Jeffrey_exercise1_hw3

Jack Jeffrey

Jack Jeffrey HW 3 - 9.22.24

1. Exploring a data set

locate data on machine and turn it into an object

```
list.files("/Users/jackjeffrey/Documents/Poli502_Jeffrey/Data/")
```

```
[1] "world.csv"
```

```
world.data <- read.csv("/Users/jackjeffrey/Documents/Poli502_Jeffrey/Data/world.csv")
```

We have learned several functions to explore a data set, including

```
dim(world.data)
```

```
[1] 191  62
```

```
head(world.data)
```

```
            country       colony confidence decentralization dem_other
1       Afghanistan           UK         NA                NA      10.5
2           Albania Soviet Union   49.33593              0.74      63.0
3           Algeria       France   52.05573                NA      40.8
4           Andorra        Spain         NA                NA     100.0
```

```
5            Angola     Portugal         NA               NA      40.8
6 Antigua & Barbuda           UK         NA               NA      87.5
  dem_other5 democ_regime    district_size3 durable effectiveness      enpp_3
1        10%           No     single member       4      13.71158
2 Approx 60%          Yes                           3      35.46099 1-3 parties
3 Approx 40%           No 6 or more members       5      32.62411
4       100%          Yes                          NA      78.72340
5 Approx 40%           No                           3      19.14894
6 Approx 90%          Yes     single member      NA      59.81088 1-3 parties
         eu fhrate04_rev fhrate08_rev frac_eth frac_eth3 free_business
1 Not member          2.5            3   0.7693      High            NA
2 Not member            5            8   0.2204       Low          68.0
3 Not member          2.5            3   0.3394    Medium          71.2
4 Not member    Most free           12   0.7139      High            NA
5 Not member          2.5            3   0.7867      High          43.4
6 Not member            6           10   0.1643       Low            NA
  free_corrupt free_finance free_fiscal free_govspend free_invest free_labor
1           NA           NA          NA            NA          NA         NA
2           34           70        92.6          74.2          70       52.1
3           32           30        83.5          73.4          45       56.4
4           NA           NA          NA            NA          NA         NA
5           19           40        85.1          62.8          35       45.2
6           NA           NA          NA            NA          NA         NA
  free_monetary free_overall free_property free_trade gdp08 gdp_10_thou
1            NA           NA            NA         NA  30.6          NA
2          78.7         66.0            35       85.8  24.3      0.1535
3          77.2         56.9            30       70.7 276.0      0.1785
4            NA           NA            NA         NA    NA          NA
5          62.6         48.4            20       70.4 106.3      0.0857
6            NA           NA            NA         NA    NA      1.0449
  gdp_cap2 gdp_cap3 gdppcap08 gender_equal3 gini04 gini08   hi_gdp indy
1                          NA             NA     NA          1919
2      Low   Middle      7715           28.2   31.1  Low GDP 1991
3      Low   Middle      8033           35.3   35.3  Low GDP 1962
4                          NA             NA     NA          1278
5      Low   Middle      5899             NA     NA  Low GDP 1975
6     High     High        NA             NA     NA High GDP 1981
        oecd  old2006  old2003     pmat12_3    pop03 pop08    pop08_3
1 Not member       NA       NA                   NA  27.4 >=16.8 mil
2 Not member 8.479821 7.278363 Low post-mat  3169064   3.1  <=4.3 mil
3 Not member 4.578136 4.045199             31832610  34.4 >=16.8 mil
4 Not member       NA       NA                66000    NA
5 Not member 2.450295 2.930542             13522110  18.0 >=16.8 mil
```

```
6 Not member       NA 8.186610                 78580    NA
           popcat3 pr_sys protact3        regime_type3      region sources
1 Moderate (1-29m)     No                 Dictatorship Middle East      NA
2 Moderate (1-29m)     No Moderate Parliamentary democ  C&E Europe      NA
3 Moderate (1-29m)    Yes                 Dictatorship      Africa      NA
4 Small (under 1m)     No          Parliamentary democ   W. Europe      NA
5 Moderate (1-29m)    Yes                 Dictatorship      Africa      NA
6 Small (under 1m)     No          Parliamentary democ  S. America      NA
         typerel unions urban03 urban06 vi_rel3 votevap00s women05 women09
1         Muslim     NA      NA   23.28                 NA      NA    27.7
2         Muslim     NA 44.2390   46.14  20-50%      59.56     6.4    16.4
3         Muslim     NA 58.8302   63.94    >50%         NA      NA     7.7
4 Roman Catholic     NA 91.7404   90.28              20.95    14.3    35.7
5 Roman Catholic     NA 36.1806   53.96                 NA      NA    37.3
6     Protestant     NA 37.7566   39.60              76.34    10.5    10.5
  womyear       womyear2  yng2003  young06
1      NA                     NA       NA
2    1920 1944 or before 27.34834 26.35428
3    1962     After 1944 33.91887 28.94154
4    1973     After 1944       NA       NA
5    1975     After 1944 47.62524 46.32196
6    1951     After 1944 20.66509       NA
```

```
tail(world.data)
```

```
                country       colony confidence decentralization dem_other
186             Vietnam       France   99.86241               NA      58.3
187       Western Samoa        Other         NA               NA      58.3
188               Yemen           UK         NA               NA      10.5
189 Serbia & Montenegro Soviet Union   31.64857               NA      63.0
190              Zambia           UK         NA               NA      40.8
191            Zimbabwe           UK   60.01903             0.87      40.8
    dem_other5 democ_regime  district_size3 durable effectiveness      enpp_3
186 Approx 60%           No >1 to 5 members      46      40.18912
187 Approx 60%           No   single member      NA      52.00946
188        10%           No   single member       7      26.00473
189 Approx 60%           No >1 to 5 members       0      29.31442
190 Approx 40%          Yes   single member       4      24.58629 1-3 parties
191 Approx 40%           No   single member      13      27.65957
            eu fhrate04_rev fhrate08_rev frac_eth frac_eth3 free_business
186 Not member          1.5            2   0.2383       Low          60.7
187 Not member            6           10   0.1376       Low          73.2
```

```
188 Not member            3            4       NA                   74.4
189 Not member          5.5            9   0.5736    Medium            NA
190 Not member            4            8   0.7808      High          66.4
191 Not member          1.5            1   0.3874    Medium          30.0
    free_corrupt free_finance free_fiscal free_govspend free_invest free_labor
186           27           30        76.1          73.4          20       68.4
187           44           30        79.6          67.5          30       80.8
188           23           30        83.2          51.3          45       65.4
189           NA           NA          NA            NA          NA         NA
190           28           50        72.4          82.6          50       57.0
191           18           10        58.4            NA          NA       48.2
    free_monetary free_overall free_property free_trade gdp08 gdp_10_thou
186          58.1         49.8            15       68.9 240.1      0.0436
187          73.8         60.4            55       70.0   0.8      0.1484
188          65.1         54.4            30       76.1  55.3      0.0537
189            NA           NA            NA         NA    NA      0.1922
190          63.3         58.0            30       79.9  17.1      0.0361
191            NA         21.4             5       44.8   2.2      0.0639
    gdp_cap2 gdp_cap3 gdppcap08 gender_equal3 gini04 gini08   hi_gdp indy
186      Low      Low      2785                36.1   34.4  Low GDP 1962
187      Low   Middle      4485                  NA     NA  Low GDP 1990
188      Low      Low      2400           Low   33.4   33.4  Low GDP 1991
189     High   Middle        NA                  NA     NA High GDP 1964
190      Low      Low      1356                52.6   50.8  Low GDP 1980
191      Low      Low       188                56.8   50.1  Low GDP 1980
         oecd   old2006   old2003     pmat12_3    pop03 pop08      pop08_3
186 Not member  5.437487  5.261546              81314240  86.2   >=16.8 mil
187 Not member  4.595193  4.978562                178000   0.2    <=4.3 mil
188 Not member  2.284142  2.622207              19173160  23.1   >=16.8 mil
189 Not member 14.114708 14.008000 Low post-mat  8104000    NA
190 Not member  3.032360  2.693117              10402960  12.6 4.4-16.4 mil
191 Not member  3.711219  3.101562              13101750  11.7 4.4-16.4 mil
           popcat3 pr_sys protact3       regime_type3       region sources
186     Large (30m+)     No                Dictatorship Asia-Pacific      NA
187 Small (under 1m)     No                Dictatorship Asia-Pacific      NA
188 Moderate (1-29m)     No                Dictatorship  Middle East      NA
189 Moderate (1-29m)     No      Low       Dictatorship   C&E Europe      NA
190 Moderate (1-29m)     No          Presidential democ       Africa      NA
191 Moderate (1-29m)     No                Dictatorship       Africa      NA
       typerel unions urban03 urban06 vi_rel3 votevap00s women05 women09
186    eastern     NA 25.4076   26.88    <20%         NA      NA    25.8
187 Protestant     NA 22.8014   22.60              76.62      NA      NA
188     Muslim     NA 25.6836   27.72                 NA      NA     0.3
```

```
189   Orthodox     NA 52.0384   52.44  20-50%         NA      NA      NA
190      other   12.5 40.3128   35.14              55.74    12.7    15.2
191 Protestant   13.9 37.4674   36.38    >50%         NA      NA    15.2
    womyear   womyear2  yng2003  young06
186    1946 After 1944 30.62024 28.78953
187    1990 After 1944 35.46627 40.41566
188    1967 After 1944 45.24762 45.99981
189    1946 After 1944 19.59660 18.03825
190    1962 After 1944 46.82837 45.63621
191    1957 After 1944 43.43543 39.46990
```

There are some other functions we can use.

