Prueba Machine Learning : Ramon Yañez, Patricio Zapata

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PREGUNTA 1 [0.75pt]

A veces, un algoritmo de machine learning no logra modelar bien los datos de entrenamiento ni generalizarse a nuevas observaciones. Elija la opción que mejor caracteriza a esta situación y justifique su elección. (a) Error de clasificación bajo. (b) Underfitting. (c) La varianza del error de estimación es pequeña. (d) Overfitting.

Respuesta: (b) Underfitting Justificación: Tenemos underfitting cuando los datos son pocos y no se puede generalizar el conocimiento.

PREGUNTA 2 [0.75pt]

Hacer un árbol de decisión más profundo asegurará un mejor ajuste, pero probablemente reducirá la exactitud (accuracy) de la validación cruzada. Justifique. (a) Verdadero. (b) Falso

Respuesta: Verdadero Justificación: Al tener mas profundidad, el ajuste con la data de entrenamiento calza plenamente pero cuando queremos generalizar fallará asi mismo como hacer una predicción con otra data o validación cruzada

PREGUNTA 3

Creacion Data frame

```
mi_df <- data.frame(
  "Edad" = c("18-40", "18-40", "18-40", "18-40", "18-40", "18-40", "18-40", "41-60", "41-60" , "41-60"
  "Combo" = c("Fiesta", "Supremo", "Supremo", "Fiesta", "Supremo", "Mediano", "Supremo", "Mediano", "Me
)


glimpse(mi_df)
```

```
## Rows: 21
## Columns: 2
## $ Edad  <chr> "18-40", "18-40", "18-40", "18-40", "18-40", "18-40", "18-40", "~
## $ Combo <chr> "Fiesta", "Supremo", "Supremo", "Fiesta", "Supremo", "Mediano", ~
```

```
new <-  table(mi_df)
new
```

```
##        Combo
## Edad    Fiesta Mediano Supremo
##   >60        3       2       2
##   18-40      2       1       4
##   41-60      2       2       3
```

(i) [0.25pt] Convierta el conjunto de datos en una tabla de frecuencia.

```
datos <- prop.table(new)
datos
```

```
##        Combo
## Edad        Fiesta    Mediano    Supremo
##   >60   0.14285714 0.09523810 0.09523810
##   18-40 0.09523810 0.04761905 0.19047619
##   41-60 0.09523810 0.09523810 0.14285714
```

(ii) [0.25pt] Obtenga las probabilidades marginales por rango de Edad y Combo.

```
mayor_60 <-  sum(datos[1,])
mayor_60
```

```
## [1] 0.3333333
```

```
entre_18_40  <-  sum(datos[2,])
entre_18_40
```

```
## [1] 0.3333333
```

```
entre_41_60  <- sum(datos[3,])
entre_41_60
```

```
## [1] 0.3333333
```

```
Fiesta  <- sum(datos[,1])
Fiesta
```

```
## [1] 0.3333333
```

```
Mediano  <- sum(datos[,2])
Mediano
```

```
## [1] 0.2380952
```

```
Supremo  <- sum(datos[,3])
Supremo
```

```
## [1] 0.4285714
```

(iii) [1.00pt] Calcule la probabilidad de recomendar cada Combo dadoel rango de Edad, es decir, la probabilidad posterior de recomendación.

```
# p(fiesta | mayor a 60 )
#    A           B
# =
# ( p(mayor_60 | Fiesta) * P(fiesta) )  / P(mayor_60)
mayor_60_Fiesta <- datos[1,1]
(mayor_60_Fiesta * Fiesta) / mayor_60
```

```
## [1] 0.1428571
```

```
# p(mediano | mayor a 60 )
#    A           B
# =
# ( p(mayor_60 | Mediano) * P(Mediano) )  / P(mayor_60)
mayor_60_Mediano <- datos[1,2]
(mayor_60_Mediano * Mediano) / mayor_60
```

```
## [1] 0.06802721
```

```
# p(supremo | mayor a 60 )
#    A           B
# =
# ( p(mayor_60 | supremo) * P(supremo) )  / P(mayor_60)
mayor_60_Supremo <- datos[1,3]
(mayor_60_Supremo * Supremo) / mayor_60
```

```
## [1] 0.122449
```

```
# p(fiesta | 18_40 )
#    A           B
# =
# ( p(18_40 | Fiesta) * P(fiesta) )  / P(18_40)
entre_18_40_Fiesta <- datos[2,1]
(entre_18_40_Fiesta * Fiesta) / entre_18_40
```

```
## [1] 0.0952381
```

```
# p(mediano | 18_40 )
#    A           B
# =
# ( p(18_40 | mediano) * P(mediano) )  / P(18_40)
entre_18_40_mediano <- datos[2,2]
(entre_18_40_mediano * Mediano) / entre_18_40
```

```
## [1] 0.03401361
```

```
# p(supremo | 18_40 )
#    A           B
# =
# ( p(18_40 | supremo) * P(supremo) )  / P(18_40)
entre_18_40_supremo <- datos[2,3]
(entre_18_40_supremo * Supremo) / entre_18_40
```

```
## [1] 0.244898
```

```
# p(fiesta | 41_60 )
#    A           B
# =
# ( p(41_60 | Fiesta) * P(fiesta) )  / P(41_60)
entre_41_60_Fiesta <- datos[3,1]
(entre_41_60_Fiesta * Fiesta) / entre_41_60
```

```
## [1] 0.0952381
```

```
# p(mediano | 41_60 )
#    A           B
# =
# ( p(41_60 | mediano) * P(mediano) )  / P(41_60)
entre_41_60_mediano <- datos[3,2]
(entre_41_60_mediano * Mediano) / entre_41_60
```

```
## [1] 0.06802721
```

```
# p(supremo | 41_60 )
#    A           B
# =
# ( p(41_60 | supremo) * P(supremo) )  / P(41_60)
entre_41_60_supremo <- datos[3,3]
(entre_41_60_supremo * Supremo) / entre_41_60
```

```
## [1] 0.1836735
```

(iv) [0.25pt] Si un cliente de 30 años (es decir, rango de edad: "18-40") se conecta al sistema, ¿qué Combo recomendaría el algoritmo?

Le recomendaría el combo supremo ya que nos da un 24% de probabilidad que lo consuma

PREGUNTA 4

La base de datos wine (disponible en el paquete rattle.data) contiene información de 178 vinos. Se desea clasificar el tipo de vino (Type=1,2,3) a partir de 13 covariables disponibles. Aquí hay más detalles sobre cada variable. Cargue la base de datos y desarrolle los siguientes ítems:

(i) [0.25pt] Estandarice las variables continuas.

```
data <- wine
glimpse(data)
```

```
## Rows: 178
## Columns: 14
## $ Type            <fct> 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, ~
## $ Alcohol         <dbl> 14.23, 13.20, 13.16, 14.37, 13.24, 14.20, 14.39, 14.06~
## $ Malic           <dbl> 1.71, 1.78, 2.36, 1.95, 2.59, 1.76, 1.87, 2.15, 1.64, ~
## $ Ash             <dbl> 2.43, 2.14, 2.67, 2.50, 2.87, 2.45, 2.45, 2.61, 2.17, ~
## $ Alcalinity      <dbl> 15.6, 11.2, 18.6, 16.8, 21.0, 15.2, 14.6, 17.6, 14.0, ~
## $ Magnesium       <int> 127, 100, 101, 113, 118, 112, 96, 121, 97, 98, 105, 95~
## $ Phenols         <dbl> 2.80, 2.65, 2.80, 3.85, 2.80, 3.27, 2.50, 2.60, 2.80, ~
## $ Flavanoids      <dbl> 3.06, 2.76, 3.24, 3.49, 2.69, 3.39, 2.52, 2.51, 2.98, ~
## $ Nonflavanoids   <dbl> 0.28, 0.26, 0.30, 0.24, 0.39, 0.34, 0.30, 0.31, 0.29, ~
## $ Proanthocyanins <dbl> 2.29, 1.28, 2.81, 2.18, 1.82, 1.97, 1.98, 1.25, 1.98, ~
## $ Color           <dbl> 5.64, 4.38, 5.68, 7.80, 4.32, 6.75, 5.25, 5.05, 5.20, ~
## $ Hue             <dbl> 1.04, 1.05, 1.03, 0.86, 1.04, 1.05, 1.02, 1.06, 1.08, ~
## $ Dilution        <dbl> 3.92, 3.40, 3.17, 3.45, 2.93, 2.85, 3.58, 3.58, 2.85, ~
## $ Proline         <int> 1065, 1050, 1185, 1480, 735, 1450, 1290, 1295, 1045, 1~
```

```r
summary(data)
```

```
##  Type      Alcohol          Malic             Ash          Alcalinity
##  1:59   Min.   :11.03   Min.   :0.740   Min.   :1.360   Min.   :10.60
##  2:71   1st Qu.:12.36   1st Qu.:1.603   1st Qu.:2.210   1st Qu.:17.20
##  3:48   Median :13.05   Median :1.865   Median :2.360   Median :19.50
##         Mean   :13.00   Mean   :2.336   Mean   :2.367   Mean   :19.49
##         3rd Qu.:13.68   3rd Qu.:3.083   3rd Qu.:2.558   3rd Qu.:21.50
##         Max.   :14.83   Max.   :5.800   Max.   :3.230   Max.   :30.00
##    Magnesium         Phenols        Flavanoids    Nonflavanoids
##  Min.   : 70.00   Min.   :0.980   Min.   :0.340   Min.   :0.1300
##  1st Qu.: 88.00   1st Qu.:1.742   1st Qu.:1.205   1st Qu.:0.2700
##  Median : 98.00   Median :2.355   Median :2.135   Median :0.3400
##  Mean   : 99.74   Mean   :2.295   Mean   :2.029   Mean   :0.3619
##  3rd Qu.:107.00   3rd Qu.:2.800   3rd Qu.:2.875   3rd Qu.:0.4375
##  Max.   :162.00   Max.   :3.880   Max.   :5.080   Max.   :0.6600
##  Proanthocyanins     Color             Hue            Dilution
##  Min.   :0.410   Min.   : 1.280   Min.   :0.4800   Min.   :1.270
##  1st Qu.:1.250   1st Qu.: 3.220   1st Qu.:0.7825   1st Qu.:1.938
##  Median :1.555   Median : 4.690   Median :0.9650   Median :2.780
##  Mean   :1.591   Mean   : 5.058   Mean   :0.9574   Mean   :2.612
##  3rd Qu.:1.950   3rd Qu.: 6.200   3rd Qu.:1.1200   3rd Qu.:3.170
##  Max.   :3.580   Max.   :13.000   Max.   :1.7100   Max.   :4.000
##     Proline
##  Min.   : 278.0
##  1st Qu.: 500.5
##  Median : 673.5
##  Mean   : 746.9
##  3rd Qu.: 985.0
##  Max.   :1680.0
```

```r
data[,-1] <- as.data.frame(scale(data[,-1]))
data[,-1]
```

```
##         Alcohol       Malic         Ash   Alcalinity   Magnesium      Phenols
## 1    1.51434077 -0.56066822  0.23139979 -1.166303174  1.90852151  0.806721729
## 2    0.24559683 -0.49800856 -0.82566722 -2.483840525  0.01809398  0.567048088
## 3    0.19632522  0.02117152  1.10621386 -0.267982252  0.08810981  0.806721729
## 4    1.68679140 -0.34583508  0.48655389 -0.806974805  0.92829983  2.484437221
## 5    0.29486844  0.22705328  1.83522559  0.450674485  1.27837900  0.806721729
## 6    1.47738706 -0.51591132  0.30430096 -1.286079296  0.85828399  1.557699140
## 7    1.71142720 -0.41744613  0.30430096 -1.465743481 -0.26196936  0.327374446
## 8    1.30493643 -0.16680747  0.88751034 -0.567422559  1.48842650  0.487156874
## 9    2.25341491 -0.62332789 -0.71631546 -1.645407665 -0.19195352  0.806721729
## 10   1.05857838 -0.88291793 -0.35180959 -1.046527051 -0.12193769  1.094330099
## 11   1.35420804 -0.15785609 -0.24245783 -0.447646437  0.36817315  1.046395371
## 12   1.37884384 -0.76654998 -0.16955666 -0.806974805 -0.33198519 -0.151972837
## 13   0.92308146 -0.54276546  0.15849862 -1.046527051 -0.75208020  0.487156874
## 14   2.15487169 -0.54276546  0.08559744 -2.423952463 -0.61204853  1.286069013
## 15   1.69910930 -0.41744613  0.04914686 -2.244288279  0.15812565  1.605633868
## 16   0.77526663 -0.47115441  1.21556562 -0.687198682  0.85828399  0.886612943
## 17   1.60056608 -0.37268923  1.28846679  0.151234178  1.41841067  0.806721729
```

```
## 18   1.02162467 -0.68598755  0.92396093  0.151234178  1.06833150  1.046395371
## 19   1.46506916 -0.66808479  0.41365272 -0.896806897  0.57822065  1.605633868
## 20   0.78758453  0.68357369  0.70525741 -1.286079296  1.13834733  0.646939302
## 21   1.30493643 -0.63227927 -0.31535901 -1.046527051  1.83850567  1.126286585
## 22  -0.08698653  1.31017034  1.03331269 -0.267982252  0.15812565  0.183570261
## 23   0.87380985 -0.42639751 -0.02375431 -0.866862867  0.08810981  0.503135117
## 24  -0.18552975 -0.65913341  0.55945507 -0.507534498 -0.33198519  0.295417961
## 25   0.61513390 -0.47115441  0.88751034  0.151234178 -0.26196936  0.375309174
## 26   0.06082829 -0.25632128  3.11099611  1.648435713  1.69847400  0.535091602
## 27   0.47963697 -0.50695994  0.92396093 -1.016583020 -0.47201686  0.886612943
## 28   0.36877585 -0.55171684 -0.82566722 -0.747086744 -0.40200103  0.167592018
## 29   1.07089628 -0.39059199  1.58007149 -0.028430007  0.50820482  1.046395371
## 30   1.25566482 -0.58752236 -0.57051311 -1.046527051 -0.26196936  0.567048088
## 31   0.89844565 -0.74864721  1.21556562  0.899834945  0.08810981  1.126286585
## 32   0.71367712 -0.60542512 -0.02375431 -0.118262099  0.43818899  0.902591186
## 33   0.83685614 -0.45325165 -0.02375431 -0.687198682  0.29815732  0.199548504
## 34   0.93539936 -0.72179307  1.21556562  0.001514024  2.25860068  1.046395371
## 35   0.62745180 -0.48010579  1.03331269 -0.148206130  0.71825232  0.087700804
## 36   0.59049809 -0.47115441  0.15849862  0.300954331  0.01809398  0.646939302
## 37   0.34414005 -0.62332789  1.72587383 -1.196247204  0.71825232  0.487156874
## 38   0.06082829 -0.61437650  0.66880683 -0.447646437 -0.12193769  0.247483232
## 39   0.08546410 -0.74864721 -0.97146956 -1.196247204 -0.12193769  0.167592018
## 40   1.50202286  1.48024658  0.52300448 -1.884959911  1.97853734  1.126286585
## 41   0.68904131 -0.56066822 -0.20600725 -0.986638989  1.20836316  1.365960227
## 42   0.50427278  1.34597587 -0.89856839 -0.208094191 -0.68206436  0.247483232
## 43   1.08321419 -0.39954337  0.81460917 -1.345967358  0.08810981  1.525742654
## 44   0.29486844  1.47129519 -0.27890842 -0.597366590  0.22814148  0.551069845
## 45   0.06082829 -0.50695994 -0.97146956 -0.747086744  0.50820482  1.126286585
## 46   1.48970496  1.52500348  0.26785038 -0.178150160  0.78826816  0.886612943
## 47   1.69910930  1.12219135 -0.31535901 -1.046527051  0.15812565  1.525742654
## 48   1.10784999 -0.58752236 -0.89856839 -1.046527051  0.08810981  1.286069013
## 49   1.35420804 -0.28317542  0.12204803 -0.208094191  0.22814148  0.726830515
## 50   1.15712160 -0.54276546 -0.35180959 -0.627310621  0.57822065  0.934547672
## 51   0.06082829 -0.54276546 -1.19017308 -2.124512156 -0.54203270  0.678895787
## 52   1.02162467 -0.61437650  0.85105976 -0.687198682 -0.40200103  0.247483232
## 53   1.00930677 -0.52486270  0.19494920 -1.645407665  0.78826816  2.532371949
## 54   0.94771726 -0.39059199  1.14266445 -0.717142713  1.06833150  1.126286585
## 55   0.91076355 -0.59647374 -0.42471076 -0.926750928  1.27837900  0.487156874
## 56   0.68904131 -0.54276546  0.34075155  0.300954331  1.13834733  1.062373614
## 57   1.50202286 -0.56961960 -0.24245783 -0.956694959  1.27837900  1.445851440
## 58   0.35645795 -0.32793232  1.14266445 -0.806974805  0.15812565  1.126286585
## 59   0.88612775 -0.81130688  0.48655389 -0.836918836  0.57822065  1.765416296
## 60  -0.77678907 -1.24992453 -3.66881295 -2.663504709 -0.82209603 -0.503494178
## 61  -0.82606067 -1.10670244 -0.31535901 -1.046527051  0.08810981 -0.391646479
## 62  -0.44420570 -0.87396654 -1.26307425 -0.806974805  0.01809398 -0.439581207
## 63   0.82453824 -0.97243173 -1.62758012 -0.447646437 -0.40200103 -0.311755265
## 64  -0.77678907 -1.07984830 -0.75276604 -0.148206130 -0.89211187  1.925198724
## 65  -1.02314711 -0.79340412  0.59590565 -0.148206130  0.29815732 -0.647298363
## 66  -0.77678907 -1.00823725  0.70525741 -0.417702406 -0.12193769  0.199548504
## 67   0.13473571 -1.18726487 -2.42949302 -1.345967358 -1.52225438  1.094330099
## 68  -0.77678907 -1.04404278 -1.62758012  0.031458055 -1.52225438 -0.295777022
## 69   0.41804746 -1.24992453 -0.02375431 -0.747086744  0.71825232  0.375309174
## 70  -0.97387550 -1.02614002 -2.24724008 -0.806974805  3.58890153 -0.711211334
## 71  -0.87533228 -0.65018203 -0.57051311  0.271010300  0.22814148 -1.909579543
```

```
## 72   1.05857838 -0.73969583  1.10621386  1.648435713 -0.96212770  1.046395371
## 73   0.60281600 -0.60542512 -0.46116135  1.348995406 -0.89211187 -0.663276606
## 74  -0.01307912 -0.59647374  0.85105976  3.145637249  2.74871152  1.605633868
## 75  -1.28182306 -1.11565382 -0.24245783  0.450674485  0.08810981  1.733459810
## 76  -1.65136013 -0.40849475 -1.62758012 -1.046527051 -0.19195352 -1.094689161
## 77   0.03619249 -1.28573006 -2.39304243 -1.046527051 -0.96212770 -0.551428907
## 78  -1.42963789  0.49559470 -0.49761194 -0.447646437  0.85828399 -0.918928490
## 79  -0.82606067 -1.20516763 -1.51822836 -1.405855419  2.53866402 -0.631320120
## 80  -0.37029829  1.37283001  0.12204803  1.049555099  0.08810981  0.854656458
## 81  -1.23255145 -1.26782729 -1.33597542 -0.148206130 -0.96212770  0.199548504
## 82  -0.34566248 -0.47115441 -0.60696370 -0.208094191 -0.96212770 -0.151972837
## 83  -1.13400823 -1.07984830  0.52300448  1.348995406 -1.52225438 -0.471537693
## 84   0.06082829  1.36387863 -0.16955666  0.899834945 -1.03214354 -1.030776190
## 85  -1.42963789 -1.29468144  0.77815859 -0.447646437 -0.40200103 -0.151972837
## 86  -0.40725200 -1.21411901 -0.46116135 -0.447646437 -0.05192185 -0.151972837
## 87  -1.03546501 -0.65018203 -0.20600725  0.989667037 -0.68206436 -0.823059034
## 88  -1.66367803 -0.59647374  0.92396093  1.947876020 -0.82209603 -0.599363635
## 89  -1.67599593 -0.24736990  0.34075155  0.630338669 -1.10215937 -0.551428907
## 90  -1.13400823 -0.90082069 -0.24245783  1.229219283 -2.08238105 -0.151972837
## 91  -1.13400823 -0.45325165 -0.16955666 -0.297926283 -1.31220687 -1.110667404
## 92  -1.23255145 -0.73969583  0.19494920  0.750114792 -0.96212770 -1.350341045
## 93  -0.38261619 -0.72179307 -0.38826018  0.360842393 -1.38222271 -1.462188745
## 94  -0.87533228  0.44188642 -0.53406252 -0.447646437 -0.82209603  0.247483232
## 95  -1.70063174 -0.31002956 -0.31535901 -0.447646437 -0.12193769  1.158243070
## 96  -0.65361004 -0.73074445 -0.60696370 -0.148206130  4.35907571  0.327374446
## 97  -1.46659160 -0.19366161  1.36136797  0.600394638  2.39863235 -1.110667404
## 98  -0.87533228 -0.82920964 -1.40887660 -1.046527051 -1.03214354  0.407265660
## 99  -0.77678907 -1.13355658 -0.97146956 -0.297926283 -0.82209603  1.957155209
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## 102 -0.49347731 -0.89186931 -1.70048129 -0.297926283 -0.82209603 -1.350341045
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## 104 -1.45427369 -0.55171684 -1.77338246  0.001514024 -0.96212770  0.327374446
## 105 -0.60433843 -0.54276546 -1.40887660  0.300954331 -1.03214354 -0.151972837
## 106 -0.71519955  0.19124776 -0.35180959  0.750114792 -0.68206436 -0.982841462
## 107 -0.92460389 -0.54276546 -0.89856839 -0.148206130 -1.38222271 -1.030776190
## 108 -0.34566248 -0.52486270 -0.31535901  0.899834945 -1.10215937 -1.462188745
## 109 -0.96155760 -0.93662621 -1.55467894 -0.148206130 -0.54203270  0.103679047
## 110 -1.71294964 -0.88291793  1.21556562  0.151234178 -0.40200103  0.710852273
## 111 -1.89771818  1.25646206 -1.99208598  0.001514024  0.50820482  1.413894955
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## 118 -0.71519955 -0.65018203 -0.64341428  0.899834945  0.57822065 -0.471537693
## 119 -0.28407297  0.97896926 -1.40887660 -1.046527051 -1.38222271 -1.062732675
## 120 -1.23255145  0.97896926 -1.33597542 -0.148206130 -0.89211187 -0.471537693
## 121 -1.91003608  0.05697705  0.19494920  0.151234178 -0.26196936  0.966504157
## 122 -1.77453915 -0.25632128  3.14744670  2.696476788  1.34839483  1.413894955
## 123 -0.71519955  1.87410733  1.32491738  2.097596174  0.15812565 -0.151972837
## 124  0.06082829  3.10044648 -0.86211780  0.600394638 -0.96212770  0.519113359
## 125 -1.39268418  1.76669076  0.08559744  0.450674485 -1.24219104  0.902591186
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## 126 -1.14632613 -0.15785609 -0.71631546  0.450674485 -1.03214354  0.487156874
## 127 -0.70288165 -0.72179307 -0.27890842  0.600394638 -0.96212770  0.710852273
## 128 -1.49122740 -0.18471023  1.50717031  2.696476788 -0.54203270 -0.263820537
## 129 -0.77678907 -0.63227927 -0.24245783  1.498715559 -0.82209603 -0.120016352
## 130 -1.18327984  1.75773938  0.04914686  0.750114792 -1.38222271 -0.311755265
## 131 -0.17321185 -0.88291793 -0.16955666 -0.447646437  1.55844234 -1.254471589
## 132 -0.14857605  0.58510851  0.12204803  0.151234178  0.29815732 -1.590014687
## 133 -0.23480136 -0.02358538  0.12204803  1.348995406 -0.12193769 -1.829688329
## 134 -0.37029829  1.08638583 -0.02375431  0.600394638  0.43818899 -0.950884976
## 135 -0.60433843 -0.98138311 -0.42471076 -0.597366590 -1.03214354 -0.471537693
## 136 -0.49347731  0.11068533 -0.60696370 -0.297926283 -0.40200103 -1.078710918
## 137 -0.92460389  2.13369737  0.63235624  0.450674485 -0.75208020 -1.462188745
## 138 -0.57970263  2.84085644  0.99686210  1.648435713 -0.26196936 -0.807080791
## 139  0.60281600  1.12219135 -0.64341428  0.001514024 -0.82209603 -1.078710918
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## 141 -0.08698653  0.42398365  1.21556562  0.450674485 -0.26196936 -1.206536860
## 142  0.44268327  0.20019914 -0.06020490  0.151234178 -0.75208020 -1.430232259
## 143  0.63976970  0.74623336  1.28846679  1.199275252 -0.19195352 -1.190558618
## 144  0.76294873  2.33957912 -0.06020490  0.151234178 -0.54203270 -0.471537693
## 145 -0.92460389  1.38178139 -0.60696370 -0.297926283  0.85828399 -1.462188745
## 146  0.19632522  1.10428859 -0.78921663  0.450674485  0.15812565 -1.270449832
## 147  1.08321419  2.42014155 -0.49761194  0.151234178 -1.38222271 -2.101318456
## 148 -0.16089395  2.03523218  0.41365272  0.600394638 -0.96212770 -0.950884976
## 149  0.39341166  0.80889302  0.04914686  0.600394638 -0.54203270 -0.583385392
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## 156  0.20864312  2.55441226 -0.16955666  0.750114792 -0.47201686 -0.886972005
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## 158 -0.67824585  0.62091403  0.99686210  2.247316327 -0.19195352 -0.631320120
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## 160  0.59049809 -0.59647374  0.99686210  0.899834945 -0.75208020  0.487156874
## 161 -0.78910697  1.33702448  0.04914686  0.450674485 -0.82209603  0.007809591
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## 163 -0.18552975  0.83574717  0.77815859  0.750114792  0.43818899 -1.030776190
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## 165  0.96003516  0.37922675 -0.24245783  0.750114792 -0.68206436 -1.510123473
## 166  0.89844565  1.81144766 -0.38826018  0.899834945 -0.82209603 -1.621971173
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##        Flavanoids Nonflavanoids Proanthocyanins        Color         Hue
```

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## 1    1.0319080692   -0.65770780     1.22143845  0.251008784  0.36115849
## 2    0.7315652835   -0.81841060    -0.54318872 -0.292496232  0.40490846
## 3    1.2121137407   -0.49700500     2.12995937  0.268262912  0.31740852
## 4    1.4623993954   -0.97911340     1.02925134  1.182731669 -0.42634104
## 5    0.6614853002    0.22615759     0.40027531 -0.318377423  0.36115849
## 6    1.3622851335   -0.17559941     0.66234866  0.729810822  0.40490846
## 7    0.4912910549   -0.49700500     0.67982021  0.082781041  0.27365854
## 8    0.4812796287   -0.41665360    -0.59560339 -0.003489596  0.44865844
## 9    0.9518166597   -0.57735640     0.67982021  0.061213382  0.53615839
## 10   1.1220109049   -1.13981619     0.45268998  0.932546820  0.22990857
## 11   1.2922051502   -1.13981619     1.37868246  0.298457635  1.27990794
## 12   0.4011882192   -0.81841060    -0.03651359 -0.025057256  0.92990815
## 13   0.7315652835   -0.57735640     0.38280376  0.233754657  0.84240820
## 14   1.6626279192    0.54756319     2.12995937  0.147484019  1.27990794
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## 17   1.1119994787   -0.25595080     0.66234866  0.492566569  0.49240841
## 18   1.3722965597    0.30650899     0.22555975  0.665107844  0.75490825
## 19   1.9029021478   -0.33630220     0.47016154  1.570949537  1.19240799
## 20   1.0018737906   -1.54157319     0.12073042  0.018078063  0.01115870
## 21   1.1420337573   -0.97911340     0.88947889  0.255322316  0.57990836
## 22   0.3811653668   -0.89876200     0.67982021 -0.240733849  0.31740852
## 23   0.8517023978   -0.73805920     0.17314508 -0.542681081  0.66740831
## 24   0.3411196621   -0.81841060    -0.22870071 -0.486605166  0.57990836
## 25   0.5813938906   -0.65770780     0.12073042 -0.663459973  0.71115828
## 26   0.6514738740    0.86896878     0.57499088 -0.637578782  0.75490825
## 27   0.9117709549   -0.17559941    -0.24617226 -0.111327893 -0.16384119
## 28   0.1609139906   -0.73805920    -0.42088782 -0.477978102  0.27365854
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## 31   1.2221251668   -0.57735640     1.37868246  0.276889975  1.01740810
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## 33   0.6614853002    0.46721179     0.66234866 -0.525426953  1.19240799
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## 35   0.5013024811   -0.57735640    -0.08892826 -0.370139806  0.62365833
## 36   0.9518166597   -0.81841060     0.47016154  0.018078063  0.36115849
## 37   0.6514738740   -0.17559941    -0.40341627 -0.197598531  0.57990836
## 38   0.4011882192   -0.57735640    -0.26364382 -0.348572146  0.71115828
## 39   0.6114281692   -0.65770780    -0.38594471 -0.585816399  0.97365812
## 40   1.0118852168   -1.30051899     0.85453577  0.018078063 -0.29509111
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## 54   0.7615995621    0.22615759     0.15567353  0.535701888  0.75490825
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## 74   0.8617138240   -1.22016759      0.64487710 -0.736790015  1.54240778
## 75   0.1108568597   -1.86297878      0.10325886 -0.797179461  0.14240862
## 76  -0.4597944332   -0.17559941     -0.77031895 -0.542681081  1.19240799
## 77   0.0007311716   -0.97911340     -0.22870071 -0.197598531  1.01740810
## 78  -0.7100800880    0.54756319     -1.11975007 -1.038737246  0.01115870
## 79  -0.1794744999   -0.09524801      2.04260159 -0.715222356  0.44865844
## 80   0.5213253335    0.54756319      0.62740554 -1.073245501  1.01740810
## 81   0.2309939740   -0.49700500     -0.28111538 -1.103440224  1.84865760
## 82   0.5013024811   -0.81841060      0.31291753 -0.499545762  0.88615818
## 83  -0.4497830070    0.30650899     -0.33353004 -1.232846180  1.54240778
## 84  -0.4397715808    1.99388837      0.05084419 -0.111327893 -0.51384098
## 85   0.1809368430   -1.13981619      1.32626779 -0.866195971 -0.73259085
## 86  -0.0893716641   -0.49700500     -0.22870071 -1.051677842  1.19240799
## 87  -0.3396573189    0.54756319     -0.05398515 -1.125007884  1.62990773
## 88  -0.4197487284    0.30650899     -0.43835938 -1.060304905  1.76115765
## 89  -0.3396573189    0.94932018     -0.42088782 -0.974034268  0.18615860
## 90  -0.4397715808    0.46721179     -0.36847316 -1.431268647  0.49240841
## 91  -0.5298744165    1.27072578      0.08578730 -1.146575543  0.53615839
## 92  -0.7801600713    1.11002298      0.06831575 -0.628951718  0.40490846
## 93  -0.5699201213    1.75283417      0.05084419 -0.866195971  0.01115870
## 94   0.2209825478   -0.89876200      0.69729177 -1.254413840  0.84240820
## 95   0.2309939740   -1.54157319     -0.42088782 -0.779925334  0.88615818
## 96   0.2410054002   -0.33630220      2.95112251 -1.060304905  0.88615818
## 97  -1.0404571523   -1.78262739     -0.05398515 -1.103440224 -0.03259127
## 98   0.4712682025   -0.57735640      0.31291753 -0.930898949  1.19240799
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## 109  0.0107425978    0.22615759     0.85453577 -1.017169587 -0.42634104
## 110  0.8917481025   -0.57735640     1.57086958 -1.038737246  0.01115870
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## 117 -0.4297601546   -0.49700500    -0.10639981 -1.340684477 -0.03259127
## 118  0.0607997287   -0.17559941     0.03337264 -1.293235627  0.44865844
## 119 -0.7801600713    0.54756319    -1.32940874 -0.715222356 -1.12634062
## 120 -0.3897144499    0.06545479     0.48763309 -1.629691113 -0.12009122
## 121  0.7615995621   -0.33630220     0.41774687 -0.779925334 -0.68884088
## 122  3.0542161597    0.86896878     0.48763309  0.406295932 -0.12009122
## 123  0.1008454335    0.54756319     0.20808820 -1.284608563 -0.16384119
## 124  0.6214395954   -0.49700500     0.73223488 -1.060304905 -0.99509069
## 125  1.0018737906   -1.22016759     2.30467493 -0.974034268 -0.90759075
## 126  0.6214395954    0.06545479    -0.42088782 -0.991288395 -0.42634104
## 127  1.1220109049    0.22615759     0.31291753 -0.482291634 -1.17009059
## 128  0.2109711216    1.75283417     0.29544598 -0.887763630  0.05490867
## 129  0.4212110716    0.30650899     0.54004776 -1.267354435 -0.29509111
## 130 -0.2795887618    0.46721179    -0.42088782 -1.060304905 -0.73259085
## 131 -0.7801600713   -1.22016759    -1.13722163 -0.413275124 -0.86384077
## 132 -0.8101943499   -0.97911340    -1.32940874  0.147484019 -0.95134072
## 133 -0.9403428904   -0.73805920    -1.32940874  0.276889975 -1.30134051
## 134 -0.8302172023   -1.54157319    -1.31193719 -0.025057256 -0.77634083
## 135 -1.4509256261    1.91353697    -0.59560339  0.169051679 -0.90759075
## 136 -1.3708342166    2.15459116    -1.13722163  0.880784438 -0.99509069
## 137 -1.5610513142    1.35107717    -1.38182341 -0.521113421 -0.90759075
## 138 -1.4309027737    2.15459116    -0.85767673 -0.025057256 -0.60134093
## 139 -1.5510398880    1.75283417    -1.24205096  0.276889975 -0.64509090
## 140 -1.4309027737    1.35107717    -1.36435186 -0.059565511 -0.29509111
## 141 -1.5310170356    1.35107717    -1.46918119 -0.197598531 -0.82009080
## 142 -1.5310170356    0.06545479    -1.66136831  0.233754657 -1.12634062
## 143 -1.5109941832    1.11002298    -1.81861232 -0.305436828 -0.29509111
## 144 -1.2306742499    0.86896878    -0.99744918 -0.283869168 -0.20759117
## 145 -1.2506971023   -0.57735640    -0.78779050  1.359586476 -1.34509048
## 146 -1.4809599046    0.54756319    -0.50824560 -0.456410443 -1.56384035
## 147 -1.6911998547    0.30650899    -1.59148209 -0.068192574 -1.65134030
## 148 -1.3808456427    0.86896878    -1.27699407  1.118028691 -1.82634020
## 149 -1.2707199546    0.70826598    -0.59560339  1.450170645 -1.78259022
## 150 -0.6400001046   -0.17559941    -0.78779050  1.872896769 -1.69509027
## 151 -0.4597944332   -1.13981619    -0.59560339  1.527814219 -1.60759033
## 152 -0.6700343832   -0.97911340    -0.57813183  2.476791231 -2.08884004
## 153 -0.7501257927   -0.81841060    -0.05398515  0.880784438 -1.52009038
## 154 -1.2006399713    1.99388837     0.48763309  2.356012338 -1.73884025
## 155 -1.4509256261    1.35107717    -0.33353004  1.096461031 -1.65134030
## 156 -1.4008684951    1.99388837    -0.07145670  1.225866988 -1.56384035
## 157 -1.2006399713    0.94932018    -0.05398515  1.704669026 -1.69509027
## 158 -1.4509256261    2.15459116    -0.78779050  1.053325713 -1.25759054
## 159 -0.7200915142    1.35107717     1.93777225  3.425768243 -1.69509027
## 160 -0.9303314642    1.27072578     1.22143845  2.886576759 -1.69509027
## 161 -1.1105371356    1.11002298    -0.96250606  1.118028691 -1.73884025
## 162 -1.4709484785    1.11002298    -1.38182341  0.354533549  0.01115870
```

