5 5 4 3 4 ...
##  $ absences.y  : int  4 2 8 2 2 2 0 0 6 10 ...
##  $ G1.y        : int  13 13 14 10 13 11 10 11 15 10 ...
```

```
##  $ G2.y        : int  13 11 13 11 13 12 11 10 15 10 ...
##  $ G3.y        : int  13 11 12 10 13 12 12 11 15 10 ...

# Visualización de datos
df3 %>% ggplot() +
  geom_histogram(mapping = aes(x = G3.y))

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




```
# nueva variable respuesta
df3$final <- factor(ifelse(df3$G3.y >= 10, 1, 0), labels = c("fail", "pass"))

# Fedu
ggplot(df3, aes(x=Fedu, group=final,fill=final)) + geom_bar()
```




```
# Partición de datos
# mediante una semilla conseguimos que el ejercicio sea reproducible
set.seed(1)

# Usamos el 70% de la base de datos como conjunto de entrenamiento y el resto como conjunto de test
sample <- sample(c(TRUE, FALSE), nrow(df3), replace=TRUE, prob=c(0.6,0.4))
datos.train  <- df3[sample, ]
datos.test   <- df3[!sample, ]

dim(datos.train)

## [1] 241  54

lr1 <- glm(final ~ Fedu , data= datos.train,family=binomial)
summary(lr1)

##
## Call:
## glm(formula = final ~ Fedu, family = binomial, data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   0.8617     0.5189   1.661  0.09679 .
## Fedu          0.6938     0.2405   2.885  0.00391 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
```

```
## Residual deviance: 128.51  on 239  degrees of freedom
## AIC: 132.51
##
## Number of Fisher Scoring iterations: 6
```

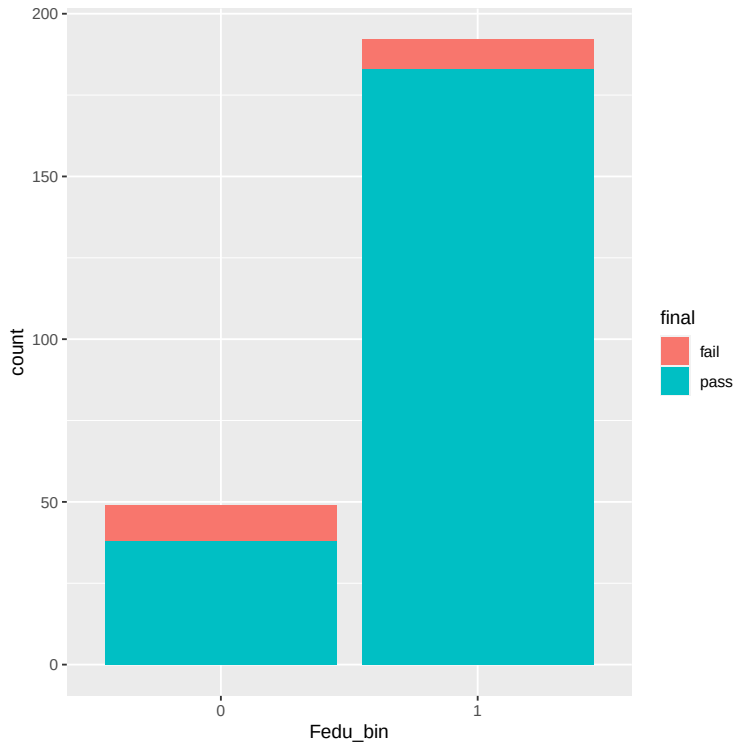
```
lr1 <- glm(final ~ as.factor(Fedu) , data= datos.train,family=binomial)
summary(lr1)
```

```
##
## Call:
## glm(formula = final ~ as.factor(Fedu), family = binomial, data = datos.train)
##
## Coefficients:
##                   Estimate Std. Error z value Pr(>|z|)
## (Intercept)          15.57    1029.12   0.015    0.988
## as.factor(Fedu)1    -14.38    1029.12  -0.014    0.989
## as.factor(Fedu)2    -12.83    1029.12  -0.012    0.990
## as.factor(Fedu)3    -12.05    1029.12  -0.012    0.991
## as.factor(Fedu)4    -12.68    1029.12  -0.012    0.990
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 122.94  on 236  degrees of freedom
## AIC: 132.94
##
## Number of Fisher Scoring iterations: 14
```

```
# Reagrupamos
datos.train=
  datos.train %>%
  mutate(Fedu_bin=as.factor(ifelse(Fedu>1,1,0)))

lr1 <- glm(final ~ Fedu_bin , data= datos.train,family=binomial)
summary(lr1)
```

```
##
## Call:
## glm(formula = final ~ Fedu_bin, family = binomial, data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.2397     0.3424   3.621 0.000294 ***
## Fedu_bin1     1.7726     0.4835   3.666 0.000246 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 124.84  on 239  degrees of freedom
## AIC: 128.84
##
## Number of Fisher Scoring iterations: 5
```

```
ggplot(datos.train, aes(x=Fedu_bin, group=final,fill=final)) + geom_bar()
```