For example, the names

function tells us the names of all the variables included in a # data frame object.

```
names(world.data)
```

```
 [1] "country"          "colony"           "confidence"       "decentralization"
 [5] "dem_other"        "dem_other5"       "democ_regime"     "district_size3"
 [9] "durable"          "effectiveness"    "enpp_3"           "eu"
[13] "fhrate04_rev"     "fhrate08_rev"     "frac_eth"         "frac_eth3"
[17] "free_business"    "free_corrupt"     "free_finance"     "free_fiscal"
[21] "free_govspend"    "free_invest"      "free_labor"       "free_monetary"
[25] "free_overall"     "free_property"    "free_trade"       "gdp08"
[29] "gdp_10_thou"      "gdp_cap2"         "gdp_cap3"         "gdppcap08"
[33] "gender_equal3"    "gini04"           "gini08"           "hi_gdp"
[37] "indy"             "oecd"             "old2006"          "old2003"
[41] "pmat12_3"         "pop03"            "pop08"            "pop08_3"
[45] "popcat3"          "pr_sys"           "protact3"         "regime_type3"
[49] "region"           "sources"          "typerel"          "unions"
[53] "urban03"          "urban06"          "vi_rel3"          "votevap00s"
[57] "women05"          "women09"          "womyear"          "womyear2"
[61] "yng2003"          "young06"
```

The colnames function gives us the same results as well.

```
colnames(world.data)
```

```
 [1] "country"          "colony"           "confidence"       "decentralization"
 [5] "dem_other"        "dem_other5"       "democ_regime"     "district_size3"
 [9] "durable"          "effectiveness"    "enpp_3"           "eu"
[13] "fhrate04_rev"     "fhrate08_rev"     "frac_eth"         "frac_eth3"
[17] "free_business"    "free_corrupt"     "free_finance"     "free_fiscal"
[21] "free_govspend"    "free_invest"      "free_labor"       "free_monetary"
[25] "free_overall"     "free_property"    "free_trade"       "gdp08"
[29] "gdp_10_thou"      "gdp_cap2"         "gdp_cap3"         "gdppcap08"
[33] "gender_equal3"    "gini04"           "gini08"           "hi_gdp"
[37] "indy"             "oecd"             "old2006"          "old2003"
[41] "pmat12_3"         "pop03"            "pop08"            "pop08_3"
[45] "popcat3"          "pr_sys"           "protact3"         "regime_type3"
[49] "region"           "sources"          "typerel"          "unions"
[53] "urban03"          "urban06"          "vi_rel3"          "votevap00s"
[57] "women05"          "women09"          "womyear"          "womyear2"
[61] "yng2003"          "young06"
```

We can also apply the summary function without specifying variable names. Then, R will provide the summary of ALL the variables included in a data frame object.

```
summary(world.data)
```

```
   country             colony            confidence      decentralization
 Length:191         Length:191         Min.   : 0.5167   Min.   :0.380
 Class :character   Class :character   1st Qu.:38.3669   1st Qu.:1.225
 Mode  :character   Mode  :character   Median :49.1978   Median :1.510
                                       Mean   :47.9704   Mean   :1.516
                                       3rd Qu.:59.2929   3rd Qu.:1.800
                                       Max.   :99.8624   Max.   :2.450
```

```
                                    NA's   :120       NA's   :124
  dem_other       dem_other5        democ_regime       district_size3
Min.   : 10.50   Length:191         Length:191         Length:191
1st Qu.: 40.80   Class :character   Class :character   Class :character
Median : 58.30   Mode  :character   Mode  :character   Mode  :character
Mean   : 60.51
3rd Qu.: 87.50
Max.   :100.00

   durable       effectiveness       enpp_3              eu
Min.   :  0.00   Min.   :  0.00   Length:191         Length:191
1st Qu.:  4.00   1st Qu.: 28.19   Class :character   Class :character
Median :  9.00   Median : 40.31   Mode  :character   Mode  :character
Mean   : 22.49   Mean   : 45.77
3rd Qu.: 31.25   3rd Qu.: 62.77
Max.   :191.00   Max.   :100.00
NA's   :31       NA's   :5
fhrate04_rev        fhrate08_rev       frac_eth       frac_eth3
Length:191         Min.   : 0.000   Min.   :0.0000   Length:191
Class :character   1st Qu.: 4.000   1st Qu.:0.1997   Class :character
Mode  :character   Median : 8.000   Median :0.4343   Mode  :character
                   Mean   : 7.553   Mean   :0.4394
                   3rd Qu.:11.250   3rd Qu.:0.6611
                   Max.   :12.000   Max.   :0.9302
                   NA's   :3        NA's   :3
free_business    free_corrupt    free_finance    free_fiscal
Min.   :10.00   Min.   : 5.00   Min.   :10.00   Min.   :35.90
1st Qu.:55.70   1st Qu.:26.00   1st Qu.:30.00   1st Qu.:68.20
Median :65.80   Median :34.00   Median :50.00   Median :77.50
Mean   :64.92   Mean   :40.42   Mean   :48.61   Mean   :75.62
3rd Qu.:76.60   3rd Qu.:51.75   3rd Qu.:60.00   3rd Qu.:84.00
Max.   :99.90   Max.   :93.00   Max.   :90.00   Max.   :99.90
NA's   :18      NA's   :17      NA's   :18      NA's   :18
free_govspend    free_invest      free_labor    free_monetary
Min.   : 6.90   Min.   : 5.00   Min.   :20.00   Min.   :46.50
1st Qu.:54.95   1st Qu.:35.00   1st Qu.:50.10   1st Qu.:66.85
Median :73.40   Median :50.00   Median :60.80   Median :71.90
Mean   :67.59   Mean   :50.75   Mean   :62.08   Mean   :71.30
3rd Qu.:83.25   3rd Qu.:70.00   3rd Qu.:75.90   3rd Qu.:76.55
Max.   :98.40   Max.   :95.00   Max.   :98.90   Max.   :88.80
NA's   :24      NA's   :24      NA's   :18      NA's   :19
 free_overall   free_property    free_trade        gdp08
Min.   : 1.00   Min.   : 5.0   Min.   :31.90   Min.   :    0.2
```

```
1st Qu.:51.35   1st Qu.:30.0   1st Qu.:67.20   1st Qu.:   11.9
Median :59.30   Median :40.0   Median :75.90   Median :   41.7
Mean   :59.18   Mean   :43.9   Mean   :74.37   Mean   :  390.4
3rd Qu.:67.30   3rd Qu.:60.0   3rd Qu.:85.00   3rd Qu.:  242.4
Max.   :86.10   Max.   :95.0   Max.   :90.00   Max.   :14200.0
NA's   :17      NA's   :18     NA's   :18      NA's   :14
 gdp_10_thou       gdp_cap2           gdp_cap3           gdppcap08
Min.   :0.0090   Length:191         Length:191         Min.   :   188
1st Qu.:0.0503   Class :character   Class :character   1st Qu.:  2308
Median :0.1897   Mode  :character   Mode  :character   Median :  7703
Mean   :0.6018                                         Mean   : 13828
3rd Qu.:0.6320                                         3rd Qu.: 19996
Max.   :4.7354                                         Max.   :118040
NA's   :14                                             NA's   :16
gender_equal3          gini04          gini08         hi_gdp
Length:191         Min.   :24.40   Min.   :24.70   Length:191
Class :character   1st Qu.:32.42   1st Qu.:33.55   Class :character
Mode  :character   Median :37.95   Median :39.20   Mode  :character
                   Mean   :40.14   Mean   :40.74
                   3rd Qu.:46.88   3rd Qu.:47.10
                   Max.   :70.70   Max.   :74.30
                   NA's   :65      NA's   :64
     indy          oecd              old2006          old2003
Min.   : 301   Length:191         Min.   : 1.076   Min.   : 1.846
1st Qu.:1915   Class :character   1st Qu.: 3.375   1st Qu.: 3.173
Median :1960   Mode  :character   Median : 4.924   Median : 4.865
Mean   :1891                      Mean   : 7.300   Mean   : 6.979
3rd Qu.:1977                      3rd Qu.:11.210   3rd Qu.:10.656
Max.   :1994                      Max.   :20.232   Max.   :18.997
NA's   :3                         NA's   :17       NA's   :10
  pmat12_3            pop03               pop08          pop08_3
Length:191         Min.   :2.000e+04   Min.   :   0.00   Length:191
Class :character   1st Qu.:1.758e+06   1st Qu.:   2.70   Class :character
Mode  :character   Median :6.720e+06   Median :   8.30   Mode  :character
                   Mean   :3.318e+07   Mean   :  36.95
                   3rd Qu.:2.121e+07   3rd Qu.:  24.60
                   Max.   :1.288e+09   Max.   :1300.00
                   NA's   :4           NA's   :14
  popcat3            pr_sys            protact3         regime_type3
Length:191         Length:191         Length:191         Length:191
Class :character   Class :character   Class :character   Class :character
Mode  :character   Mode  :character   Mode  :character   Mode  :character
```

```
   region          sources          typerel              unions
Length:191         Mode:logical   Length:191         Min.   : 2.00
Class :character   NA's:191       Class :character   1st Qu.:11.45
Mode  :character                  Mode  :character   Median :19.10
                                                     Mean   :24.74
                                                     3rd Qu.:30.80
                                                     Max.   :96.10
                                                     NA's   :100
   urban03           urban06         vi_rel3            votevap00s
Min.   :  6.556   Min.   : 10.32   Length:191         Min.   :18.29
1st Qu.: 36.413   1st Qu.: 35.49   Class :character   1st Qu.:54.58
Median : 57.491   Median : 56.76   Mode  :character   Median :65.12
Mean   : 55.620   Mean   : 54.55                      Mean   :65.08
3rd Qu.: 73.830   3rd Qu.: 72.75                      3rd Qu.:77.66
Max.   :100.000   Max.   :100.00                      Max.   :98.39
NA's   :5         NA's   :4                           NA's   :92
   women05          women09          womyear       womyear2
Min.   : 0.00   Min.   : 0.00   Min.   :1893   Length:191
1st Qu.: 8.25   1st Qu.: 9.70   1st Qu.:1931   Class :character
Median :13.00   Median :15.55   Median :1949   Mode  :character
Mean   :15.38   Mean   :17.18   Mean   :1947
3rd Qu.:20.45   3rd Qu.:22.95   3rd Qu.:1960
Max.   :45.30   Max.   :56.30   Max.   :1990
NA's   :80      NA's   :11      NA's   :16
   yng2003          young06
Min.   :14.02   Min.   :13.50
1st Qu.:21.31   1st Qu.:19.53
Median :31.95   Median :30.65
Mean   :31.41   Mean   :30.45
3rd Qu.:41.30   3rd Qu.:39.72
Max.   :49.77   Max.   :50.50
NA's   :10      NA's   :17
```