```
## 163 -1.4309027737    1.91353697     -1.10227851  0.225127593 -0.38259106
## 164 -1.3307885118    0.30650899     -1.13722163  0.095721637 -1.21384056
## 165 -1.3508113642    0.38686039     -0.97997762  1.950540342 -1.12634062
## 166 -1.5610513142    1.27072578     -0.77031895  0.673734908 -0.77634083
## 167 -1.1105371356    0.54756319     -0.22870071  2.425028848 -0.47009101
## 168 -1.3708342166    0.30650899     -1.08480696  2.243860510 -1.03884067
## 169 -1.1906285451    0.22615759     -0.08892826  1.553695410 -0.95134072
## 170 -1.0704914308   -0.73805920     -0.84020517  1.484678900 -1.25759054
## 171 -1.5410284618    0.30650899     -1.50412430  0.190619338 -1.30134051
## 172 -1.5210056094    0.94932018     -1.66136831  2.088572931 -1.69509027
## 173 -1.3307885118    0.62791458     -0.61307494  2.002302725 -1.47634041
## 174 -1.4208913475    1.27072578     -0.92756295  1.139596350 -1.38884046
## 175 -1.2807313808    0.54756319     -0.31605849  0.967055075 -1.12634062
## 176 -1.3407999380    0.54756319     -0.42088782  2.217979318 -1.60759033
## 177 -1.3508113642    1.35107717     -0.22870071  1.829761450 -1.56384035
## 178 -1.2707199546    1.59213137     -0.42088782  1.786626131 -1.52009038
##        Dilution      Proline
## 1    1.84272147  1.010159388
## 2    1.11031723  0.962526349
## 3    0.78636920  1.391223700
## 4    1.18074072  2.328006800
## 5    0.44833648 -0.037767469
## 6    0.33565890  2.232740722
## 7    1.36384178  1.724654973
## 8    1.36384178  1.740532653
## 9    0.33565890  0.946648670
## 10   1.32158768  0.946648670
## 11   0.78636920  2.423272878
## 12   0.29340481  1.692899614
## 13   0.40608239  1.819921051
## 14   0.16664254  1.280079943
## 15   0.54692935  2.540767708
## 16   0.37791299  1.788165692
## 17   0.05396496  1.692899614
## 18  -0.05871261  1.216569224
## 19   0.29340481  2.963113987
## 20   1.05397844  0.311541483
## 21   1.54694284  0.105131647
## 22   1.27933359  0.073376288
## 23   1.95539905  0.914893310
## 24   1.43426526  0.851382592
## 25   1.70187450  0.311541483
## 26   0.82862329  0.263908444
## 27   0.85679269  1.422979059
## 28   0.22298133  1.708777293
## 29   1.11031723  0.533828998
## 30   1.37792647  0.914893310
## 31   0.13847314  1.708777293
## 32   0.37791299  2.439150558
## 33   0.36382829  0.771994193
## 34   0.54692935  1.550000497
## 35   0.36382829  1.105425466
## 36   1.20891011  0.549706678
## 37   0.23706602  0.422685241
```

```
## 38  -0.14322079  1.137180826
## 39   0.11030375  0.867260271
## 40   1.29341829  0.041620929
## 41   1.08214784  0.152764686
## 42   0.54692935  0.914893310
## 43   1.33567238  1.105425466
## 44   0.54692935 -0.212421946
## 45   1.03989375  0.438562920
## 46   1.01172435  1.057792427
## 47   1.16665602  1.010159388
## 48   1.01172435  0.756116514
## 49   0.19481193  0.994281709
## 50   0.68777632  1.629388895
## 51   0.42016708  1.280079943
## 52   1.06806314  1.645266575
## 53   0.91313147  1.407101380
## 54   0.44833648  1.994575527
## 55   0.82862329  0.994281709
## 56   0.58918345  1.184813865
## 57   0.98355496  0.708483475
## 58   0.32157420  1.661144254
## 59   0.36382829  1.708777293
## 60  -1.11506488 -0.720507695
## 61  -1.32633534 -0.212421946
## 62  -1.43901291 -0.942795210
## 63  -0.21364428 -0.371198742
## 64   0.36382829 -1.038061288
## 65  -0.53759231 -1.244471124
## 66  -0.43899943 -0.218773018
## 67   0.80045390 -0.777667342
## 68   1.22299481 -0.752263054
## 69  -0.96013322  0.009865569
## 70   0.64552223 -0.091751580
## 71  -1.11506488  0.390929881
## 72   0.77228450 -1.069816648
## 73   0.23706602 -0.872933420
## 74   1.25116420  0.756116514
## 75   0.73003041  0.441738456
## 76  -0.66435458 -1.012657001
## 77  -0.18547489 -1.126976294
## 78  -0.12913610 -0.784018414
## 79  -0.42491473  0.009865569
## 80   0.73003041 -0.901513243
## 81   0.71594572 -1.488987391
## 82   0.74411511 -0.104453724
## 83   0.15255784 -0.371198742
## 84  -0.84745564 -0.736385375
## 85   0.65960693 -0.720507695
## 86   0.77228450 -0.942795210
## 87  -0.49533822 -0.799896093
## 88   0.84270799 -0.587135186
## 89   0.19481193 -0.212421946
## 90   0.84270799 -0.387076422
## 91  -0.48125352 -0.847529132
```

```
## 92   0.05396496 -0.942795210
## 93  -0.77703216 -0.799896093
## 94   0.96947026 -1.450880959
## 95   0.49059057 -1.276226483
## 96   0.02579557  0.603690789
## 97  -0.49533822 -0.387076422
## 98   0.18072723 -1.012657001
## 99   0.22298133 -0.275932664
## 100  0.30748951 -1.082518791
## 101  0.49059057 -0.117155868
## 102  0.22298133 -0.587135186
## 103  1.08214784 -0.980901641
## 104 -0.24181367 -1.053938968
## 105  1.34975708 -0.237826233
## 106  0.96947026 -1.371492561
## 107  0.78636920 -0.752263054
## 108 -0.26998307 -0.822124845
## 109  0.57509875 -1.381019169
## 110  0.91313147 -0.212421946
## 111  0.27932011 -0.587135186
## 112  0.23706602 -1.339737202
## 113 -0.15730549 -0.444236069
## 114 -0.42491473 -0.993603785
## 115  0.81453860 -1.149205046
## 116  0.36382829 -1.079343255
## 117  1.01172435 -0.799896093
## 118  0.49059057 -1.276226483
## 119 -0.69252397 -1.190487013
## 120  0.61735284 -0.580784114
## 121  1.09623253 -0.387076422
## 122  1.51877344 -0.895162171
## 123  0.71594572 -1.212715765
## 124  0.68777632 -1.165082726
## 125  1.44834996 -1.165082726
## 126  0.94130087 -1.171433797
## 127  0.32157420 -1.253997732
## 128 -0.24181367 -0.891986635
## 129  0.23706602 -1.285753091
## 130 -0.05871261 -0.529975539
## 131 -1.86155382 -0.371198742
## 132 -1.67845276 -0.688752336
## 133 -1.76296094 -0.593486258
## 134 -1.86155382 -0.466464820
## 135 -1.55169049 -0.307688024
## 136 -1.45309761 -0.164788907
## 137 -1.88972321 -0.085400508
## 138 -1.29816594 -0.736385375
## 139 -1.11506488 -0.529975539
## 140 -0.65026988 -0.498220180
## 141 -0.42491473 -0.466464820
## 142 -0.19955958  0.105131647
## 143 -0.77703216 -0.720507695
## 144 -0.79111685 -0.625241617
## 145 -0.86154034  0.343296842
```

```
## 146 -1.31225064  0.263908444
## 147 -1.80521503 -1.053938968
## 148 -1.05872609 -0.387076422
## 149 -1.39675882 -0.307688024
## 150 -1.80521503 -0.625241617
## 151 -1.84746912 -0.784018414
## 152 -1.60802927 -0.847529132
## 153 -1.80521503 -1.022183609
## 154 -1.55169049 -0.228299625
## 155 -1.49535170 -0.339443383
## 156 -1.59394458 -0.069522829
## 157 -1.36858943 -0.847529132
## 158 -1.24182715  0.422685241
## 159 -0.91787912 -0.275932664
## 160 -1.17140367 -0.402954102
## 161 -1.45309761 -0.720507695
## 162 -1.11506488 -0.212421946
## 163 -0.70660867 -0.561730898
## 164 -1.21365776 -0.228299625
## 165 -1.31225064 -0.418831781
## 166 -1.21365776 -0.720507695
## 167 -1.48126700 -0.164788907
## 168 -1.21365776 -0.196544266
## 169 -1.14323428  0.009865569
## 170 -0.97421791 -0.371198742
## 171 -1.10098018 -0.752263054
## 172 -1.38267412 -0.879284492
## 173 -1.26999655 -0.275932664
## 174 -1.22774246 -0.021889790
## 175 -1.48126700  0.009865569
## 176 -1.48126700  0.279786124
## 177 -1.39675882  0.295663803
## 178 -1.42492821 -0.593486258
```

(ii) [0.25pt] Divida la base de datos en 70% para entrenamiento y 30% para prueba (Utilice una semilla para que el resultado sea replicable).

```
set.seed(2020)
posTraining <- sample(1:nrow(data), 0.7*nrow(data))
posTraining
```

```
##   [1] 156  87  22  65  17 164 170 109 128  56  42  80  29  98 131  66  93 120
##  [19] 132 114  78  76 158   7  18  52  44 123  82 138  95  70 111  43  32 124
##  [37]  88 141 171 163 148 167  77 129   3 166  25  69 107  58 102 139 160  35
##  [55]  24  50  33 118 155   8  85 169  13 165 173  68  19  23 113 150 168   1
##  [73]  47  86  31  60  16 147 142  55  26  10  90  28 175 174  40  15 152 151
##  [91] 136   5  48  20 153  14 116 149  41 103  92  27  59 125   2 119  61 144
## [109] 110  39  46  99  53  36 143 105 137  79 133  81  54  74  71 162
```