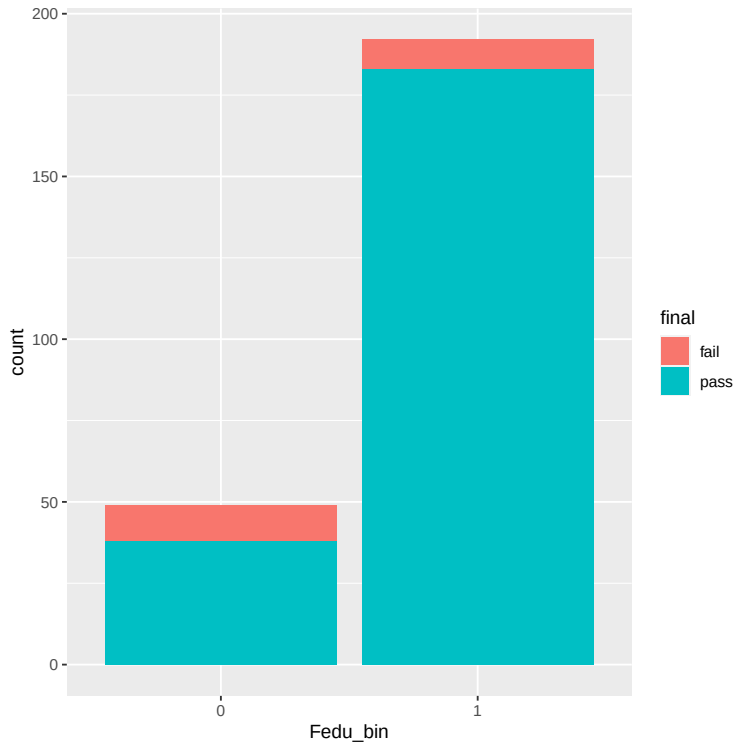

```
# Medu

lr1 <- glm(final ~ Medu , data= datos.train,family=binomial)
summary(lr1)

##
## Call:
## glm(formula = final ~ Medu, family = binomial, data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.1114     0.5649   1.967   0.0492 *
## Medu          0.5079     0.2227   2.281   0.0226 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 132.45  on 239  degrees of freedom
## AIC: 136.45
##
## Number of Fisher Scoring iterations: 5

lr1 <- glm(final ~ as.factor(Medu) , data= datos.train,family=binomial)
summary(lr1)

##
## Call:
## glm(formula = final ~ as.factor(Medu), family = binomial, data = datos.train)
```

```
##
## Coefficients:
##                  Estimate Std. Error z value Pr(>|z|)
## (Intercept)         15.57    1455.40   0.011    0.991
## as.factor(Medu)1   -14.10    1455.40  -0.010    0.992
## as.factor(Medu)2   -13.26    1455.40  -0.009    0.993
## as.factor(Medu)3   -13.15    1455.40  -0.009    0.993
## as.factor(Medu)4   -12.31    1455.40  -0.008    0.993
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 131.35  on 236  degrees of freedom
## AIC: 141.35
##
## Number of Fisher Scoring iterations: 14
```

```
# Aquí podríamos agrupar, o no. Agrupamos y estudiamos qué ocurre.

# Reagrupamos
datos.train=
  datos.train %>%
  mutate(Medu_bin=as.factor(ifelse(Medu>1,1,0)))

lr1 <- glm(final ~ Medu_bin , data= datos.train,family=binomial)
summary(lr1)
```

```
##
## Call:
## glm(formula = final ~ Medu_bin, family = binomial, data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.5041     0.4513   3.333 0.000861 ***
## Medu_bin1     1.1247     0.5294   2.124 0.033633 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 133.89  on 239  degrees of freedom
## AIC: 137.89
##
## Number of Fisher Scoring iterations: 5
```

```
ggplot(datos.train, aes(x=Fedu_bin, group=final,fill=final)) + geom_bar()
```




```
# En este caso, se pierde significatividad estadística y se decide no agrupar con las mismas categorías
# sino como sigue:
datos.train=
  datos.train %>%
  mutate(Medu_bin=as.factor(ifelse(Medu==4,1,0)))

lr1 <- glm(final ~ Medu_bin , data= datos.train,family=binomial)
summary(lr1)

##
## Call:
## glm(formula = final ~ Medu_bin, family = binomial, data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   2.1296     0.2565   8.301   <2e-16 ***
## Medu_bin1     1.1285     0.6418   1.758   0.0787 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 134.02  on 239  degrees of freedom
## AIC: 138.02
##
## Number of Fisher Scoring iterations: 6

# LR
```

```r
lr1 <- glm(final ~ Fedu_bin+Medu_bin, data= datos.train,family=binomial)
summary(lr1)
```

```
##
## Call:
## glm(formula = final ~ Fedu_bin + Medu_bin, family = binomial,
##     data = datos.train)
##
## Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   1.2315     0.3427   3.594 0.000326 ***
## Fedu_bin1     1.6130     0.5299   3.044 0.002333 **
## Medu_bin1     0.4561     0.7082   0.644 0.519549
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 124.41  on 238  degrees of freedom
## AIC: 130.41
##
## Number of Fisher Scoring iterations: 6
```

```r
# Modelo básico
base.mod <- glm(final ~ 1 , data= datos.train,family=binomial)

# Modelo completo
all.mod <- glm(final ~ Fedu_bin+Medu_bin+age+sex+school+famsize+Mjob+Fjob+reason , data= datos.train,fam

# Step-wise
stepMod <- step(base.mod, scope = list(lower = base.mod, upper = all.mod), direction = "both", trace = 0

# Variables en el modelo
formula(stepMod)
```

```
## final ~ Fedu_bin + sex + school
```

```r
# Construcción del modelo
set.seed(1337)

#  10-fold cross validation
train_control <- trainControl(method="cv", number=10)

# Entrenamos el modelo empleando glm
model <- train(formula(stepMod), data = datos.train, method = "glm",trControl=train_control,family = bin

# Resumen del modelo
summary(model)
```

```
##
## Call:
## NULL
##
## Coefficients:
```

```
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept)   2.4959     0.5815   4.292 1.77e-05 ***
## Fedu_bin1     1.6921     0.5135   3.295 0.000984 ***
## sexM         -1.4388     0.5751  -2.502 0.012360 *
## schoolMS     -1.5843     0.5832  -2.717 0.006597 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 137.85  on 240  degrees of freedom
## Residual deviance: 111.62  on 237  degrees of freedom
## AIC: 119.62
##
## Number of Fisher Scoring iterations: 6
```

```
# Evaluación del modelo
datos.test=
  datos.test %>%
  mutate(Fedu_bin=as.factor(ifelse(Fedu>1,1,0)), Medu_bin=as.factor(ifelse(Medu==4,1,0)))


prediction <- predict(model, newdata = datos.test, type = "raw")
confusionMatrix(table(prediction, datos.test$final), positive = "pass")
```

```
## Confusion Matrix and Statistics
##
##
## prediction fail pass
##       fail    0    1
##       pass   12  128
##
##                Accuracy : 0.9078
##                  95% CI : (0.8475, 0.95)
##     No Information Rate : 0.9149
##     P-Value [Acc > NIR] : 0.686406
##
##                   Kappa : -0.0133
##
##  Mcnemar's Test P-Value : 0.005546
##
##             Sensitivity : 0.9922
##             Specificity : 0.0000
##          Pos Pred Value : 0.9143
##          Neg Pred Value : 0.0000
##              Prevalence : 0.9149
##          Detection Rate : 0.9078
##    Detection Prevalence : 0.9929
##       Balanced Accuracy : 0.4961
##
##        'Positive' Class : pass
##
```