The str() function tells us the structure of a data frame object, meaning that it tells us which variables are factor, which ones are numerical, which ones are logical, etc.

```
str(world.data)
```

```
'data.frame':   191 obs. of  62 variables:
 $ country         : chr  "Afghanistan" "Albania" "Algeria" "Andorra" ...
 $ colony          : chr  "UK" "Soviet Union" "France" "Spain" ...
 $ confidence      : num  NA 49.3 52.1 NA NA ...
 $ decentralization: num  NA 0.74 NA NA NA NA 2.4 NA 1.74 1.81 ...
 $ dem_other       : num  10.5 63 40.8 100 40.8 87.5 87.5 63 58.3 100 ...
 $ dem_other5      : chr  "10%" "Approx 60%" "Approx 40%" "100%" ...
 $ democ_regime    : chr  "No" "Yes" "No" "Yes" ...
 $ district_size3  : chr  "single member" "" "6 or more members" "" ...
 $ durable         : int  4 3 5 NA 3 NA 17 2 99 54 ...
 $ effectiveness   : num  13.7 35.5 32.6 78.7 19.1 ...
 $ enpp_3          : chr  "" "1-3 parties" "" "" ...
 $ eu              : chr  "Not member" "Not member" "Not member" "Not member" ...
 $ fhrate04_rev    : chr  "2.5" "5" "2.5" "Most free" ...
 $ fhrate08_rev    : int  3 8 3 12 3 10 10 4 12 12 ...
 $ frac_eth        : num  0.769 0.22 0.339 0.714 0.787 ...
 $ frac_eth3       : chr  "High" "Low" "Medium" "High" ...
 $ free_business   : num  NA 68 71.2 NA 43.4 NA 62.1 83.4 90.3 73.6 ...
 $ free_corrupt    : int  NA 34 32 NA 19 NA 29 29 87 81 ...
 $ free_finance    : int  NA 70 30 NA 40 NA 30 70 90 70 ...
 $ free_fiscal     : num  NA 92.6 83.5 NA 85.1 NA 69.5 89.3 61.4 51.2 ...
 $ free_govspend   : num  NA 74.2 73.4 NA 62.8 NA 75.6 90.9 64.9 28.8 ...
 $ free_invest     : int  NA 70 45 NA 35 NA 45 75 80 75 ...
 $ free_labor      : num  NA 52.1 56.4 NA 45.2 NA 50.1 70.6 94.9 79.1 ...
 $ free_monetary   : num  NA 78.7 77.2 NA 62.6 NA 61.2 72.9 82.7 79.3 ...
 $ free_overall    : num  NA 66 56.9 NA 48.4 NA 51.2 69.2 82.6 71.6 ...
 $ free_property   : int  NA 35 30 NA 20 NA 20 30 90 90 ...
 $ free_trade      : num  NA 85.8 70.7 NA 70.4 NA 69.5 80.5 85.1 87.5 ...
 $ gdp08           : num  30.6 24.3 276 NA 106.3 ...
 $ gdp_10_thou     : num  NA 0.1535 0.1785 NA 0.0857 ...
 $ gdp_cap2        : chr  "" "Low" "Low" "" ...
 $ gdp_cap3        : chr  "" "Middle" "Middle" "" ...
```

```
$ gdppcap08       : int  NA 7715 8033 NA 5899 NA 14333 6070 35677 38152 ...
$ gender_equal3   : chr  "" "" "" "" ...
$ gini04          : num  NA 28.2 35.3 NA NA NA 52.2 37.9 35.2 30 ...
$ gini08          : num  NA 31.1 35.3 NA NA NA 51.3 33.8 35.2 29.1 ...
$ hi_gdp          : chr  "" "Low GDP" "Low GDP" "" ...
$ indy            : int  1919 1991 1962 1278 1975 1981 1816 1991 1901 1156 ...
$ oecd            : chr  "Not member" "Not member" "Not member" "Not member" ...
$ old2006         : num  NA 8.48 4.58 NA 2.45 ...
$ old2003         : num  NA 7.28 4.05 NA 2.93 ...
$ pmat12_3        : chr  "" "Low post-mat" "" "" ...
$ pop03           : num  NA 3169064 31832610 66000 13522110 ...
$ pop08           : num  27.4 3.1 34.4 NA 18 NA 39.9 3.1 21 8.3 ...
$ pop08_3         : chr  ">=16.8 mil" "<=4.3 mil" ">=16.8 mil" "" ...
$ popcat3         : chr  "Moderate (1-29m)" "Moderate (1-29m)" "Moderate (1-29m)" "Small (u
$ pr_sys          : chr  "No" "No" "Yes" "No" ...
$ protact3        : chr  "" "Moderate" "" "" ...
$ regime_type3    : chr  "Dictatorship" "Parliamentary democ" "Dictatorship" "Parliamentary
$ region          : chr  "Middle East" "C&E Europe" "Africa" "W. Europe" ...
$ sources         : logi  NA NA NA NA NA NA ...
$ typerel         : chr  "Muslim" "Muslim" "Muslim" "Roman Catholic" ...
$ unions          : num  NA NA NA NA NA ...
$ urban03         : num  NA 44.2 58.8 91.7 36.2 ...
$ urban06         : num  23.3 46.1 63.9 90.3 54 ...
$ vi_rel3         : chr  "" "20-50%" ">50%" "" ...
$ votevap00s      : num  NA 59.6 NA 20.9 NA ...
$ women05         : num  NA 6.4 NA 14.3 NA 10.5 33.7 5.3 24.7 33.9 ...
$ women09         : num  27.7 16.4 7.7 35.7 37.3 10.5 41.6 8.4 26.7 27.9 ...
$ womyear         : int  NA 1920 1962 1973 1975 1951 1947 1921 1902 1918 ...
$ womyear2        : chr  "" "1944 or before" "After 1944" "After 1944" ...
$ yng2003         : num  NA 27.3 33.9 NA 47.6 ...
$ young06         : num  NA 26.4 28.9 NA 46.3 ...
```

2. Summarizing categorical variables——————————

The output from the str function above tells us that there are many factor variables in the data set. For example, the democ_regime variable is a factor variable (nominal-level). Summarize the information contained in this variable by creating a frequency table.

load tidyverse package

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becor
```

```
dem_freq_table <- table(world.data$democ_regime)
print(dem_freq_table)
```

```
 No Yes
 75 114
```

The typerel variable is another factor variable.

This variable measures predominant religion in a given country. # Create a frequency table for this variable.