```
data_training <- data[posTraining, ]
data_training
```

```
##     Type     Alcohol       Malic         Ash   Alcalinity   Magnesium
```

```
## 156    3  0.20864312  2.55441226 -0.16955666  0.750114792 -0.47201686
## 87     2 -1.03546501 -0.65018203 -0.20600725  0.989667037 -0.68206436
## 22     1 -0.08698653  1.31017034  1.03331269 -0.267982252  0.15812565
## 65     2 -1.02314711 -0.79340412  0.59590565 -0.148206130  0.29815732
## 17     1  1.60056608 -0.37268923  1.28846679  0.151234178  1.41841067
## 164    3 -0.05003283  0.99687202 -0.06020490 -0.297926283  0.43818899
## 170    3  0.49195487  2.02628080  1.79877500  1.648435713  0.85828399
## 109    2 -0.96155760 -0.93662621 -1.55467894 -0.148206130 -0.54203270
## 128    2 -1.49122740 -0.18471023  1.50717031  2.696476788 -0.54203270
## 56     1  0.68904131 -0.54276546  0.34075155  0.300954331  1.13834733
## 42     1  0.50427278  1.34597587 -0.89856839 -0.208094191 -0.68206436
## 80     2 -0.37029829  1.37283001  0.12204803  1.049555099  0.08810981
## 29     1  1.07089628 -0.39059199  1.58007149 -0.028430007  0.50820482
## 98     2 -0.87533228 -0.82920964 -1.40887660 -1.046527051 -1.03214354
## 131    3 -0.17321185 -0.88291793 -0.16955666 -0.447646437  1.55844234
## 66     2 -0.77678907 -1.00823725  0.70525741 -0.417702406 -0.12193769
## 93     2 -0.38261619 -0.72179307 -0.38826018  0.360842393 -1.38222271
## 120    2 -1.23255145  0.97896926 -1.33597542 -0.148206130 -0.89211187
## 132    3 -0.14857605  0.58510851  0.12204803  0.151234178  0.29815732
## 114    2 -1.95930769 -1.42895215  0.48655389  0.450674485 -0.82209603
## 78     2 -1.42963789  0.49559470 -0.49761194 -0.447646437  0.85828399
## 76     2 -1.65136013 -0.40849475 -1.62758012 -1.046527051 -0.19195352
## 158    3 -0.67824585  0.62091403  0.99686210  2.247316327 -0.19195352
## 7      1  1.71142720 -0.41744613  0.30430096 -1.465743481 -0.26196936
## 18     1  1.02162467 -0.68598755  0.92396093  0.151234178  1.06833150
## 52     1  1.02162467 -0.61437650  0.85105976 -0.687198682 -0.40200103
## 44     1  0.29486844  1.47129519 -0.27890842 -0.597366590  0.22814148
## 123    2 -0.71519955  1.87410733  1.32491738  2.097596174  0.15812565
## 82     2 -0.34566248 -0.47115441 -0.60696370 -0.208094191 -0.96212770
## 138    3 -0.57970263  2.84085644  0.99686210  1.648435713 -0.26196936
## 95     2 -1.70063174 -0.31002956 -0.31535901 -0.447646437 -0.12193769
## 70     2 -0.97387550 -1.02614002 -2.24724008 -0.806974805  3.58890153
## 111    2 -1.89771818  1.25646206 -1.99208598  0.001514024  0.50820482
## 43     1  1.08321419 -0.39954337  0.81460917 -1.345967358  0.08810981
## 32     1  0.71367712 -0.60542512 -0.02375431 -0.118262099  0.43818899
## 124    2  0.06082829  3.10044648 -0.86211780  0.600394638 -0.96212770
## 88     2 -1.66367803 -0.59647374  0.92396093  1.947876020 -0.82209603
## 141    3 -0.08698653  0.42398365  1.21556562  0.450674485 -0.26196936
## 171    3 -0.98619340  0.62091403 -0.16955666 -0.148206130 -0.26196936
## 163    3 -0.18552975  0.83574717  0.77815859  0.750114792  0.43818899
## 148    3 -0.16089395  2.03523218  0.41365272  0.600394638 -0.96212770
## 167    3  0.55354439  1.22065654  0.85105976  1.049555099  0.78826816
## 77     2  0.03619249 -1.28573006 -2.39304243 -1.046527051 -0.96212770
## 129    2 -0.77678907 -0.63227927 -0.24245783  1.498715559 -0.82209603
## 3      1  0.19632522  0.02117152  1.10621386 -0.267982252  0.08810981
## 166    3  0.89844565  1.81144766 -0.38826018  0.899834945 -0.82209603
## 25     1  0.61513390 -0.47115441  0.88751034  0.151234178 -0.26196936
## 69     2  0.41804746 -1.24992453 -0.02375431 -0.747086744  0.71825232
## 107    2 -0.92460389 -0.54276546 -0.89856839 -0.148206130 -1.38222271
## 58     1  0.35645795 -0.32793232  1.14266445 -0.806974805  0.15812565
## 102    2 -0.49347731 -0.89186931 -1.70048129 -0.297926283 -0.82209603
## 139    3  0.60281600  1.12219135 -0.64341428  0.001514024 -0.82209603
## 160    3  0.59049809 -0.59647374  0.99686210  0.899834945 -0.75208020
## 35     1  0.62745180 -0.48010579  1.03331269 -0.148206130  0.71825232
```

```
## 24     1 -0.18552975 -0.65913341  0.55945507 -0.507534498 -0.33198519
## 50     1  1.15712160 -0.54276546 -0.35180959 -0.627310621  0.57822065
## 33     1  0.83685614 -0.45325165 -0.02375431 -0.687198682  0.29815732
## 118    2 -0.71519955 -0.65018203 -0.64341428  0.899834945  0.57822065
## 155    3 -0.51811312 -0.93662621 -0.97146956  0.151234178  0.22814148
## 8      1  1.30493643 -0.16680747  0.88751034 -0.567422559  1.48842650
## 85     2 -1.42963789 -1.29468144  0.77815859 -0.447646437 -0.40200103
## 169    3  0.71367712  0.21810190  1.17911504  1.498715559  0.36817315
## 13     1  0.92308146 -0.54276546  0.15849862 -1.046527051 -0.75208020
## 165    3  0.96003516  0.37922675 -0.24245783  0.750114792 -0.68206436
## 173    3  1.42811545  0.15544223  0.41365272  0.151234178 -0.61204853
## 68     2 -0.77678907 -1.04404278 -1.62758012  0.031458055 -1.52225438
## 19     1  1.46506916 -0.66808479  0.41365272 -0.896806897  0.57822065
## 23     1  0.87380985 -0.42639751 -0.02375431 -0.866862867  0.08810981
## 113    2 -1.52818111  0.30761571  2.01747852  0.151234178  0.22814148
## 150    3  0.09778200  1.39968415 -0.02375431  0.600394638  0.92829983
## 168    3 -0.22248346  0.92526097 -0.24245783  0.001514024 -0.82209603
## 1      1  1.51434077 -0.56066822  0.23139979 -1.166303174  1.90852151
## 47     1  1.69910930  1.12219135 -0.31535901 -1.046527051  0.15812565
## 86     2 -0.40725200 -1.21411901 -0.46116135 -0.447646437 -0.05192185
## 31     1  0.89844565 -0.74864721  1.21556562  0.899834945  0.08810981
## 60     2 -0.77678907 -1.24992453 -3.66881295 -2.663504709 -0.82209603
## 16     1  0.77526663 -0.47115441  1.21556562 -0.687198682  0.85828399
## 147    3  1.08321419  2.42014155 -0.49761194  0.151234178 -1.38222271
## 142    3  0.44268327  0.20019914 -0.06020490  0.151234178 -0.75208020
## 55     1  0.91076355 -0.59647374 -0.42471076 -0.926750928  1.27837900
## 26     1  0.06082829 -0.25632128  3.11099611  1.648435713  1.69847400
## 10     1  1.05857838 -0.88291793 -0.35180959 -1.046527051 -0.12193769
## 90     2 -1.13400823 -0.90082069 -0.24245783  1.229219283 -2.08238105
## 28     1  0.36877585 -0.55171684 -0.82566722 -0.747086744 -0.40200103
## 175    3  0.49195487  1.40863553  0.41365272  1.049555099  0.15812565
## 174    3  0.87380985  2.96617577  0.30430096  0.300954331 -0.33198519
## 40     1  1.50202286  1.48024658  0.52300448 -1.884959911  1.97853734
## 15     1  1.69910930 -0.41744613  0.04914686 -2.244288279  0.15812565
## 152    3 -0.25943717  0.29866433  0.41365272  0.750114792  0.85828399
## 151    3  0.61513390  0.70147646  0.92396093  1.348995406  1.62845817
## 136    3 -0.49347731  0.11068533 -0.60696370 -0.297926283 -0.40200103
## 5      1  0.29486844  0.22705328  1.83522559  0.450674485  1.27837900
## 48     1  1.10784999 -0.58752236 -0.89856839 -1.046527051  0.08810981
## 20     1  0.78758453  0.68357369  0.70525741 -1.286079296  1.13834733
## 153    3  0.13473571 -0.39059199  1.39781855  1.798155867  1.13834733
## 14     1  2.15487169 -0.54276546  0.08559744 -2.423952463 -0.61204853
## 116    2 -2.42738798 -0.73969583 -0.60696370  0.600394638 -1.03214354
## 149    3  0.39341166  0.80889302  0.04914686  0.600394638 -0.54203270
## 41     1  0.68904131 -0.56066822 -0.20600725 -0.986638989  1.20836316
## 103    2 -0.81374277  0.10173395  0.34075155  0.450674485 -0.12193769
## 92     2 -1.23255145 -0.73969583  0.19494920  0.750114792 -0.96212770
## 27     1  0.47963697 -0.50695994  0.92396093 -1.016583020 -0.47201686
## 59     1  0.88612775 -0.81130688  0.48655389 -0.836918836  0.57822065
## 125    2 -1.39268418  1.76669076  0.08559744  0.450674485 -1.24219104
## 2      1  0.24559683 -0.49800856 -0.82566722 -2.483840525  0.01809398
## 119    2 -0.28407297  0.97896926 -1.40887660 -1.046527051 -1.38222271
## 61     2 -0.82606067 -1.10670244 -0.31535901 -1.046527051  0.08810981
## 144    3  0.76294873  2.33957912 -0.06020490  0.151234178 -0.54203270
```

```
## 110    2 -1.71294964 -0.88291793  1.21556562  0.151234178 -0.40200103
## 39     1  0.08546410 -0.74864721 -0.97146956 -1.196247204 -0.12193769
## 46     1  1.48970496  1.52500348  0.26785038 -0.178150160  0.78826816
## 99     2 -0.77678907 -1.13355658 -0.97146956 -0.297926283 -0.82209603
## 53     1  1.00930677 -0.52486270  0.19494920 -1.645407665  0.78826816
## 36     1  0.59049809 -0.47115441  0.15849862  0.300954331  0.01809398
## 143    3  0.63976970  0.74623336  1.28846679  1.199275252 -0.19195352
## 105    2 -0.60433843 -0.54276546 -1.40887660  0.300954331 -1.03214354
## 137    3 -0.92460389  2.13369737  0.63235624  0.450674485 -0.75208020
## 79     2 -0.82606067 -1.20516763 -1.51822836 -1.405855419  2.53866402
## 133    3 -0.23480136 -0.02358538  0.12204803  1.348995406 -0.12193769
## 81     2 -1.23255145 -1.26782729 -1.33597542 -0.148206130 -0.96212770
## 54     1  0.94771726 -0.39059199  1.14266445 -0.717142713  1.06833150
## 74     2 -0.01307912 -0.59647374  0.85105976  3.145637249  2.74871152
## 71     2 -0.87533228 -0.65018203 -0.57051311  0.271010300  0.22814148
## 162    3  0.84917404  0.82679579  0.63235624  0.151234178  0.50820482
##        Phenols    Flavanoids Nonflavanoids Proanthocyanins        Color
## 156 -0.8869720 -1.4008684951    1.99388837     -0.07145670  1.225866988
## 87  -0.8230590 -0.3396573189    0.54756319     -0.05398515 -1.125007884
## 22   0.1835703  0.3811653668   -0.89876200      0.67982021 -0.240733849
## 65  -0.6472984 -0.2795887618    0.70826598     -0.97997762 -0.909331290
## 17   0.8067217  1.1119994787   -0.25595080      0.66234866  0.492566569
## 164 -1.4462105 -1.3307885118    0.30650899     -1.13722163  0.095721637
## 170 -0.5034942 -1.0704914308   -0.73805920     -0.84020517  1.484678900
## 109  0.1036790  0.0107425978    0.22615759      0.85453577 -1.017169587
## 128 -0.2638205  0.2109711216    1.75283417      0.29544598 -0.887763630
## 56   1.0623736  0.7515881359   -1.30051899      1.50098335  0.514134228
## 42   0.2474832  0.6514738740   -0.73805920     -0.19375759 -0.335631551
## 80   0.8546565  0.5213253335    0.54756319      0.62740554 -1.073245501
## 29   1.0463954  0.9418052335    0.06545479      0.29544598 -0.240733849
## 98   0.4072657  0.4712682025   -0.57735640      0.31291753 -0.930898949
## 131 -1.2544716 -0.7801600713   -1.22016759     -1.13722163 -0.413275124
## 66   0.1995485  0.6214395954    0.06545479      0.85453577 -0.197598531
## 93  -1.4621887 -0.5699201213    1.75283417      0.05084419 -0.866195971
## 120 -0.4715377 -0.3897144499    0.06545479      0.48763309 -1.629691113
## 132 -1.5900147 -0.8101943499   -0.97911340     -1.32940874  0.147484019
## 114  0.2954180 -0.0192916808    0.46721179     -0.26364382 -0.853255375
## 78  -0.9189285 -0.7100800880    0.54756319     -1.11975007 -1.038737246
## 76  -1.0946892 -0.4597944332   -0.17559941     -0.77031895 -0.542681081
## 158 -0.6313201 -1.4509256261    2.15459116     -0.78779050  1.053325713
## 7    0.3273744  0.4912910549   -0.49700500      0.67982021  0.082781041
## 18   1.0463954  1.3722965597    0.30650899      0.22555975  0.665107844
## 52   0.2474832  0.9618280859   -1.13981619      1.22143845  0.233754657
## 44   0.5510698  0.6014167430   -0.33630220      0.12073042 -0.301123296
## 123 -0.1519728  0.1008454335    0.54756319      0.20808820 -1.284608563
## 82  -0.1519728  0.5013024811   -0.81841060      0.31291753 -0.499545762
## 138 -0.8070808 -1.4309027737    2.15459116     -0.85767673 -0.025057256
## 95   1.1582431  0.2309939740   -1.54157319     -0.42088782 -0.779925334
## 70  -0.7112113 -0.7501257927   -1.78262739      1.58834113 -0.952466609
## 111  1.4138950  0.5513596121   -0.97911340      3.47526919 -0.930898949
## 43   1.5257427  1.5324793788   -1.54157319      0.19061664  0.160424615
## 32   0.9025912  1.1620566097   -1.13981619      0.62740554  0.794513800
## 124  0.5191134  0.6214395954   -0.49700500      0.73223488 -1.060304905
## 88  -0.5993636 -0.4197487284    0.30650899     -0.43835938 -1.060304905
```

```
## 141 -1.2065369 -1.5310170356    1.35107717     -1.46918119 -0.197598531
## 171 -1.6699059 -1.5410284618    0.30650899     -1.50412430  0.190619338
## 163 -1.0307762 -1.4309027737    1.91353697     -1.10227851  0.225127593
## 148 -0.9508850 -1.3808456427    0.86896878     -1.27699407  1.118028691
## 167 -0.9508850 -1.1105371356    0.54756319     -0.22870071  2.425028848
## 77  -0.5514289  0.0007311716   -0.97911340     -0.22870071 -0.197598531
## 129 -0.1200164  0.4212110716    0.30650899      0.54004776 -1.267354435
## 3    0.8067217  1.2121137407   -0.49700500      2.12995937  0.268262912
## 166 -1.6219712 -1.5610513142    1.27072578     -0.77031895  0.673734908
## 25   0.3753092  0.5813938906   -0.65770780      0.12073042 -0.663459973
## 69   0.3753092 -0.7301029403    1.51177997     -2.04574255 -0.814433589
## 107 -1.0307762  0.0007311716    0.06545479      0.06831575 -0.715222356
## 58   1.1262866  1.2021023145   -0.41665360      0.12073042  0.406295932
## 102 -1.3503410 -0.6700343832   -0.57735640     -0.42088782 -1.125007884
## 139 -1.0787109 -1.5510398880    1.75283417     -1.24205096  0.276889975
## 160  0.4871569 -0.9303314642    1.27072578      1.22143845  2.886576759
## 35   0.0877008  0.5013024811   -0.57735640     -0.08892826 -0.370139806
## 24   0.2954180  0.3411196621   -0.81841060     -0.22870071 -0.486605166
## 50   0.9345477  1.5124565264   -0.33630220      0.85453577  1.657220175
## 33   0.1995485  0.6614853002    0.46721179      0.66234866 -0.525426953
## 118 -0.4715377  0.0607997287   -0.17559941      0.03337264 -1.293235627
## 155 -1.3024063 -1.4509256261    1.35107717     -0.33353004  1.096461031
## 8    0.4871569  0.4812796287   -0.41665360     -0.59560339 -0.003489596
## 85  -0.1519728  0.1809368430   -1.13981619      1.32626779 -0.866195971
## 169 -1.1905586 -1.1906285451    0.22615759     -0.08892826  1.553695410
## 13   0.4871569  0.7315652835   -0.57735640      0.38280376  0.233754657
## 165 -1.5101235 -1.3508113642    0.38686039     -0.97997762  1.950540342
## 173 -0.9828415 -1.3307885118    0.62791458     -0.61307494  2.002302725
## 68  -0.2957770 -0.0293031070   -0.73805920     -0.96250606 -0.163090276
## 19   1.6056339  1.9029021478   -0.33630220      0.47016154  1.570949537
## 23   0.5031351  0.8517023978   -0.73805920      0.17314508 -0.542681081
## 113 -0.8709938  0.0007311716    1.91353697     -0.94503451 -0.542681081
## 150 -1.4142540 -0.6400001046   -0.17559941     -0.78779050  1.872896769
## 168 -1.3024063 -1.3708342166    0.30650899     -1.08480696  2.243860510
## 1    0.8067217  1.0319080692   -0.65770780      1.22143845  0.251008784
## 47   1.5257427  1.1420337573   -0.73805920      1.04672289 -0.068192574
## 86  -0.1519728 -0.0893716641   -0.49700500     -0.22870071 -1.051677842
## 31   1.1262866  1.2221251668   -0.57735640      1.37868246  0.276889975
## 60  -0.5034942 -1.4609370523   -0.65770780     -2.04574255 -1.340684477
## 16   0.8866129  0.8817366764   -0.49700500     -0.22870071  0.967055075
## 147 -2.1013185 -1.6911998547    0.30650899     -1.59148209 -0.068192574
## 142 -1.4302323 -1.5310170356    0.06545479     -1.66136831  0.233754657
## 55   0.4871569  0.8717252502   -1.22016759      0.05084419  0.341592953
## 26   0.5350916  0.6514738740    0.86896878      0.57499088 -0.637578782
## 10   1.0943301  1.1220109049   -1.13981619      0.45268998  0.932546820
## 90  -0.1519728 -0.4397715808    0.46721179     -0.36847316 -1.431268647
## 28   0.1675920  0.1609139906   -0.73805920     -0.42088782 -0.477978102
## 175 -0.7911025 -1.2807313808    0.54756319     -0.31605849  0.967055075
## 174 -0.9828415 -1.4208913475    1.27072578     -0.92756295  1.139596350
## 40   1.1262866  1.0118852168   -1.30051899      0.85453577  0.018078063
## 15   1.6056339  1.6125707883   -0.57735640      2.39203271  1.053325713
## 152 -1.3024063 -0.6700343832   -0.97911340     -0.57813183  2.476791231
## 151 -1.4302323 -0.4597944332   -1.13981619     -0.59560339  1.527814219
## 136 -1.0787109 -1.3708342166    2.15459116     -1.13722163  0.880784438
```