The R session information (including the OS info, R version and all packages used):

```
sessionInfo()
```

```
## R version 4.3.1 (2023-06-16)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 20.04.6 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/atlas/libblas.so.3.10.3
## LAPACK: /usr/lib/x86_64-linux-gnu/atlas/liblapack.so.3.10.3;  LAPACK version 3.9.0
##
## locale:
##  [1] LC_CTYPE=es_ES.UTF-8       LC_NUMERIC=C               LC_TIME=es_ES.UTF-8
##  [4] LC_COLLATE=es_ES.UTF-8     LC_MONETARY=es_ES.UTF-8    LC_MESSAGES=es_ES.UTF-8
##  [7] LC_PAPER=es_ES.UTF-8       LC_NAME=C                  LC_ADDRESS=C
## [10] LC_TELEPHONE=C             LC_MEASUREMENT=es_ES.UTF-8 LC_IDENTIFICATION=C
##
## time zone: Europe/Madrid
## tzcode source: system (glibc)
##
## attached base packages:
## [1] grid      stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
##  [1] randomForestExplainer_0.10.1 partykit_1.2-20
##  [3] mvtnorm_1.2-3                libcoin_1.0-10
##  [5] blorr_0.3.0                  Hmisc_5.1-1
##  [7] readr_2.1.4                  caretEnsemble_2.0.3
##  [9] DALEX_2.4.3                  ROCR_1.0-11
## [11] randomForest_4.7-1.1         arulesViz_1.5-2
## [13] arules_1.7-6                 Matrix_1.6-1.1
## [15] liver_1.15                   ggfortify_0.4.16
## [17] factoextra_1.0.7             mlbench_2.1-3.1
## [19] readxl_1.4.3                 caret_6.0-94
## [21] lattice_0.21-9               ggplot2_3.4.3
## [23] rpart.plot_3.1.1             rpart_4.1.19
## [25] caTools_1.18.2               dplyr_1.1.3
## [27] ISLR2_1.3-2
##
## loaded via a namespace (and not attached):
##   [1] RColorBrewer_1.1-3   rstudioapi_0.15.0    jsonlite_1.8.7       magrittr_2.0.3
##   [5] farver_2.1.1         rmarkdown_2.25       vctrs_0.6.3          base64enc_0.1-3
##   [9] iBreakDown_2.0.1     tinytex_0.47         htmltools_0.5.6.1    cellranger_1.1.0
##  [13] Formula_1.2-5        pROC_1.18.4          parallelly_1.36.0    htmlwidgets_1.6.2
##  [17] plyr_1.8.9           lubridate_1.9.3      igraph_1.5.1         lifecycle_1.0.3
##  [21] iterators_1.0.14     pkgconfig_2.0.3      R6_2.5.1             fastmap_1.1.1
##  [25] future_1.33.0        digest_0.6.33        reshape_0.8.9        GGally_2.1.2
##  [29] colorspace_2.1-0     labeling_0.4.3       fansi_1.0.5          timechange_0.2.0
##  [33] abind_1.4-5          polyclip_1.10-6      compiler_4.3.1       proxy_0.4-27
##  [37] bit64_4.0.5          withr_2.5.1          htmlTable_2.4.1      backports_1.4.1
##  [41] carData_3.0-5        viridis_0.6.4        highr_0.10           ggforce_0.4.1
##  [45] MASS_7.3-60          lava_1.7.2.1         ModelMetrics_1.2.2.2 tools_4.3.1
##  [49] foreign_0.8-85       future.apply_1.11.0  nnet_7.3-19          glue_1.6.2
##  [53] inum_1.0-5           nlme_3.1-163         checkmate_2.2.0      cluster_2.1.4
##  [57] reshape2_1.4.4       generics_0.1.3       recipes_1.0.8        gtable_0.3.4
```