```
typerel_variable <- table(world.data$typerel)
print(typerel_variable)
```

```
       eastern          Hindu         Jewish         Muslim       Orthodox
            15              2              1             50             13
         other     Protestant Roman Catholic
            12             35             63
```

Make this frequency table vertical using the data.frame

function

```
data.frame(typerel_variable)
```

```
            Var1 Freq
1        eastern   15
2          Hindu    2
3         Jewish    1
4         Muslim   50
5       Orthodox   13
6          other   12
7     Protestant   35
8 Roman Catholic   63
```

We have seen in the lecture that we often report RELATIVE frequencies as well as raw frequencies. Relative frequencies can be obtained by dividing each of the raw frequency values by the total number of observations. Let's see how we do this. To do so, it is better if we create a new object that stores the frequency table. Let's create an object called ft.colony that is equal to the vertical frequency table for the colony variable, as follows.

```
ft.colony <- data.frame( table(world.data$colony) )
```

To make sure we did this correctly, let's take a look

```
print(ft.colony)
```

```
           Var1 Freq
1       Belgium    3
2        France   28
3   Netherlands    4
4          none   20
5         Other   15
6       Ottoman    2
7      Portugal    8
8  Soviet Union   27
9         Spain   21
10           UK   63
```

We can see that the first column, Var1, records all possible values and the second column, Freq, records the raw frequency. To convert the raw frequencies into relative frequencies, we divide the values by the sum of Freq. As we learned before, we use the sum function to calculate the sum of all the values, as follows.

```
sum( ft.colony $ Freq )
```

```
[1] 191
```

The relative frequencies are Freq divided by sum(ft.colony $ Freq)

```
ft.colony $ Freq / sum( ft.colony $ Freq )
```

```
 [1] 0.01570681 0.14659686 0.02094241 0.10471204 0.07853403 0.01047120
 [7] 0.04188482 0.14136126 0.10994764 0.32984293
```

Alternatively, we can use the prop.table function to obtain the same results

```
prop.table(ft.colony $ Freq)
```

```
 [1] 0.01570681 0.14659686 0.02094241 0.10471204 0.07853403 0.01047120
 [7] 0.04188482 0.14136126 0.10994764 0.32984293
```

We would want to convert these further into percentages.

To make a ratio into a percentage, we simply multiply it by 100

```
prop.table(ft.colony $ Freq) * 100
```

```
 [1]  1.570681 14.659686  2.094241 10.471204  7.853403  1.047120  4.188482
 [8] 14.136126 10.994764 32.984293
```

We would want to round these numbers to simplify the representation. As we leanred two weeks ago, we use the round function to do that.

```
round(prop.table(ft.colony $ Freq) * 100, digits = 2)
```

```
 [1]  1.57 14.66  2.09 10.47  7.85  1.05  4.19 14.14 10.99 32.98
```

Finally, we want to insert these numbers into the frequency table we created and stored in ft.colony.

```
ft.colony
```

```
           Var1 Freq
1       Belgium    3
2        France   28
3   Netherlands    4
4          none   20
5         Other   15
6       Ottoman    2
7      Portugal    8
8  Soviet Union   27
9         Spain   21
10           UK   63
```

How do we do it? We do this by creating a new column in the ft.colony object. As we learned last week, we use the $ symbol to create a new column in a data frame object, as follows

```
ft.colony $ Percent <- round(prop.table(ft.colony $ Freq) * 100, digits = 2)
```

Now, our frequency table contains three columns, as follows

```
ft.colony
```

```
           Var1 Freq Percent
1       Belgium    3    1.57
2        France   28   14.66
3   Netherlands    4    2.09
4          none   20   10.47
5         Other   15    7.85
6       Ottoman    2    1.05
7      Portugal    8    4.19
8  Soviet Union   27   14.14
9         Spain   21   10.99
10           UK   63   32.98
```

Finally, we may want to change the column name for the first column from "Var1" to something more intuitive. To do so, we use the colnames function, as follows

```
colnames(ft.colony)[colnames(ft.colony) == "Var1"] <- "Colonizer"
ft.colony
```

```
      Colonizer Freq Percent
1       Belgium    3    1.57
2        France   28   14.66
3   Netherlands    4    2.09
4          none   20   10.47
5         Other   15    7.85
6       Ottoman    2    1.05
7      Portugal    8    4.19
8  Soviet Union   27   14.14
9         Spain   21   10.99
10           UK   63   32.98
```

We can see that about 33% of the countries in the world are former colonies of the UK, about 15% of them are former colonies of France, about 10% of them were never colonized, etc. Create a frequency table for the typerel variable

```
freq_table_typerel <- table(world.data$typerel)
freq_table_typerel
```

```
      eastern         Hindu        Jewish        Muslim      Orthodox
```

```
   15             2             1            50            13
other     Protestant Roman Catholic
   12            35            63
```

Which religion is the most “popular” in the world?

Answer eqals Roman Catholic with 63

What is the percentage of countries where muslim is the majority?

```
count_muslim <- freq_table_typerel["Muslim"]
count_muslim
```

```
Muslim
    50
```

```
total_countries <- sum(freq_table_typerel)
total_countries
```

```
[1] 191
```

```
percentage_muslim <- (count_muslim / total_countries) * 100
percentage_muslim
```

```
  Muslim
26.17801
```

Muslim is the majority in 26.18% of countries

Create a frequency table for democ_regime

```
dem_freq_table <- table(world.data$democ_regime)
dem_freq_table
```

```
 No Yes
 75 114
```

What percentage of countries have a democratic regime?

```
dem_freq_table_clean <- na.omit(dem_freq_table)
count_dem <- dem_freq_table_clean["Yes"]
count_dem
```

```
Yes
114
```

```
total_countries <- sum(dem_freq_table_clean, na.rm = TRUE)
percentage_democratic <- (count_dem / total_countries) * 100
percentage_democratic
```

```
     Yes
60.31746
```

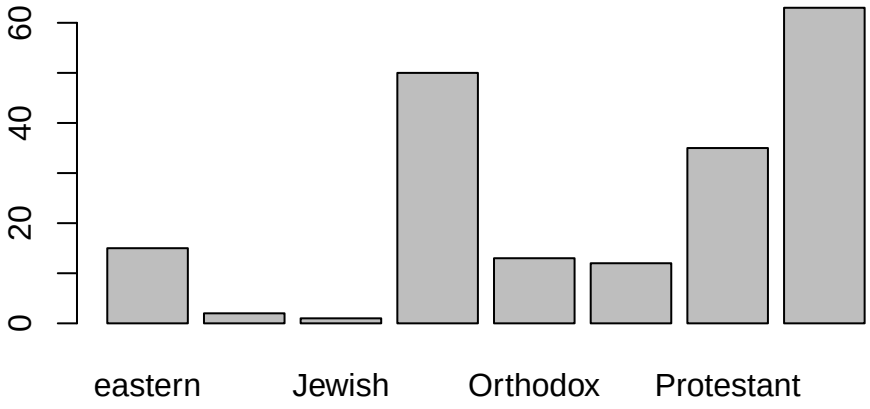
```
round(percentage_democratic, digits = 2)
```

```
  Yes
60.32
```

60.32 percent of countries are democratic

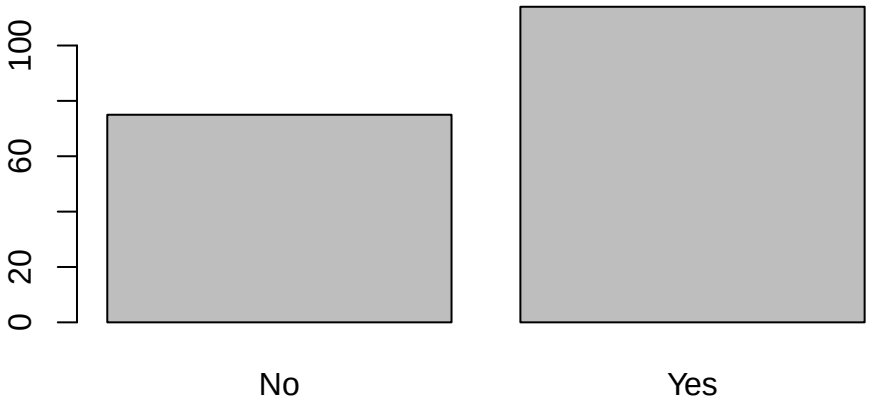
Create a bar chart to summarize the typerel variable