```
## 5    0.8067217  0.6614853002    0.22615759      0.40027531 -0.318377423
## 48   1.2860690  1.3622851335   -1.22016759      0.95936511  0.449431250
## 20   0.6469393  1.0018737906   -1.54157319      0.12073042  0.018078063
## 153 -0.1519728 -0.7501257927   -0.81841060     -0.05398515  0.880784438
## 14   1.2860690  1.6626279192    0.54756319      2.12995937  0.147484019
## 116  0.2634615  0.1408911382    1.27072578      0.73223488 -1.362252137
## 149 -0.5833854 -1.2707199546    0.70826598     -0.59560339  1.450170645
## 41   1.3659602  1.2621708716   -0.17559941      1.30879623  0.462371846
## 103  0.4232439  0.0808225811   -0.17559941     -0.49077405 -0.974034268
## 92  -1.3503410 -0.7801600713    1.11002298      0.06831575 -0.628951718
## 27   0.8866129  0.9117709549   -0.17559941     -0.24617226 -0.111327893
## 59   1.7654163  1.6426050669   -1.38087039      0.78464955  0.751378481
## 125  0.9025912  1.0018737906   -1.22016759      2.30467493 -0.974034268
## 2    0.5670481  0.7315652835   -0.81841060     -0.54318872 -0.292496232
## 119 -1.0627327 -0.7801600713    0.54756319     -1.32940874 -0.715222356
## 61  -0.3916465 -0.9403428904    2.15459116     -2.06321410 -0.771298270
## 144 -0.4715377 -1.2306742499    0.86896878     -0.99744918 -0.283869168
## 110  0.7108523  0.8917481025   -0.57735640      1.57086958 -1.038737246
## 39   0.1675920  0.6114281692   -0.65770780     -0.38594471 -0.585816399
## 46   0.8866129  0.6214395954   -0.49700500     -0.59560339  0.078467509
## 99   1.9571552  1.7226964764   -0.97911340      0.62740554 -0.240733849
## 53   2.5323719  1.7126850502   -0.33630220      0.48763309  0.859216778
## 36   0.6469393  0.9518166597   -0.81841060      0.47016154  0.018078063
## 143 -1.1905586 -1.5109941832    1.11002298     -1.81861232 -0.305436828
## 105 -0.1519728 -0.1093945165   -0.33630220     -0.19375759 -0.913644822
## 137 -1.4621887 -1.5610513142    1.35107717     -1.38182341 -0.521113421
## 79  -0.6313201 -0.1794744999   -0.09524801      2.04260159 -0.715222356
## 133 -1.8296883 -0.9403428904   -0.73805920     -1.32940874  0.276889975
## 81   0.1995485  0.2309939740   -0.49700500     -0.28111538 -1.103440224
## 54   1.1262866  0.7615995621    0.22615759      0.15567353  0.535701888
## 74   1.6056339  0.8617138240   -1.22016759      0.64487710 -0.736790015
## 71  -1.9095795 -1.0104228737    0.06545479     -0.22870071 -0.866195971
## 162 -0.7431678 -1.4709484785    1.11002298     -1.38182341  0.354533549
##             Hue    Dilution      Proline
## 156 -1.56384035 -1.59394458 -0.069522829
## 87   1.62990773 -0.49533822 -0.799896093
## 22   0.31740852  1.27933359  0.073376288
## 65   2.15490741 -0.53759231 -1.244471124
## 17   0.49240841  0.05396496  1.692899614
## 164 -1.21384056 -1.21365776 -0.228299625
## 170 -1.25759054 -0.97421791 -0.371198742
## 109 -0.42634104  0.57509875 -1.381019169
## 128  0.05490867 -0.24181367 -0.891986635
## 56   0.09865865  0.58918345  1.184813865
## 42  -0.20759117  0.54692935  0.914893310
## 80   1.01740810  0.73003041 -0.901513243
## 29   1.27990794  1.11031723  0.533828998
## 98   1.19240799  0.18072723 -1.012657001
## 131 -0.86384077 -1.86155382 -0.371198742
## 66   1.01740810 -0.43899943 -0.218773018
## 93   0.01115870 -0.77703216 -0.799896093
## 120 -0.12009122  0.61735284 -0.580784114
## 132 -0.95134072 -1.67845276 -0.688752336
## 114  0.62365833 -0.42491473 -0.993603785
```

```
## 78   0.01115870 -0.12913610 -0.784018414
## 76   1.19240799 -0.66435458 -1.012657001
## 158 -1.25759054 -1.24182715  0.422685241
## 7    0.27365854  1.36384178  1.724654973
## 18   0.75490825 -0.05871261  1.216569224
## 52   1.23615797  1.06806314  1.645266575
## 44  -0.60134093  0.54692935 -0.212421946
## 123 -0.16384119  0.71594572 -1.212715765
## 82   0.88615818  0.74411511 -0.104453724
## 138 -0.60134093 -1.29816594 -0.736385375
## 95   0.88615818  0.49059057 -1.276226483
## 70   1.41115786  0.64552223 -0.091751580
## 111 -0.90759075  0.27932011 -0.587135186
## 43  -0.33884109  1.33567238  1.105425466
## 32   0.57990836  0.37791299  2.439150558
## 124 -0.99509069  0.68777632 -1.165082726
## 88   1.76115765  0.84270799 -0.587135186
## 141 -0.82009080 -0.42491473 -0.466464820
## 171 -1.30134051 -1.10098018 -0.752263054
## 163 -0.38259106 -0.70660867 -0.561730898
## 148 -1.82634020 -1.05872609 -0.387076422
## 167 -0.47009101 -1.48126700 -0.164788907
## 77   1.01740810 -0.18547489 -1.126976294
## 129 -0.29509111  0.23706602 -1.285753091
## 3    0.31740852  0.78636920  1.391223700
## 166 -0.77634083 -1.21365776 -0.720507695
## 25   0.71115828  1.70187450  0.311541483
## 69   0.27365854 -0.96013322  0.009865569
## 107  0.18615860  0.78636920 -0.752263054
## 58   0.49240841  0.32157420  1.661144254
## 102  0.36115849  0.22298133 -0.587135186
## 139 -0.64509090 -1.11506488 -0.529975539
## 160 -1.69509027 -1.17140367 -0.402954102
## 35   0.62365833  0.36382829  1.105425466
## 24   0.57990836  1.43426526  0.851382592
## 50   0.71115828  0.68777632  1.629388895
## 33   1.19240799  0.36382829  0.771994193
## 118  0.44865844  0.49059057 -1.276226483
## 155 -1.65134030 -1.49535170 -0.339443383
## 8    0.44865844  1.36384178  1.740532653
## 85  -0.73259085  0.65960693 -0.720507695
## 169 -0.95134072 -1.14323428  0.009865569
## 13   0.84240820  0.40608239  1.819921051
## 165 -1.12634062 -1.31225064 -0.418831781
## 173 -1.47634041 -1.26999655 -0.275932664
## 68   0.71115828  1.22299481 -0.752263054
## 19   1.19240799  0.29340481  2.963113987
## 23   0.66740831  1.95539905  0.914893310
## 113  1.19240799 -0.15730549 -0.444236069
## 150 -1.69509027 -1.80521503 -0.625241617
## 168 -1.03884067 -1.21365776 -0.196544266
## 1    0.36115849  1.84272147  1.010159388
## 47   0.36115849  1.16665602  1.010159388
## 86   1.19240799  0.77228450 -0.942795210
```

```
## 31   1.01740810  0.13847314  1.708777293
## 60   0.40490846 -1.11506488 -0.720507695
## 16   1.41115786  0.37791299  1.788165692
## 147 -1.65134030 -1.80521503 -1.053938968
## 142 -1.12634062 -0.19955958  0.105131647
## 55  -0.16384119  0.82862329  0.994281709
## 26   0.75490825  0.82862329  0.263908444
## 10   0.22990857  1.32158768  0.946648670
## 90   0.49240841  0.84270799 -0.387076422
## 28   0.27365854  0.22298133  1.708777293
## 175 -1.12634062 -1.48126700  0.009865569
## 174 -1.38884046 -1.22774246 -0.021889790
## 40  -0.29509111  1.29341829  0.041620929
## 15   1.06115807  0.54692935  2.540767708
## 152 -2.08884004 -1.60802927 -0.847529132
## 151 -1.60759033 -1.84746912 -0.784018414
## 136 -0.99509069 -1.45309761 -0.164788907
## 5    0.36115849  0.44833648 -0.037767469
## 48  -0.20759117  1.01172435  0.756116514
## 20   0.01115870  1.05397844  0.311541483
## 153 -1.52009038 -1.80521503 -1.022183609
## 14   1.27990794  0.16664254  1.280079943
## 116  3.29240673  0.36382829 -1.079343255
## 149 -1.78259022 -1.39675882 -0.307688024
## 41  -0.03259127  1.08214784  0.152764686
## 103 -0.68884088  1.08214784 -0.980901641
## 92   0.40490846  0.05396496 -0.942795210
## 27  -0.16384119  0.85679269  1.422979059
## 59  -0.29509111  0.36382829  1.708777293
## 125 -0.90759075  1.44834996 -1.165082726
## 2    0.40490846  1.11031723  0.962526349
## 119 -1.12634062 -0.69252397 -1.190487013
## 61   1.27990794 -1.32633534 -0.212421946
## 144 -0.20759117 -0.79111685 -0.625241617
## 110  0.01115870  0.91313147 -0.212421946
## 39   0.97365812  0.11030375  0.867260271
## 46  -0.38259106  1.01172435  1.057792427
## 99   0.36115849  0.22298133 -0.275932664
## 53   0.22990857  0.91313147  1.407101380
## 36   0.36115849  1.20891011  0.549706678
## 143 -0.29509111 -0.77703216 -0.720507695
## 105  0.36115849  1.34975708 -0.237826233
## 137 -0.90759075 -1.88972321 -0.085400508
## 79   0.44865844 -0.42491473  0.009865569
## 133 -1.30134051 -1.76296094 -0.593486258
## 81   1.84865760  0.71594572 -1.488987391
## 54   0.75490825  0.44833648  1.994575527
## 74   1.54240778  1.25116420  0.756116514
## 71  -0.22509116 -1.11506488  0.390929881
## 162  0.01115870 -1.11506488 -0.212421946
```

```
data_test <- data[-posTraining, ]
data_test
```

```
##     Type     Alcohol       Malic         Ash   Alcalinity   Magnesium
## 4      1  1.68679140 -0.34583508  0.48655389 -0.806974805  0.92829983
## 6      1  1.47738706 -0.51591132  0.30430096 -1.286079296  0.85828399
## 9      1  2.25341491 -0.62332789 -0.71631546 -1.645407665 -0.19195352
## 11     1  1.35420804 -0.15785609 -0.24245783 -0.447646437  0.36817315
## 12     1  1.37884384 -0.76654998 -0.16955666 -0.806974805 -0.33198519
## 21     1  1.30493643 -0.63227927 -0.31535901 -1.046527051  1.83850567
## 30     1  1.25566482 -0.58752236 -0.57051311 -1.046527051 -0.26196936
## 34     1  0.93539936 -0.72179307  1.21556562  0.001514024  2.25860068
## 37     1  0.34414005 -0.62332789  1.72587383 -1.196247204  0.71825232
## 38     1  0.06082829 -0.61437650  0.66880683 -0.447646437 -0.12193769
## 45     1  0.06082829 -0.50695994 -0.97146956 -0.747086744  0.50820482
## 49     1  1.35420804 -0.28317542  0.12204803 -0.208094191  0.22814148
## 51     1  0.06082829 -0.54276546 -1.19017308 -2.124512156 -0.54203270
## 57     1  1.50202286 -0.56961960 -0.24245783 -0.956694959  1.27837900
## 62     2 -0.44420570 -0.87396654 -1.26307425 -0.806974805  0.01809398
## 63     2  0.82453824 -0.97243173 -1.62758012 -0.447646437 -0.40200103
## 64     2 -0.77678907 -1.07984830 -0.75276604 -0.148206130 -0.89211187
## 67     2  0.13473571 -1.18726487 -2.42949302 -1.345967358 -1.52225438
## 72     2  1.05857838 -0.73969583  1.10621386  1.648435713 -0.96212770
## 73     2  0.60281600 -0.60542512 -0.46116135  1.348995406 -0.89211187
## 75     2 -1.28182306 -1.11565382 -0.24245783  0.450674485  0.08810981
## 83     2 -1.13400823 -1.07984830  0.52300448  1.348995406 -1.52225438
## 84     2  0.06082829  1.36387863 -0.16955666  0.899834945 -1.03214354
## 89     2 -1.67599593 -0.24736990  0.34075155  0.630338669 -1.10215937
## 91     2 -1.13400823 -0.45325165 -0.16955666 -0.297926283 -1.31220687
## 94     2 -0.87533228  0.44188642 -0.53406252 -0.447646437 -0.82209603
## 96     2 -0.65361004 -0.73074445 -0.60696370 -0.148206130  4.35907571
## 97     2 -1.46659160 -0.19366161  1.36136797  0.600394638  2.39863235
## 100    2 -0.87533228  0.74623336 -0.57051311 -0.447646437 -0.82209603
## 101    2 -1.13400823 -0.22946714 -2.42949302 -0.597366590 -0.19195352
## 104    2 -1.45427369 -0.55171684 -1.77338246  0.001514024 -0.96212770
## 106    2 -0.71519955  0.19124776 -0.35180959  0.750114792 -0.68206436
## 108    2 -0.34566248 -0.52486270 -0.31535901  0.899834945 -1.10215937
## 112    2 -0.59202053  0.08383119 -0.71631546  0.450674485 -0.82209603
## 115    2 -1.13400823 -0.84711240  0.48655389  0.899834945 -1.10215937
## 117    2 -1.45427369 -0.77550136 -1.37242601  0.390786423 -0.96212770
## 121    2 -1.91003608  0.05697705  0.19494920  0.151234178 -0.26196936
## 122    2 -1.77453915 -0.25632128  3.14744670  2.696476788  1.34839483
## 126    2 -1.14632613 -0.15785609 -0.71631546  0.450674485 -1.03214354
## 127    2 -0.70288165 -0.72179307 -0.27890842  0.600394638 -0.96212770
## 130    2 -1.18327984  1.75773938  0.04914686  0.750114792 -1.38222271
## 134    3 -0.37029829  1.08638583 -0.02375431  0.600394638  0.43818899
## 135    3 -0.60433843 -0.98138311 -0.42471076 -0.597366590 -1.03214354
## 140    3 -0.19784766  0.55825437  0.88751034  1.348995406  0.08810981
## 145    3 -0.92460389  1.38178139 -0.60696370 -0.297926283  0.85828399
## 146    3  0.19632522  1.10428859 -0.78921663  0.450674485  0.15812565
## 154    3  0.28255053  0.86260131 -0.31535901 -0.297926283 -0.12193769
## 157    3  1.03394258  1.59661452  0.04914686  0.001514024 -0.75208020
## 159    3  1.64983769 -0.58752236  1.21556562  1.648435713 -0.12193769
## 161    3 -0.78910697  1.33702448  0.04914686  0.450674485 -0.82209603
## 172    3 -0.28407297  0.04802567 -0.31535901  0.001514024 -0.96212770
## 176    3  0.33182214  1.73983662 -0.38826018  0.151234178  1.41841067
## 177    3  0.20864312  0.22705328  0.01269627  0.151234178  1.41841067
```