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##  [61] tzdb_0.4.0           class_7.3-22         tidyr_1.3.0          data.table_1.14.8
##  [65] hms_1.1.3            car_3.1-2            tidygraph_1.2.3      utf8_1.2.3
##  [69] ggrepel_0.9.3        foreach_1.5.2        pillar_1.9.0         stringr_1.5.0
##  [73] vroom_1.6.4          splines_4.3.1        tweenr_2.0.2         survival_3.5-7
##  [77] bit_4.0.5            tidyselect_1.2.0     pbapply_1.7-2        knitr_1.44
##  [81] gridExtra_2.3        stats4_4.3.1         xfun_0.40            graphlayouts_1.0.1
##  [85] hardhat_1.3.0        timeDate_4022.108    DT_0.30              visNetwork_2.1.2
##  [89] stringi_1.7.12       yaml_2.3.7           evaluate_0.22        codetools_0.2-19
##  [93] ggraph_2.1.0         tibble_3.2.1         cli_3.6.1            munsell_0.5.0
##  [97] Rcpp_1.0.11          globals_0.16.2       parallel_4.3.1       ellipsis_0.3.2
## [101] gower_1.0.1          bitops_1.0-7         listenv_0.9.0        viridisLite_0.4.2
## [105] ipred_0.9-14         scales_1.2.1         prodlim_2023.08.28   e1071_1.7-13
## [109] purrr_1.0.2          crayon_1.5.2         rlang_1.1.1

Sys.time()

## [1] "2023-11-03 11:55:32 CET"
```