```
barplot(typerel_variable)
```



Create a bar chart to summarize the democ_regime variable

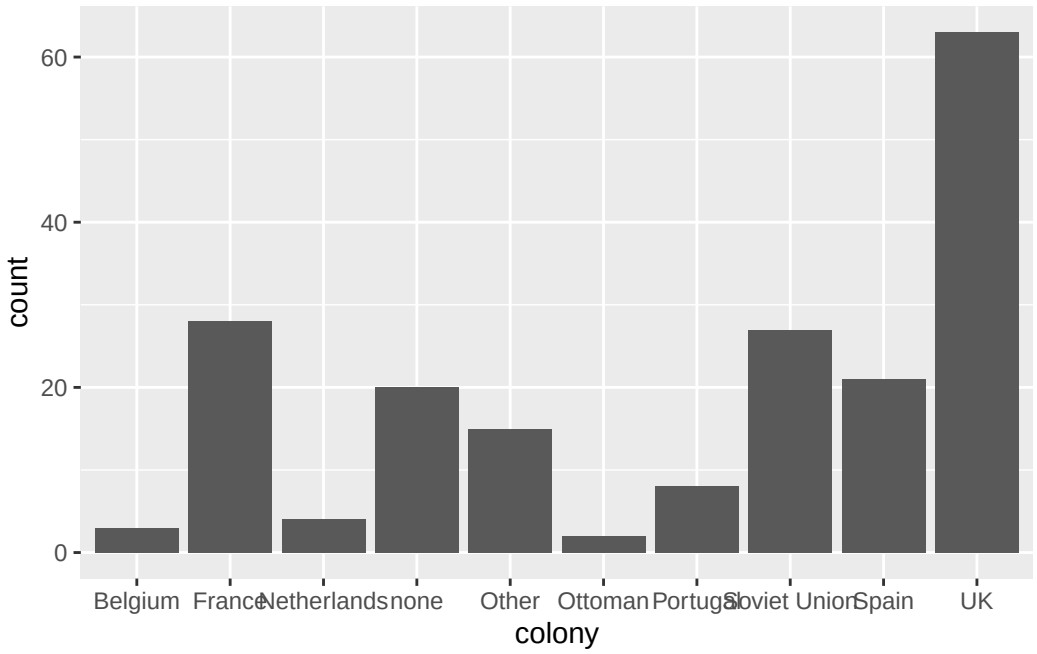
```
barplot(dem_freq_table_clean)
```



3. Making ggplot graphs look nicer——————————————

We have seen how to create a graph using the ggplot function

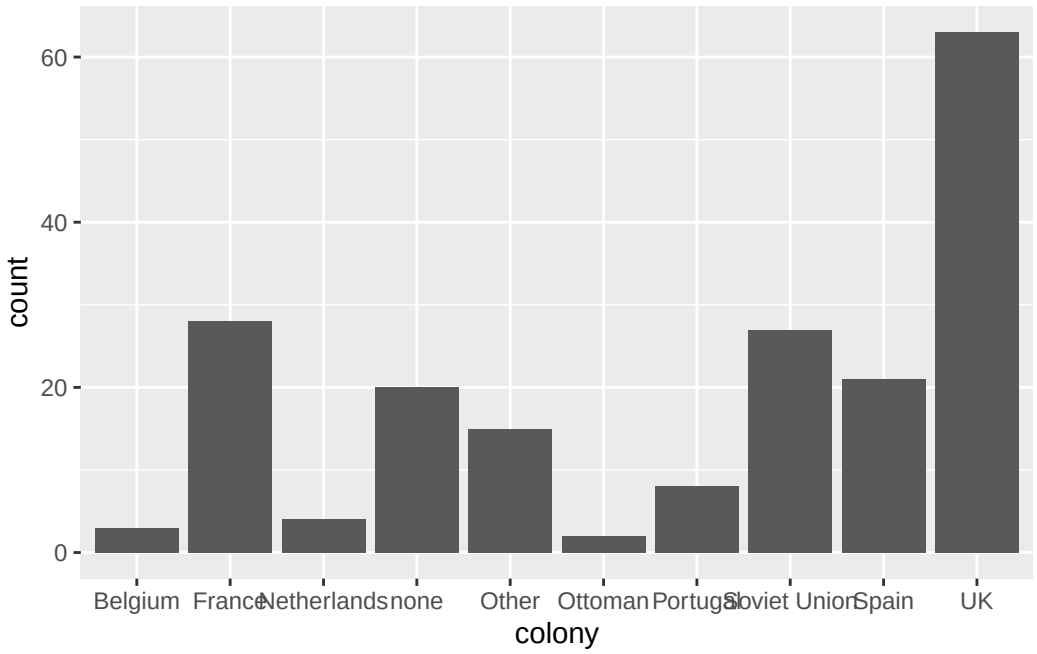
```
ggplot(world.data, aes(x = colony)) + geom_bar()
```


60
40
20
0
count
Belgium
France
Netherlands
none
Other
Ottoman
Portugal
Soviet Union
Spain
UK
colony

The command above is the easiest way to produce a simple ggplot graph, but we would want to modify some parts of the graph, such as axis labels. For example, the graph above currently says "colony" on the x-axis and "count" on the y-axis. We may want to modify them so they can be more informative.

When we want to modify graphs, we usually create a ggplot graph and store it into an object. Then we gradually add some features to modify them. The above command can be re-written as follows:

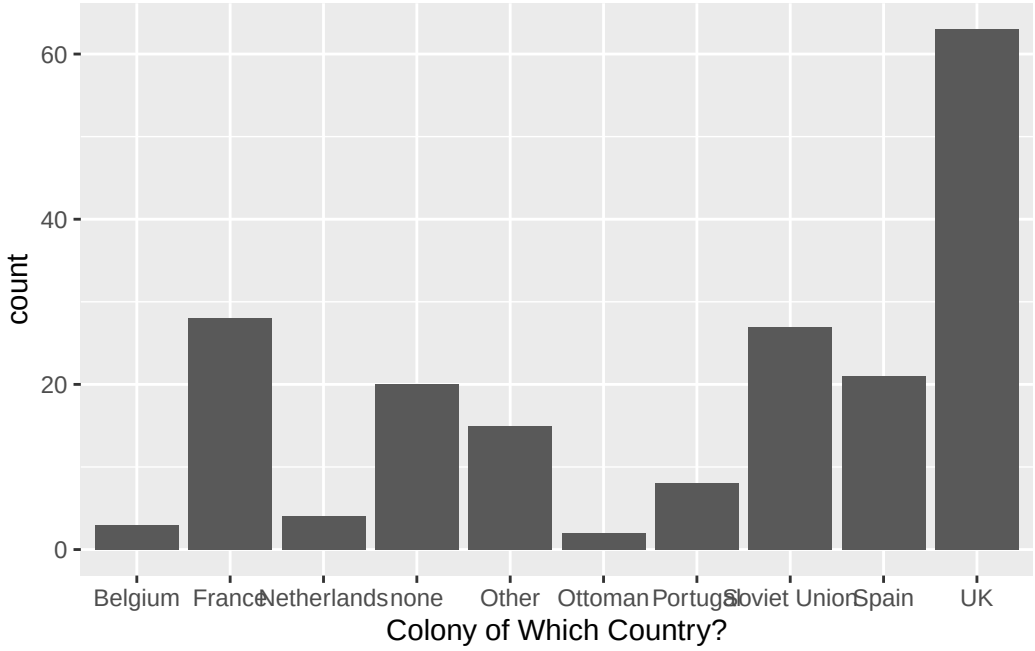
```
g <- ggplot(world.data)
g <- g + aes(x = colony)
g <- g + geom_bar()
g
```



Now that we stored the graph into an object called g, we can modify graph appearances by adding more options.

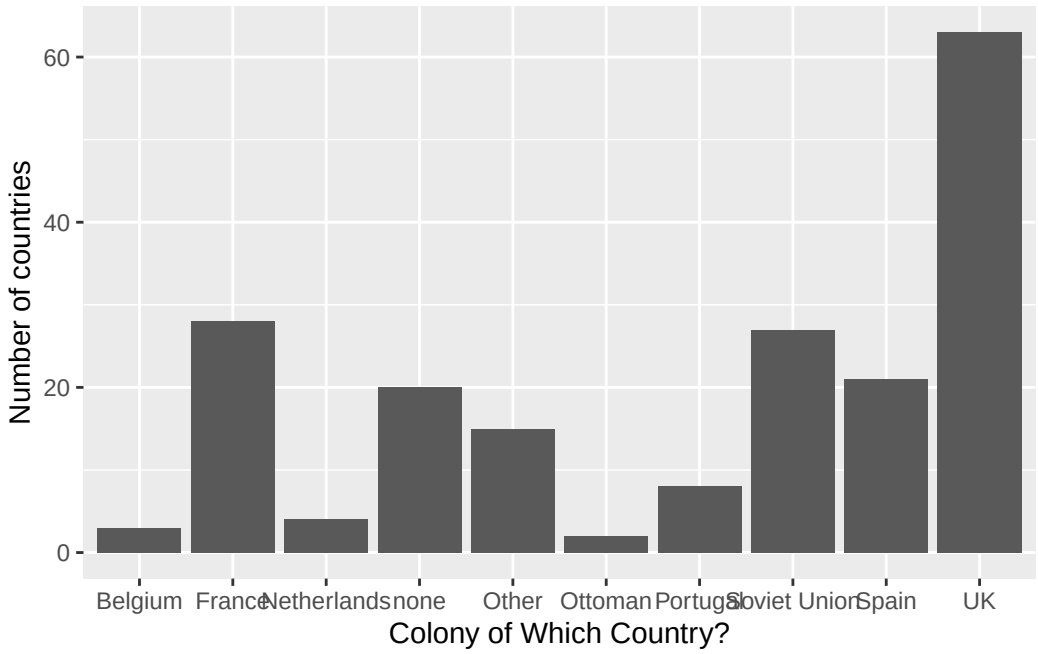
To change the label for the x-axis, we use the xlab option, as follows