```
## 178    3  1.39116174  1.57871176  1.36136797  1.498715559 -0.26196936
##          Phenols Flavanoids Nonflavanoids Proanthocyanins        Color
## 4    2.484437221  1.4623994   -0.97911340      1.02925134  1.182731669
## 6    1.557699140  1.3622851   -0.17559941      0.66234866  0.729810822
## 9    0.806721729  0.9518167   -0.57735640      0.67982021  0.061213382
## 11   1.046395371  1.2922052   -1.13981619      1.37868246  0.298457635
## 12  -0.151972837  0.4011882   -0.81841060     -0.03651359 -0.025057256
## 21   1.126286585  1.1420338   -0.97911340      0.88947889  0.255322316
## 30   0.567048088  0.3010740   -0.81841060      0.67982021 -0.154463212
## 34   1.046395371  0.7115424    1.11002298     -0.42088782  0.147484019
## 37   0.487156874  0.6514739   -0.17559941     -0.40341627 -0.197598531
## 38   0.247483232  0.4011882   -0.57735640     -0.26364382 -0.348572146
## 45   1.126286585  0.9718395   -0.65770780      0.76717799 -0.007803128
## 49   0.726830515  0.8917481   -0.33630220      1.37868246  0.492566569
## 51   0.678895787  1.2421480   -1.54157319      2.30467493  0.923919756
## 57   1.445851440  0.9718395   -0.81841060      0.76717799  0.570210143
## 62  -0.439581207 -0.6199773    1.35107717     -1.69631142  0.298457635
## 63  -0.311755265 -0.2395431   -0.33630220     -1.50412430 -0.542681081
## 64   1.925198724  1.0719538   -1.38087039      0.48763309 -0.262301509
## 67   1.094330099  1.1520452   -0.81841060      1.20396690  0.104348700
## 72   1.046395371  0.8316795   -1.22016759      0.48763309 -0.723849419
## 73  -0.663276606 -0.1894859   -0.73805920     -0.97997762 -0.568562272
## 75   1.733459810  0.1108569   -1.86297878      0.10325886 -0.797179461
## 83  -0.471537693 -0.4497830    0.30650899     -0.33353004 -1.232846180
## 84  -1.030776190 -0.4397716    1.99388837      0.05084419 -0.111327893
## 89  -0.551428907 -0.3396573    0.94932018     -0.42088782 -0.974034268
## 91  -1.110667404 -0.5298744    1.27072578      0.08578730 -1.146575543
## 94   0.247483232  0.2209825   -0.89876200      0.69729177 -1.254413840
## 96   0.327374446  0.2410054   -0.33630220      2.95112251 -1.060304905
## 97  -1.110667404 -1.0404572   -1.78262739     -0.05398515 -1.103440224
## 100  0.886612943  0.9618281    0.70826598      2.12995937 -1.189710862
## 101 -0.104038109  0.1408911   -0.81841060     -0.33353004 -0.758357674
## 104  0.327374446 -0.3897144    0.06545479     -0.29858693 -1.293235627
## 106 -0.982841462 -0.1894859    2.39564536     -0.29858693 -1.017169587
## 108 -1.462188745 -0.2695773    0.94932018      0.06831575 -0.758357674
## 112  0.407265660  0.2410054   -0.81841060     -0.64801805 -1.319116818
## 115  0.423243903  0.2610283    0.54756319     -0.96250606 -0.930898949
## 117 -0.503494178 -0.4297602   -0.49700500     -0.10639981 -1.340684477
## 121  0.966504157  0.7615996   -0.33630220      0.41774687 -0.779925334
## 122  1.413894955  3.0542162    0.86896878      0.48763309  0.406295932
## 126  0.487156874  0.6214396    0.06545479     -0.42088782 -0.991288395
## 127  0.710852273  1.1220109    0.22615759      0.31291753 -0.482291634
## 130 -0.311755265 -0.2795888    0.46721179     -0.42088782 -1.060304905
## 134 -0.950884976 -0.8302172   -1.54157319     -1.31193719 -0.025057256
## 135 -0.471537693 -1.4509256    1.91353697     -0.59560339  0.169051679
## 140  0.039766076 -1.4309028    1.35107717     -1.36435186 -0.059565511
## 145 -1.462188745 -1.2506971   -0.57735640     -0.78779050  1.359586476
## 146 -1.270449832 -1.4809599    0.54756319     -0.50824560 -0.456410443
## 154 -0.791102548 -1.2006400    1.99388837      0.48763309  2.356012338
## 157 -0.791102548 -1.2006400    0.94932018     -0.05398515  1.704669026
## 159  0.806721729 -0.7200915    1.35107717      1.93777225  3.425768243
## 161  0.007809591 -1.1105371    1.11002298     -0.96250606  1.118028691
## 172 -1.446210502 -1.5210056    0.94932018     -1.66136831  2.088572931
## 176 -1.126645647 -1.3407999    0.54756319     -0.42088782  2.217979318
```

```
## 177 -1.030776190 -1.3508114    1.35107717     -0.22870071  1.829761450
## 178 -0.391646479 -1.2707200    1.59213137     -0.42088782  1.786626131
##             Hue    Dilution    Proline
## 4   -0.42634104  1.18074072  2.3280068
## 6    0.40490846  0.33565890  2.2327407
## 9    0.53615839  0.33565890  0.9466487
## 11   1.27990794  0.78636920  2.4232729
## 12   0.92990815  0.29340481  1.6928996
## 21   0.57990836  1.54694284  0.1051316
## 30   0.36115849  1.37792647  0.9148933
## 34   1.27990794  0.54692935  1.5500005
## 37   0.57990836  0.23706602  0.4226852
## 38   0.71115828 -0.14322079  1.1371808
## 45  -0.33884109  1.03989375  0.4385629
## 49   0.49240841  0.19481193  0.9942817
## 51   0.71115828  0.42016708  1.2800799
## 57  -0.07634125  0.98355496  0.7084835
## 62   0.09865865 -1.43901291 -0.9427952
## 63   1.19240799 -0.21364428 -0.3711987
## 64   1.14865802  0.36382829 -1.0380613
## 67   0.71115828  0.80045390 -0.7776673
## 72   1.76115765  0.77228450 -1.0698166
## 73   0.09865865  0.23706602 -0.8729334
## 75   0.14240862  0.73003041  0.4417385
## 83   1.54240778  0.15255784 -0.3711987
## 84  -0.51384098 -0.84745564 -0.7363854
## 89   0.18615860  0.19481193 -0.2124219
## 91   0.53615839 -0.48125352 -0.8475291
## 94   0.84240820  0.96947026 -1.4508810
## 96   0.88615818  0.02579557  0.6036908
## 97  -0.03259127 -0.49533822 -0.3870764
## 100  2.02365749  0.30748951 -1.0825188
## 101  1.36740789  0.49059057 -0.1171559
## 104 -0.07634125 -0.24181367 -1.0539390
## 106 -0.42634104  0.96947026 -1.3714926
## 108 -0.33884109 -0.26998307 -0.8221248
## 112 -0.25134114  0.23706602 -1.3397372
## 115 -0.12009122  0.81453860 -1.1492050
## 117 -0.03259127  1.01172435 -0.7998961
## 121 -0.68884088  1.09623253 -0.3870764
## 122 -0.12009122  1.51877344 -0.8951622
## 126 -0.42634104  0.94130087 -1.1714338
## 127 -1.17009059  0.32157420 -1.2539977
## 130 -0.73259085 -0.05871261 -0.5299755
## 134 -0.77634083 -1.86155382 -0.4664648
## 135 -0.90759075 -1.55169049 -0.3076880
## 140 -0.29509111 -0.65026988 -0.4982202
## 145 -1.34509048 -0.86154034  0.3432968
## 146 -1.56384035 -1.31225064  0.2639084
## 154 -1.73884025 -1.55169049 -0.2282996
## 157 -1.69509027 -1.36858943 -0.8475291
## 159 -1.69509027 -0.91787912 -0.2759327
## 161 -1.73884025 -1.45309761 -0.7205077
## 172 -1.69509027 -1.38267412 -0.8792845
```

```
## 176 -1.60759033 -1.48126700  0.2797861
## 177 -1.56384035 -1.39675882  0.2956638
## 178 -1.52009038 -1.42492821 -0.5934863
```

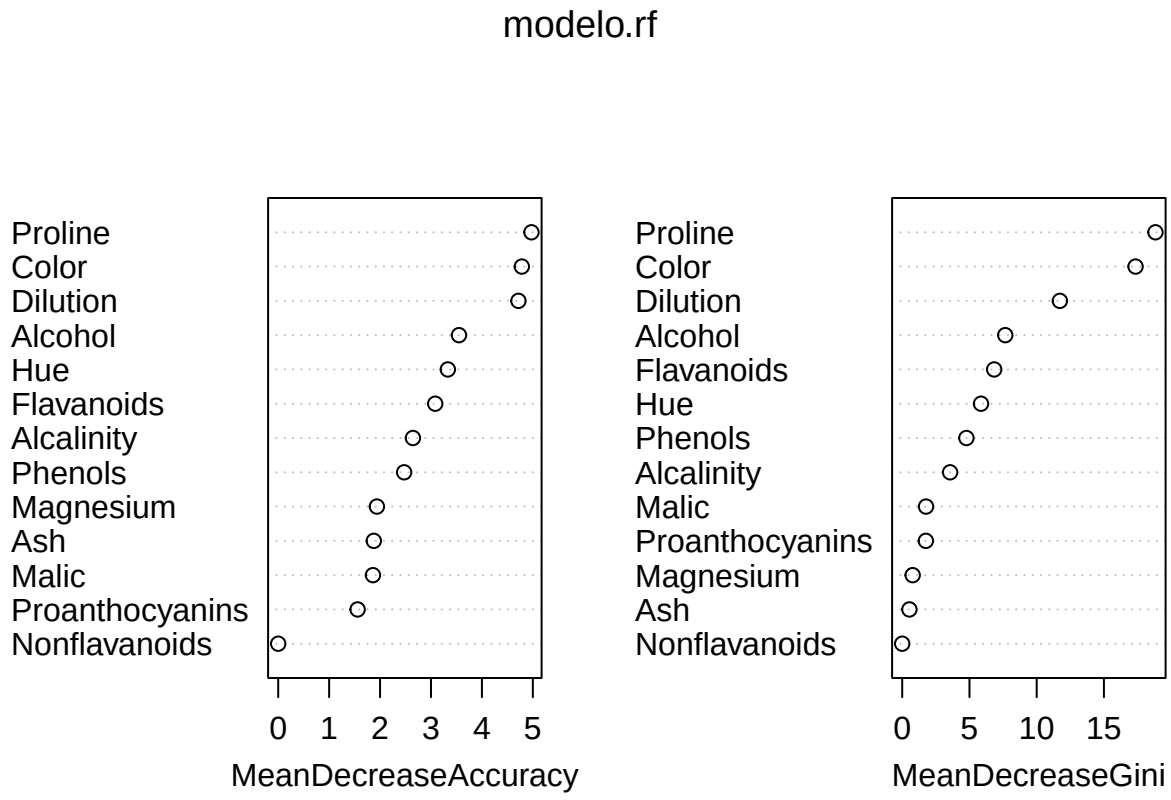
```
nrow(data_training) + nrow(data_test) # Corroboramos 178 filas
```

```
## [1] 178
```

(iii) [0.25pt] Implemente los algoritmos de Random Forest (20 árboles y 4 variables) y Support Vector Machine (kernel radial) utilizando todas las variables.

```
#set.seed(2020)
# randomForest
modelo.rf <- randomForest(Type ~ ., data=data_training,
                          ntree=20, mtry=4, replace=TRUE, importance=T)

varImpPlot(modelo.rf)
```




```
# set.seed(2020)
# SVM
modelo.svm <- svm(Type ~ ., data=data_training, kernel="radial")
modelo.svm
```

```
##
```

```
## Call:
## svm(formula = Type ~ ., data = data_training, kernel = "radial")
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##
## Number of Support Vectors:  58
```

(iv) [0.25pt] ¿Cuál es el porcentaje de clasificaciones correctas para cada algoritmo utilizando la base de entrenamiento?

RANDOM FOREST Predicciones

```
# Valores predictivos
predval.rf1 <- predict(modelo.rf, data_training)
# Matriz de confusión
table(data_training$Type, predval.rf1)
```

```
##    predval.rf1
##      1  2  3
##   1 45  0  0
##   2  0 44  0
##   3  0  0 35
```

```
# % de clasificación correcta
mean(data_training$Type == predval.rf1)
```

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

```
# --> El % de predicción respecto a la data de entrenamiento con modelo Random Forest es de 100%
```

SVM Predicciones

```
predval.svm <- predict(modelo.svm, data_training)
# Matriz de confusión
table(data_training$Type, predval.svm)
```

```
##    predval.svm
##      1  2  3
##   1 45  0  0
##   2  0 44  0
##   3  0  0 35
```

```r
# % de clasificación correcta
mean(data_training$Type == predval.svm)
```

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

```r
# --> El % de predicción respecto a la data de prueba con modelo Support Vector Machine es de
# 100% (es claramente un sobreajuste puesto que estamos usando la misma base de datos de entrenamiento)
```

(v) [0.25pt] Aplique una validación cruzada para ambos algoritmos usando 30 folds (number) y 70% para la submuestra de entrenamiento (p). Basado en la validación cruzada, elija uno de los métodos como el más apropiado.

CV con Random Forest

```r
set.seed(2020)

#
( cv_rf <- train(Type ~., data=data_training, method="rf",
                 trControl=trainControl(method="cv", number=30, p=0.7),
                 tuneGrid=expand.grid(.mtry=3)) )
```

```
## Random Forest
##
## 124 samples
##  13 predictor
##   3 classes: '1', '2', '3'
##
## No pre-processing
## Resampling: Cross-Validated (30 fold)
## Summary of sample sizes: 121, 120, 118, 121, 120, 119, ...
## Resampling results:
##
##   Accuracy   Kappa
##   0.9916667  0.9851852
##
## Tuning parameter 'mtry' was held constant at a value of 3
```

```r
# La validacion cruzada da un accuracy de 0.993 para Random Forest
```

CV con SVM

```r
set.seed(2020)
( cv.svm <- train(Type ~., data=data_training, method="svmRadial",
                  trControl=trainControl(method="cv", number=30, p=0.7)) )
```

```
## Support Vector Machines with Radial Basis Function Kernel
##
## 124 samples
##  13 predictor
##   3 classes: '1', '2', '3'
##
## No pre-processing
## Resampling: Cross-Validated (30 fold)
## Summary of sample sizes: 121, 120, 118, 121, 120, 119, ...
## Resampling results across tuning parameters:
##
##   C     Accuracy   Kappa
##   0.25  0.9833333  0.9703704
##   0.50  0.9916667  0.9851852
##   1.00  0.9805556  0.9685185
##
## Tuning parameter 'sigma' was held constant at a value of 0.08024913
## Accuracy was used to select the optimal model using the largest value.
## The final values used for the model were sigma = 0.08024913 and C = 0.5.
```

```
# Con sigma = 0.0830777 and C = 1, me da un accuracy de 0.991
```

Se elige algoritmo Random Forest, ya que entrega un accuracy superior al SVM.

(vi) [0.25pt] Aplique ambos modelos ajustados a la base de prueba y concluya si el modelo elegido en el ítem anterior predice mejor.

Predicciones con BD de prueba para RANDOM FOREST

```
# Valores predictivos
predval.rf2 <- predict(modelo.rf, data_test)
# Matriz de confusión
table(data_test$Type, predval.rf2)
```

```
##    predval.rf2
##      1  2  3
##   1 14  0  0
##   2  0 25  2
##   3  0  0 13
```

```
# % de clasificación correcta
mean(data_test$Type == predval.rf2)
```

```
## [1] 0.962963
```

```
# El % de predicción respecto a la data de prueba con modelo Random Forest es de 96%

# entrega el algoritmo de SVM.
```

Predicciones con BD de prueba para SVM

```
# Ajustamos el modelo con parametros de Validacion Cruzada.
modelo.svm.ajustado <- svm(Type ~ ., data=data_training, kernel="radial",C=1, sigma=0.0830777 )


# SVM Predicciones
predval.svm2 <- predict(modelo.svm.ajustado, data_test)
# Matriz de confusión
table(data_test$Type, predval.svm2)
```

```
##    predval.svm2
##      1  2  3
##   1 14  0  0
##   2  0 26  1
##   3  0  0 13
```

```
# % de clasificación correcta
mean(data_test$Type == predval.svm2)
```

```
## [1] 0.9814815
```

```
# El % de predicción respecto a la data de prueba con modelo Support Vector Machine es de 98%
```

En la pregunta 5, basándonos en accuracy, el Random Forest fue mejor predictor. Pero en la práctica haciendo predicciones con base de datos de test, la mejor matriz de confusion la entrega el algoritmo de SVM.

PREGUNTA 5

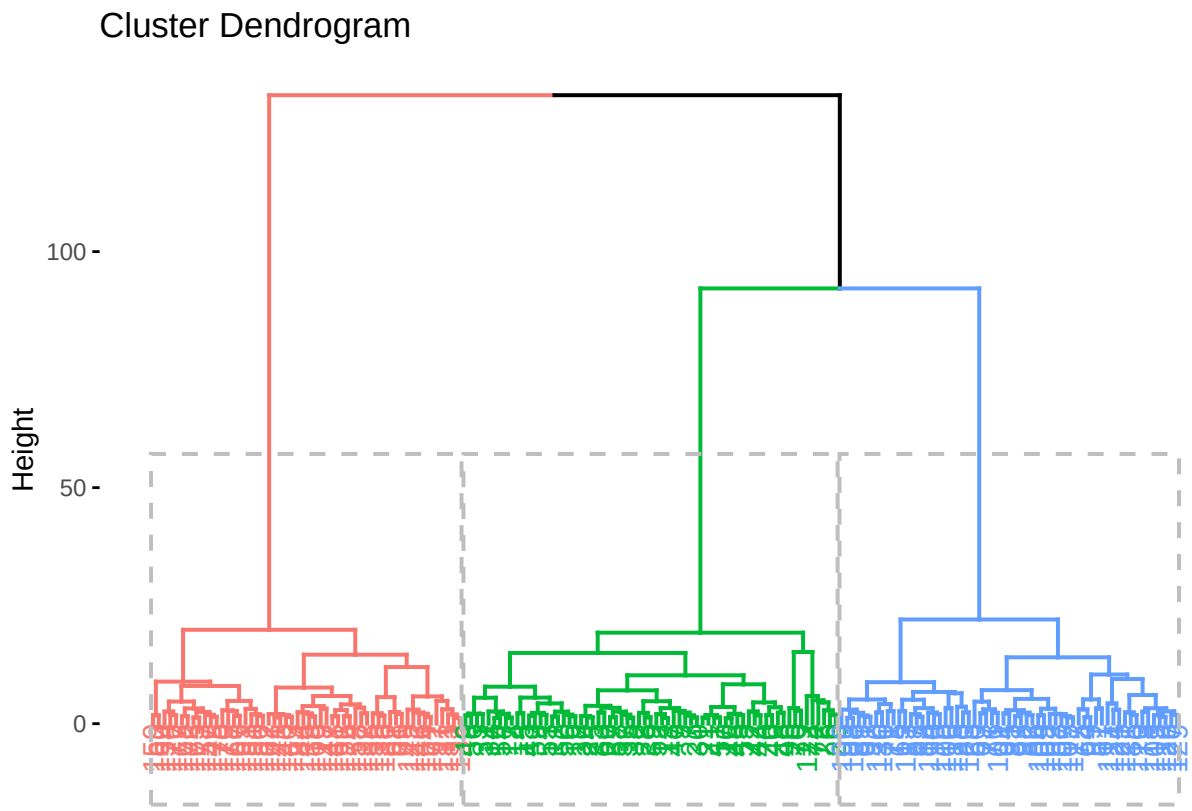
(i) [0.25pt] Aplique el Clustering Jerárquico con k=3 y linkage "ward.D". Visualice el resultado final con un gráfico dendrograma.

```
data_5 <-  data[,-1]

# Matriz de distancias euclídeas
d <- dist(data_5, method="euclidean")

# Dendrograma estándar
fviz_dend(hcut(data_5, k=3, hc_method="ward.D"), rect=TRUE)
```

```
## Warning: The `<scale>` argument of `guides()` cannot be `FALSE`. Use "none" instead as
## of ggplot2 3.3.4.
## i The deprecated feature was likely used in the factoextra package.
##   Please report the issue at <https://github.com/kassambara/factoextra/issues>.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```



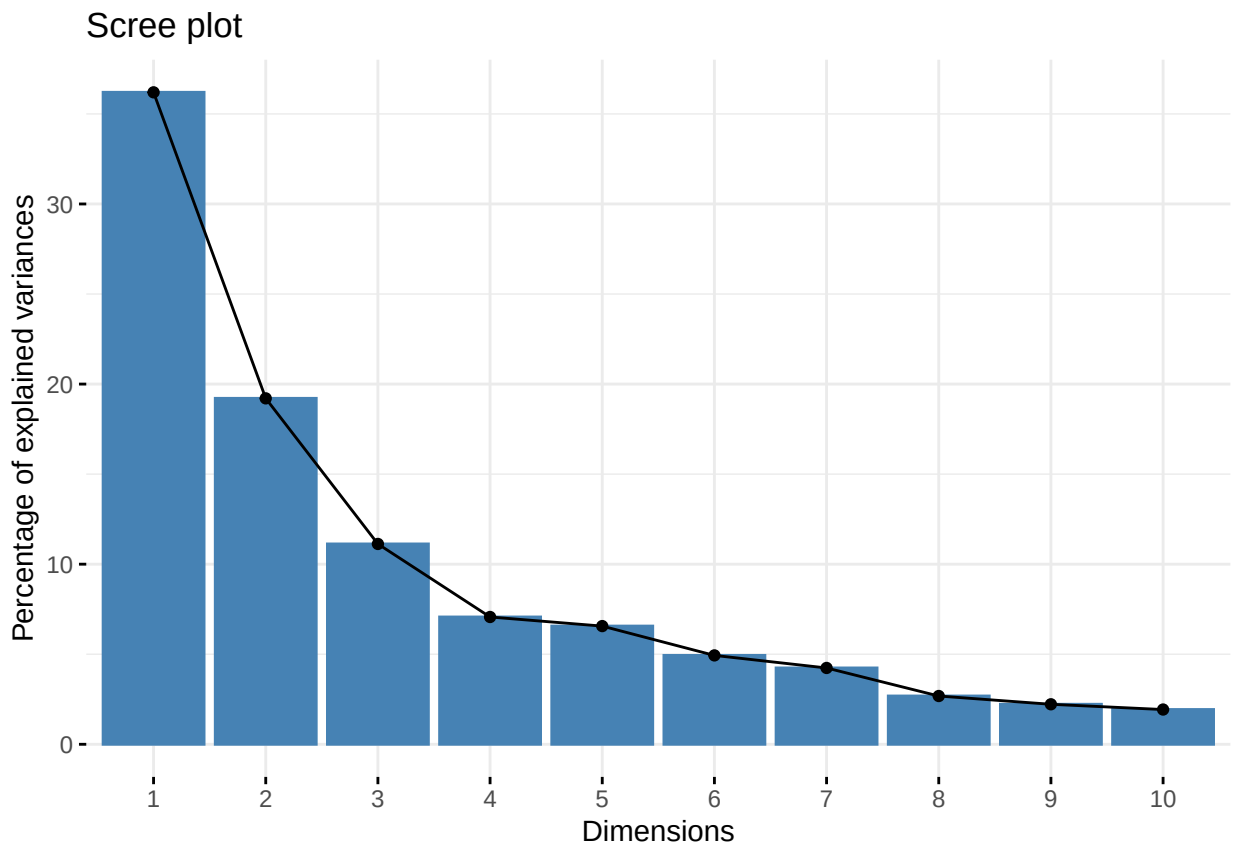

```
model_hcut <- hcut(data_5, k = 3, hc_method = "ward.D")
```

(ii) [0.25pt] Haga un PCA con 2 componentes principales y guarde los scores de ambos componentes como nuevas variables.

```
# PCA
model_pca <- prcomp(data_5)
model_pca$rotation[,1]
```

```
##         Alcohol           Malic             Ash      Alcalinity       Magnesium
##    -0.144329395     0.245187580     0.002051061     0.239320405    -0.141992042
##         Phenols      Flavanoids   Nonflavanoids Proanthocyanins           Color
##    -0.394660845    -0.422934297     0.298533103    -0.313429488     0.088616705
##             Hue        Dilution         Proline
##    -0.296714564    -0.376167411    -0.286752227
```

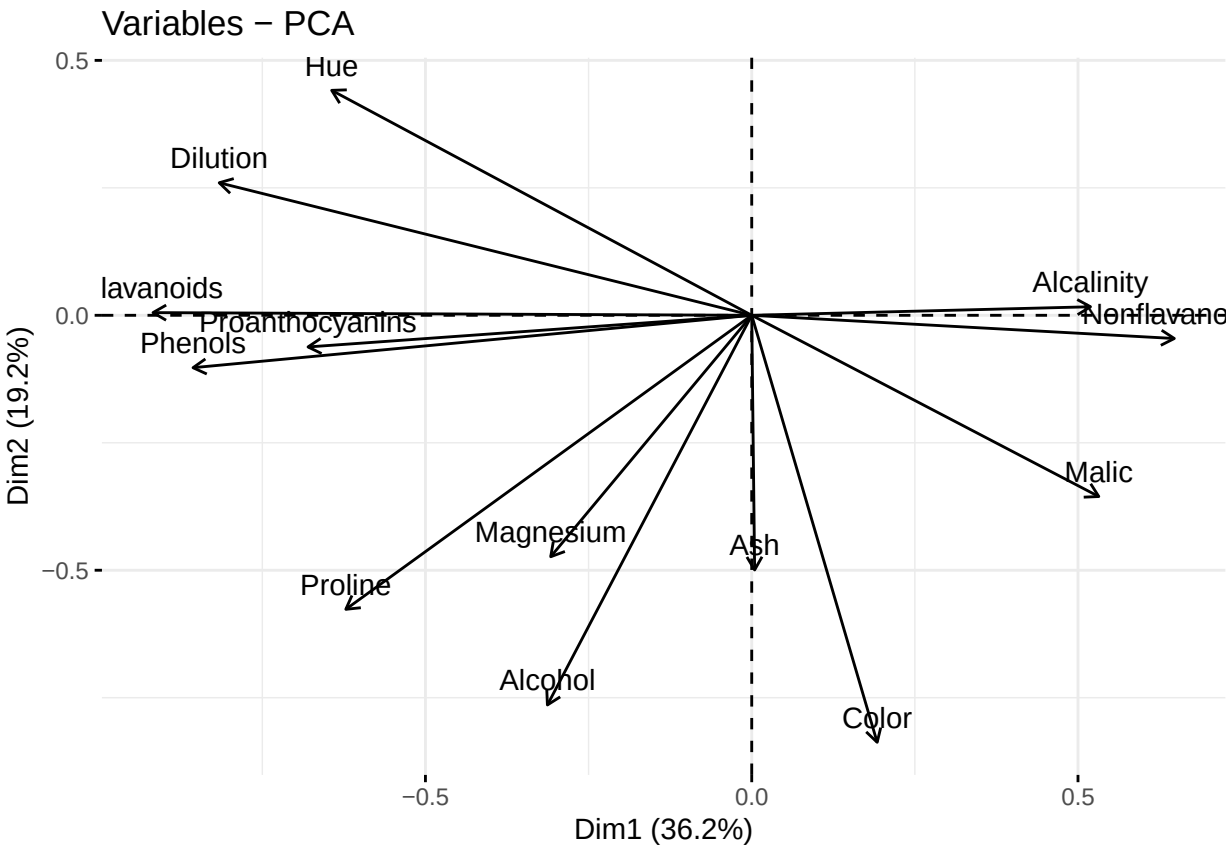
```
## Seleccion de componentes
# Escojo 2 componentes principales
fviz_eig(model_pca)
```



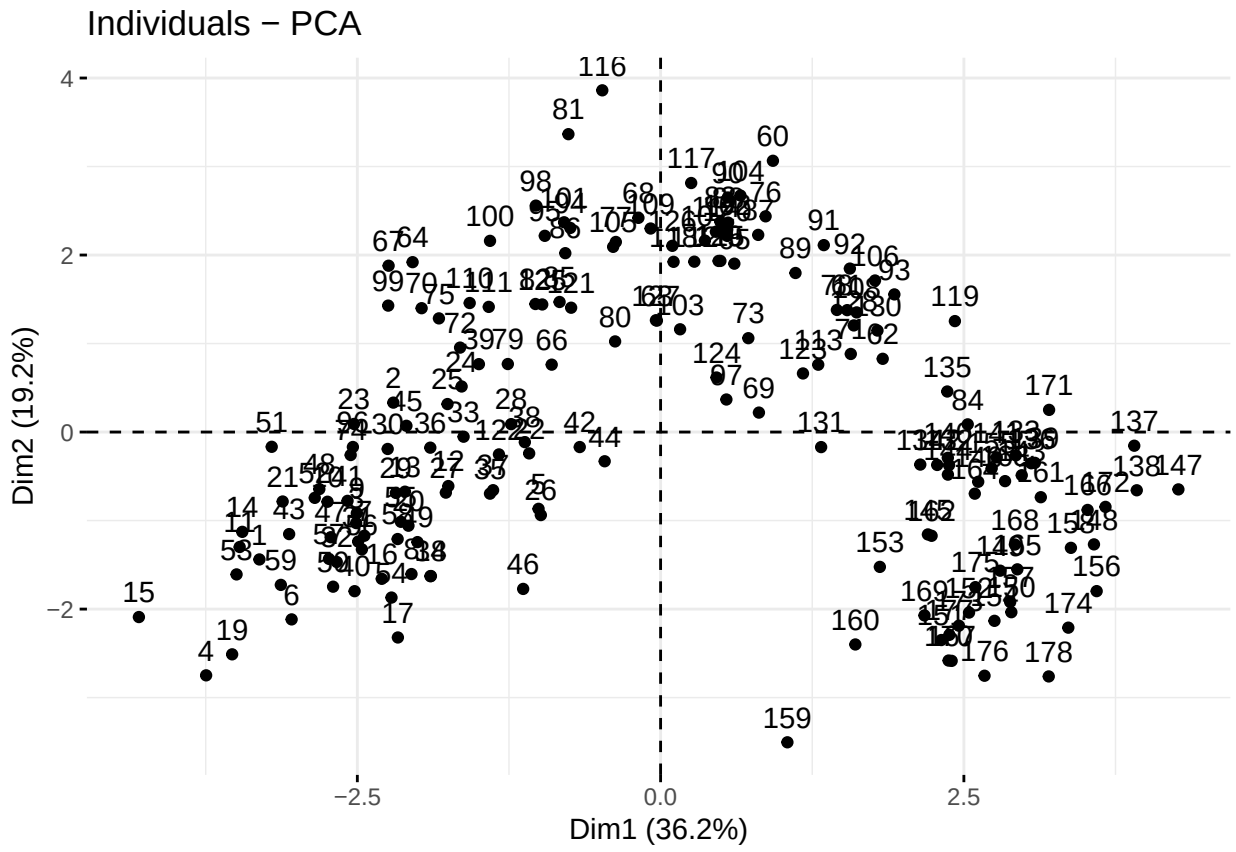

```
summary(model_pca)
```

```
## Importance of components:
##                           PC1    PC2    PC3     PC4     PC5     PC6     PC7
## Standard deviation     2.169 1.5802 1.2025 0.95863 0.92370 0.80103 0.74231
## Proportion of Variance 0.362 0.1921 0.1112 0.07069 0.06563 0.04936 0.04239
## Cumulative Proportion  0.362 0.5541 0.6653 0.73599 0.80162 0.85098 0.89337
##                           PC8     PC9    PC10    PC11    PC12    PC13
## Standard deviation     0.59034 0.53748 0.5009 0.47517 0.41082 0.32152
## Proportion of Variance 0.02681 0.02222 0.0193 0.01737 0.01298 0.00795
## Cumulative Proportion  0.92018 0.94240 0.9617 0.97907 0.99205 1.00000
```