```
g <- g + xlab("Colony of Which Country?")
g
```



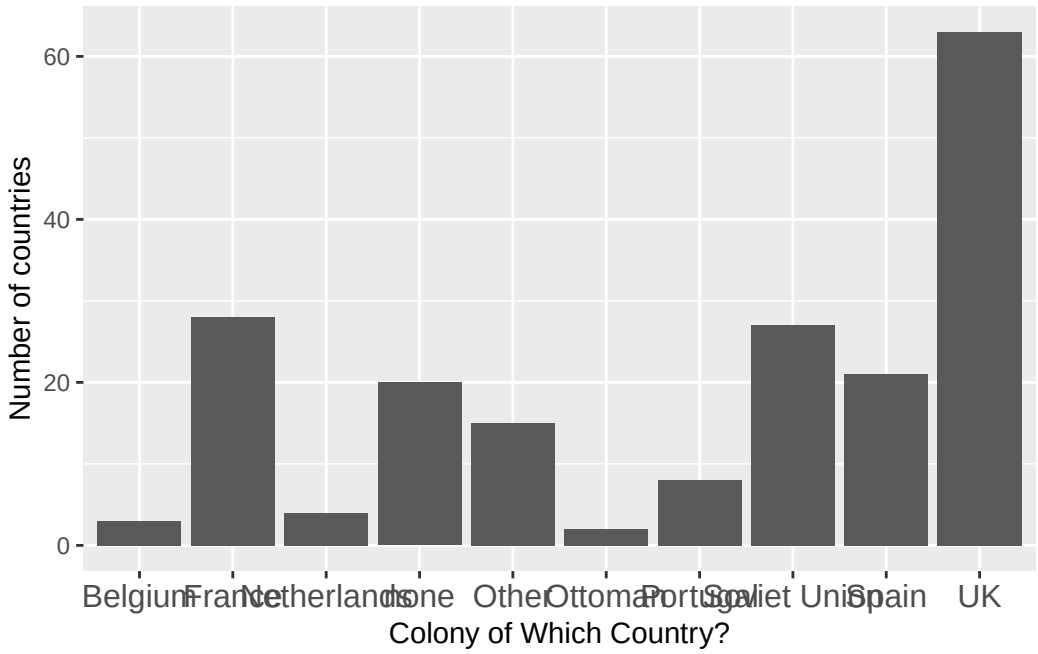
Similarly, we can modify the label for the y-axis

```
g <- g + ylab("Number of countries")
g
```



If you want to change the text size for axes, do

```
g <- g + theme(axis.text.x = element_text(size = 12))
g
```



We can save this graph as a PDF file using the ggsave function.

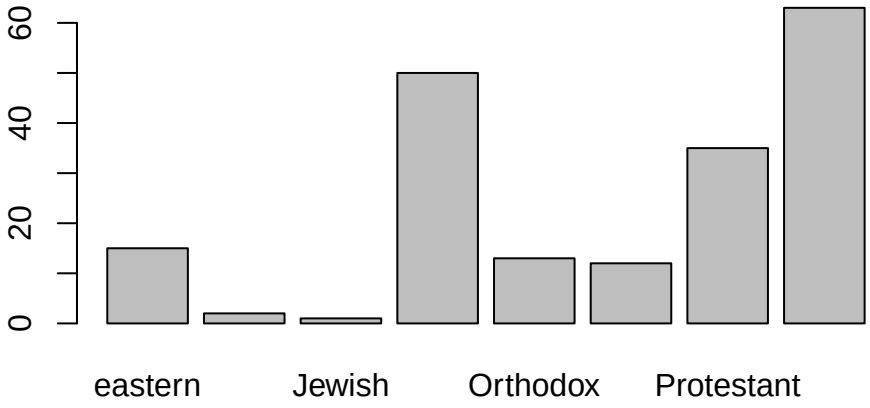
```
ggsave(file = "colony_bar.pdf", width = 10, height = 8)
```

The file option specifies the file name of the PDF file you want to create. The width and height option control the width and height of the PDF file, respectively.

Once you save a graph in a PDF, you can easily embed it in a # Word document simply by drag & drop.

Create a bar chart for the typerel variable, and save it as a PDF file

```
typerel_bar <- barplot(typerel_variable)
```




```
ggsave(file = "typerel_bar.pdf", width = 10, height = 8)
```

4. Summarizing numerical variables ——————————

There are two variables in the data set, gini04 and gini08, that measure the levels of economic inequality in a country numerically. These are what's called Gini coefficient (Gini index or Gini ratio), which takes values between 0 and 1 (or 0% and 100%). A value of 0 corresponds to the "perfect equality" case, where everyone in a country is earning the same amount of money, whereas a value of 1 (100%) corresponds to the maximal inequality case, where one person is earning ALL the money in a country and everyone else is earning nothing. The gini04 variable is from the year 2004 whereas the gini08 variable is from the year 2008.

Numerically summarize the gini04 variable. That is, calculate and present the measures for central tendency and those for dispersion.

```r
gini04 <- (world.data$gini04)
gini04_clean <- na.omit(gini04)
gini04_clean
```

```
  [1] 28.2 35.3 52.2 37.9 35.2 30.0 36.5 31.8 30.4 25.0 44.7 26.2 63.0 59.1 31.9
 [16] 48.2 33.3 40.4 44.6 33.1 61.3 57.1 44.7 57.6 46.5 45.2 29.0 25.4 24.7 47.4
 [31] 43.7 34.4 53.2 37.2 30.0 26.9 32.7 38.0 36.9 28.3 30.0 35.4 48.3 47.0 40.3
 [46] 43.2 55.0 24.4 32.5 34.3 43.0 35.9 35.5 36.0 37.9 24.9 36.4 31.3 44.5 31.6
 [61] 29.0 37.0 32.4 63.2 31.9 30.8 28.2 47.5 50.3 49.2 50.5 39.0 54.6 36.2 44.0
 [76] 39.5 39.6 70.7 36.7 32.6 36.2 55.1 50.5 50.6 25.8 33.0 56.4 50.9 56.8 49.8
 [91] 46.1 31.6 38.5 30.3 45.6 28.9 41.3 62.9 42.5 25.8 28.4 59.3 32.5 34.4 42.6
[106] 60.9 25.0 33.1 34.7 38.2 43.2 40.3 39.8 40.0 40.8 43.0 29.0 36.0 40.8 44.6
[121] 26.8 49.1 36.1 33.4 52.6 56.8
attr(,"na.action")
 [1]   1   4   5   6  12  13  15  18  19  20  25  32  34  38  39  40  44  45  48
[20]  49  54  55  58  61  67  72  75  79  88  89  91  95  97  98  99 106 108 109
[39] 111 113 115 119 121 129 131 139 143 144 145 147 152 153 157 159 160 161 165
[58] 166 170 171 176 177 184 187 189
attr(,"class")
[1] "omit"
```

```r
mean(gini04_clean) # mean equals 40.14
```

```
[1] 40.13889
```

```r
range(gini04_clean) # range equals 24.4 and 70.7
```

```
[1] 24.4 70.7
```

```r
var(gini04_clean) # variance equals 107.33
```

```
[1] 107.3291
```

```r
sd(gini04_clean) # standard variation equals 10.36
```

```
[1] 10.35998
```

Numerically summarize the gini08 variable.

```
gini08_clean <- na.omit(world.data$gini08)
gini08_clean
```

```
  [1] 31.1 35.3 51.3 33.8 35.2 29.1 36.5 33.4 29.7 33.0 36.5 60.1 26.2 60.5 57.0
 [16] 29.2 39.5 42.4 41.7 44.6 32.6 61.3 54.9 46.9 58.6 49.8 44.6 29.0 25.4 24.7
 [31] 51.6 53.6 34.4 52.4 35.8 30.0 26.9 32.7 50.2 40.4 28.3 40.8 34.3 55.1 47.0
 [46] 38.6 59.2 53.8 26.9 36.8 34.3 43.0 34.3 39.2 36.0 45.5 24.9 38.8 33.9 42.5
 [61] 31.6 30.3 34.6 37.7 63.2 36.0 31.0 39.0 47.5 39.0 49.2 40.1 39.0 46.1 33.2
 [76] 32.8 39.5 47.3 74.3 47.2 30.9 36.2 43.1 50.5 43.7 25.8 30.6 56.1 50.9 58.4
 [91] 52.0 44.5 34.5 38.5 31.0 39.9 46.8 41.3 62.9 42.5 25.8 28.4 57.8 34.7 40.2
[106] 43.0 50.4 25.0 33.7 32.6 34.6 42.0 38.9 39.8 43.6 40.8 45.7 28.1 36.0 40.8
[121] 44.9 36.8 48.2 34.4 33.4 50.8 50.1
attr(,"na.action")
 [1]   1   4   5   6  12  13  15  18  20  25  32  34  38  39  40  44  45  48  49
[20]  54  55  58  61  67  71  75  79  88  89  91  95  97  98  99 106 108 109 111
[39] 113 115 119 121 129 131 139 143 144 145 147 152 153 157 159 160 161 165 166
[58] 170 171 176 177 184 187 189
attr(,"class")
[1] "omit"
```

```
mean(gini08_clean) # mean equals 40.74
```

```
[1] 40.74252
```

```
range(gini08_clean) # range equals 24.7 and 74.3
```

```
[1] 24.7 74.3
```

```
var(gini08_clean) # variance equals 99.98
```

```
[1] 99.98484
```

```
sd(gini08_clean) # standard deviation equals 9.99
```

```
[1] 9.999242
```

Compare the distributions of gini04 and gini08. Do you think

that the level of economic inequality is getting worse,

getting better, or neither? Why or why not?

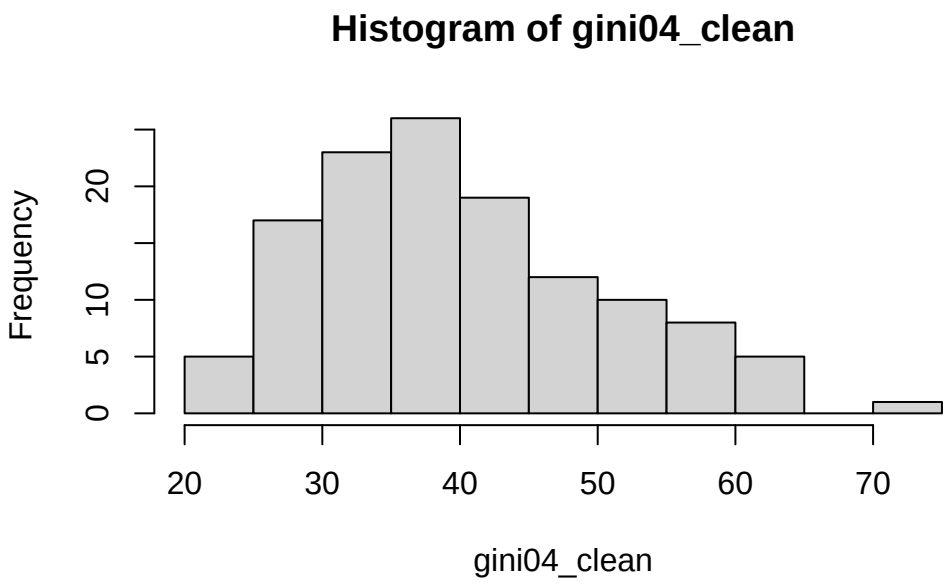
based on the summary I have produced for the two years, I don't believe definitive conclusions can be made on the evolution of income inequality. There is a slight increase in income inequality based on the mean value increasing from 40.14 to 40.74 which is notable. The max also increased from 70.7 to 74.3 which suggests that the wealthy have increased in wealth relative to the .3 increase for the minimum. Both the mean and range suggest increases in inequality. However, because we do not know the direction in the variance or the standard deviation it is hard to make concrete, definitive takeaways.

Create a histogram of gini04

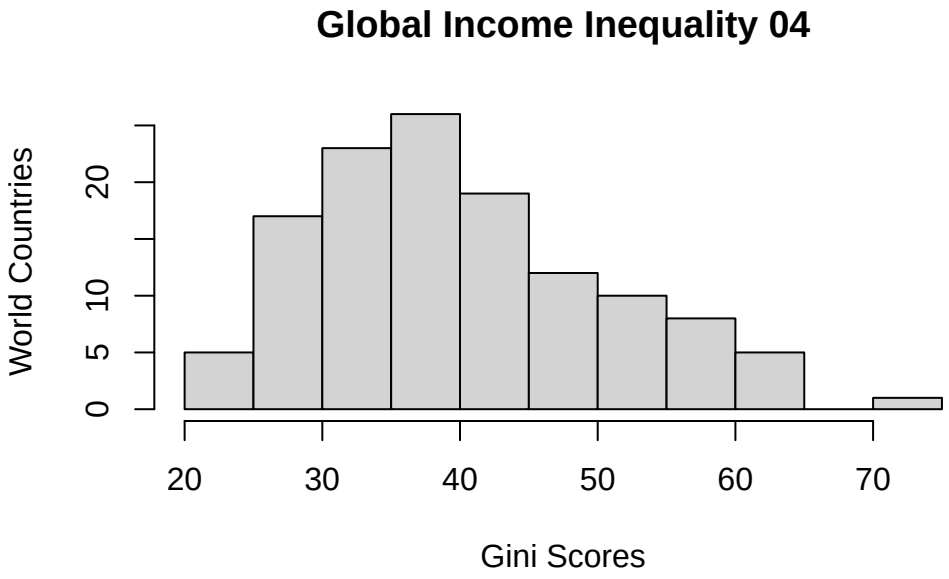
Modify the axis labels accordingly to make them informative

and intuitive. Save the graph as a PDF file.

```
hist(gini04_clean)
```




```
hist_gini04 <- hist(gini04_clean, xlab = "Gini Scores", ylab = "World Countries", main = "Gl
```



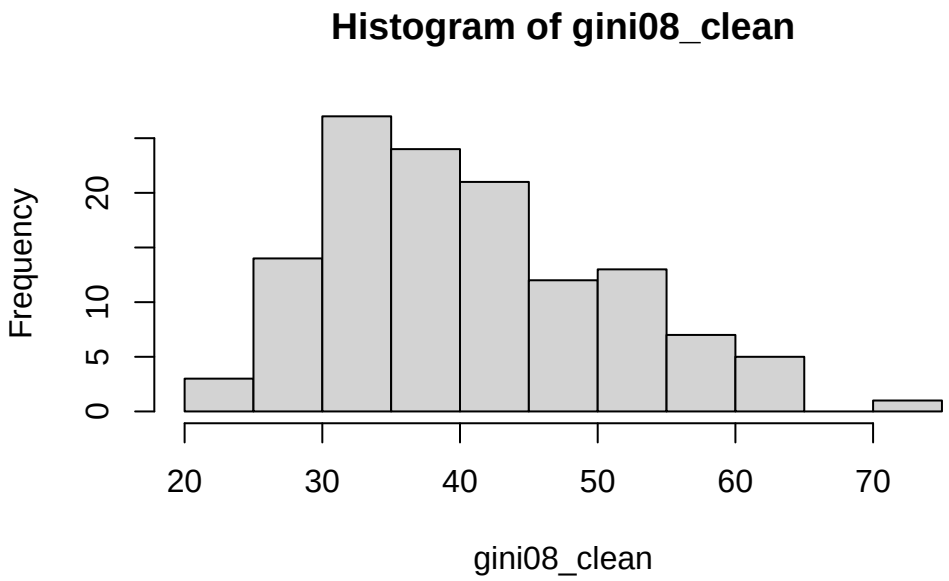

```
pdf("gini_04_histogram.pdf", width = 8, height = 6)
hist(gini04_clean, xlab = "Gini Scores", ylab = "World Countries", main = "Global Income Ine
dev.off()
```