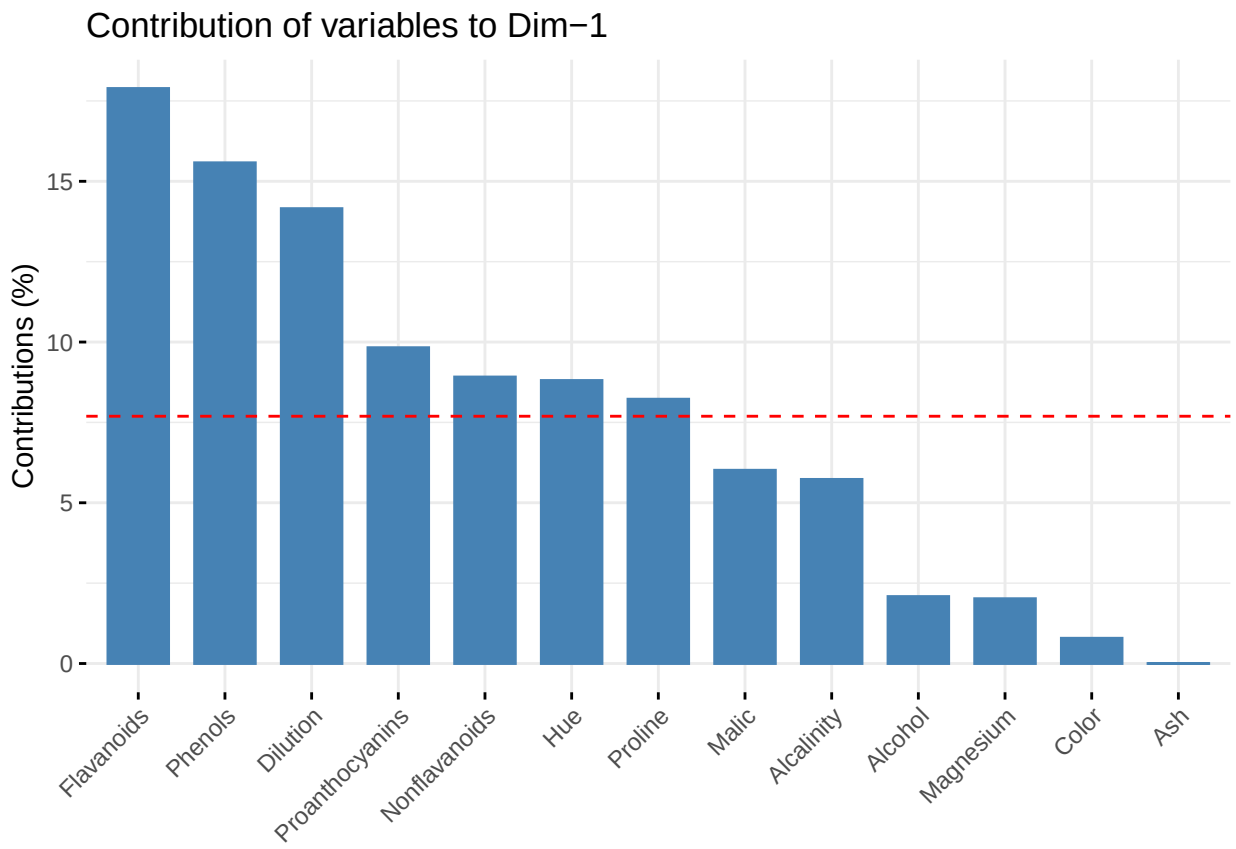
```
## Grafico de contribucicion  de las variables en PC1 y PC2
fviz_pca_var(model_pca)
```



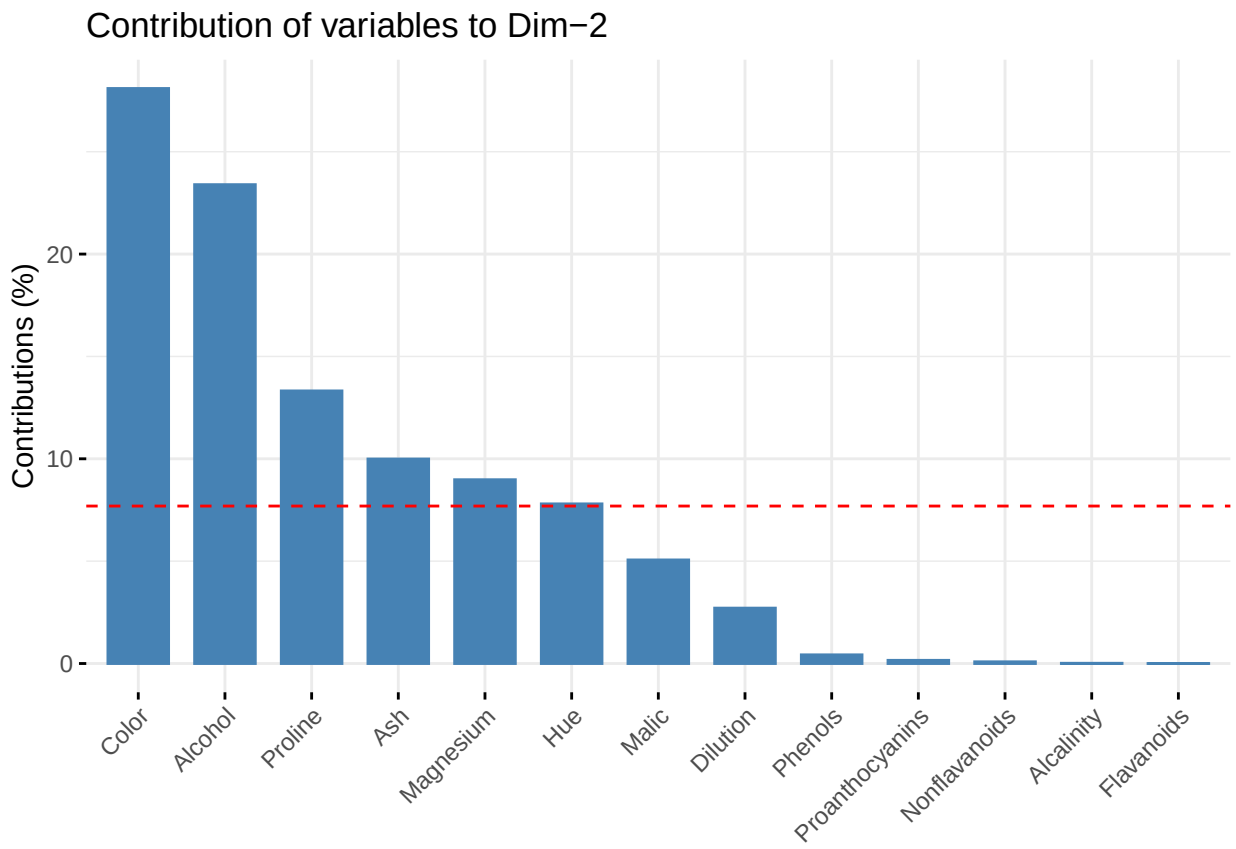

```
fviz_pca_ind(model_pca)
```




```
# contribucicion de cada variable en las componentes principales
fviz_contrib(model_pca, choice = "var" , axes = 1)
```




```
fviz_contrib(model_pca, choice = "var" , axes = 2)
```

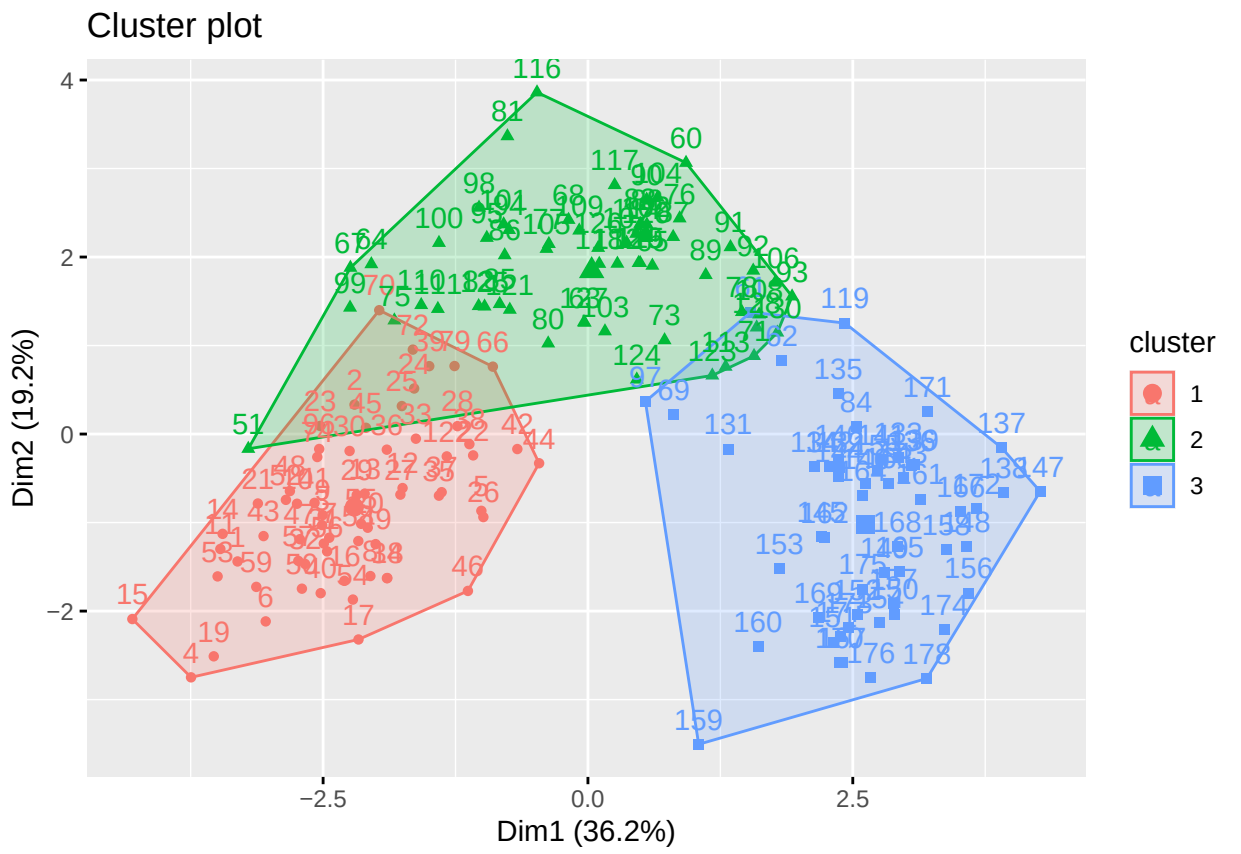



```
# Obtener componentes principales para cada observacion
componentes_principales <- as_tibble(model_pca$x[,1:2])
```

(iii) [0.25pt] Utilice los scores del ítem anterior para graficar los datos y pinte cada punto según la agrupación calculada con el clustering jerárquico del ítem (i).

Grafico de visualizacion de clusters

```
grafico_cluster <- fviz_cluster(model_hcut, data = data_5)
grafico_cluster
```



(iv) [0.50pt] Haga el mismo gráfico del ítem anterior pero ahora pinte los puntos según el tipo de vino (variable Type). Compare este gráfico con el del ítem (iii) y concluya si la agrupación del clustering jerárquico podría ser un buen clasificador de vinos..

Grafico de visualizacion de clusters

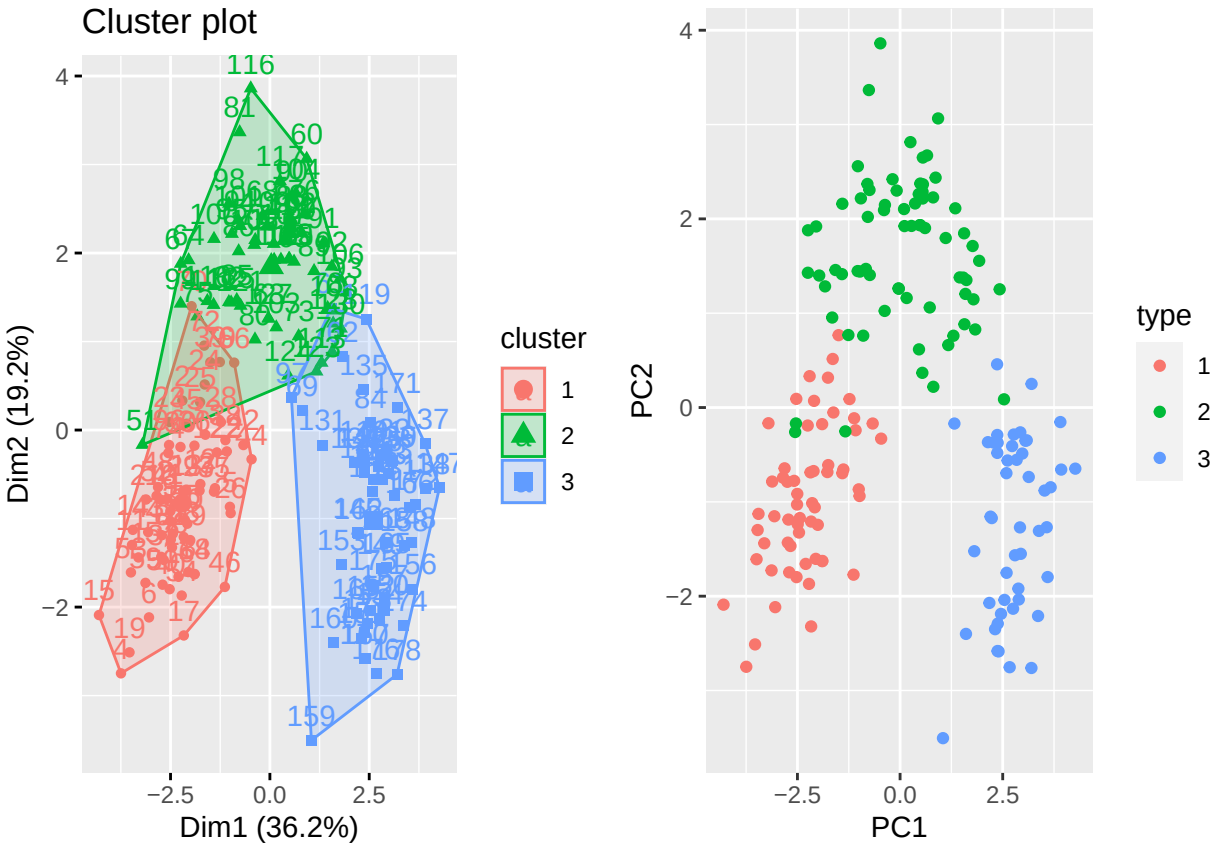
```
componentes_principales['type'] = data$Type

graficos_componente_type <- ggplot(data = componentes_principales, aes(x=PC1, y=PC2, color=type )) +
  geom_point()



# comparacion del grafico_cluster y graficos_componente_type

grid.arrange(grafico_cluster,graficos_componente_type,  ncol=2)
```



se puede apreciar que ambos graficos son muy similares, pero comparando las clasificaciones de tipo vs las clasificaciones de cluster se puede ver una pequeñas diferencias. se podria decir que el cluster de vinos clasifica bien