```
pdf
  2
```

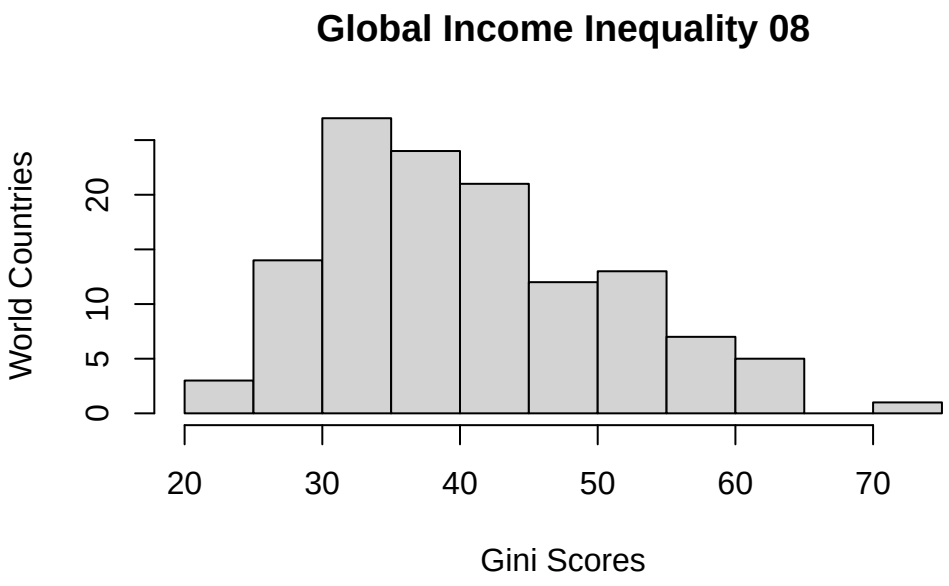
Create a histogram of gini08

Modify the axis labels accordingly to make them informative and intuitive. Save the graph as a PDF file.

```
hist(gini08_clean)
```




```
hist_gini08 <- hist(gini08_clean, xlab = "Gini Scores", ylab = "World Countries", main = "Gl
```




```
pdf("gini_08_histogram.pdf", width = 8, height = 6)
hist(gini08_clean, xlab = "Gini Scores", ylab = "World Countries", main = "Global Income Ine
dev.off()
```

```
pdf
  2
```

Compare the distributions of gini04 and gini08 graphically by placing the two PDF files you just created side by side.

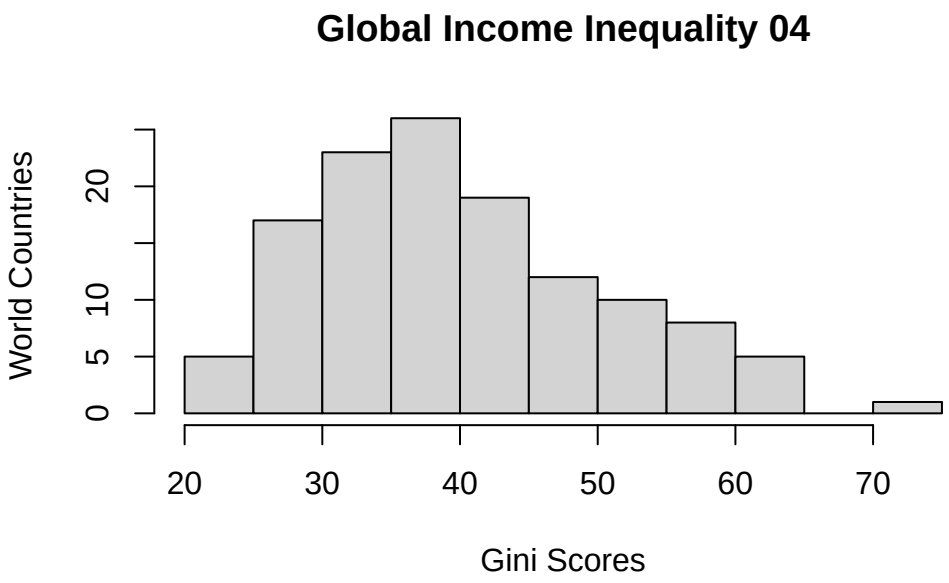
Do you confirm the conclusion you derived previously?

Generally the conclusions that there is not enough evidence to support increases or decreases in income inequality over the four years based on the histograms remains true. The one notable difference in the graph compared to the statistical summary, is that the variation appears to increase in terms of more income equality based on the fact that the bars with smaller Gini values increase slighlty in the 08 graph compared to the 04 graph. Additionally, there is a slight reduction to the bars with higher Gini values.

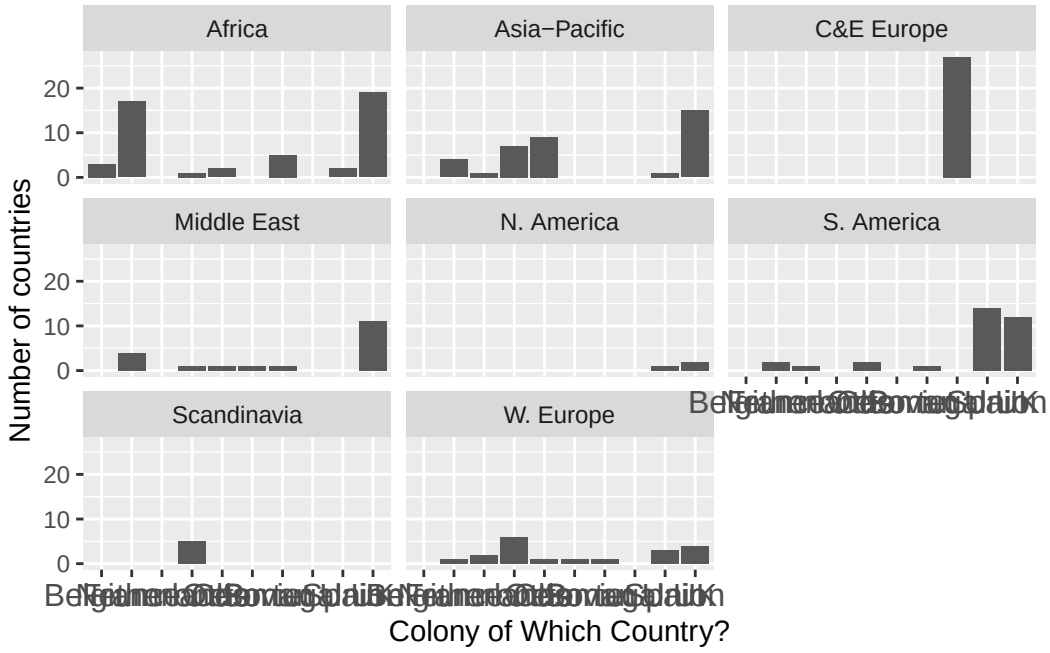
As we saw in the lecture, we sometimes create histograms for different values of a nominal-level variable. For example, we may want to create separate histograms of gini04 for countries in different regions.

To do so, we use the facet_wrap option, as follows.

```
hist_gini04 <- hist(gini04_clean, xlab = "Gini Scores", ylab = "World Countries", main = "Gl
```

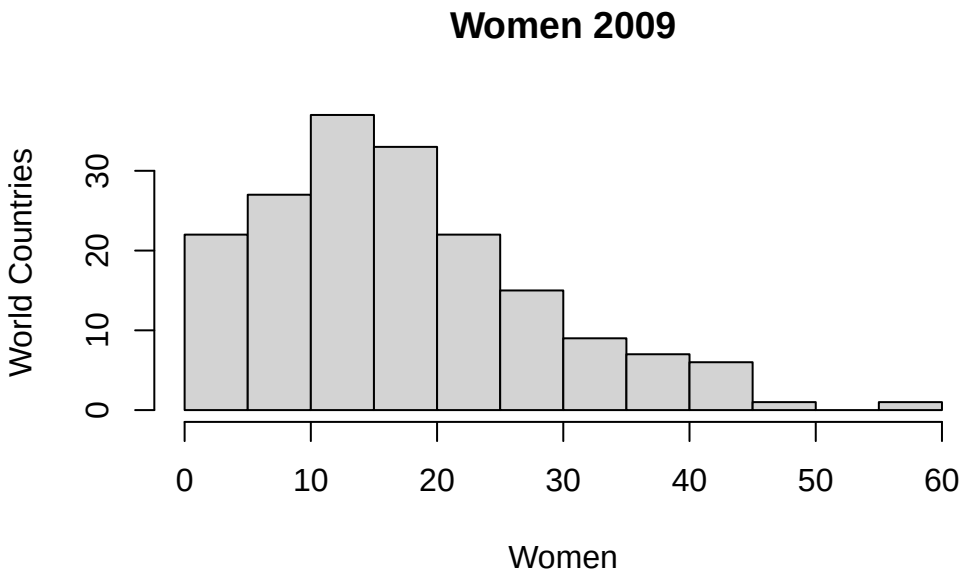



```
g <- g + facet_wrap( ~ region)
g
```

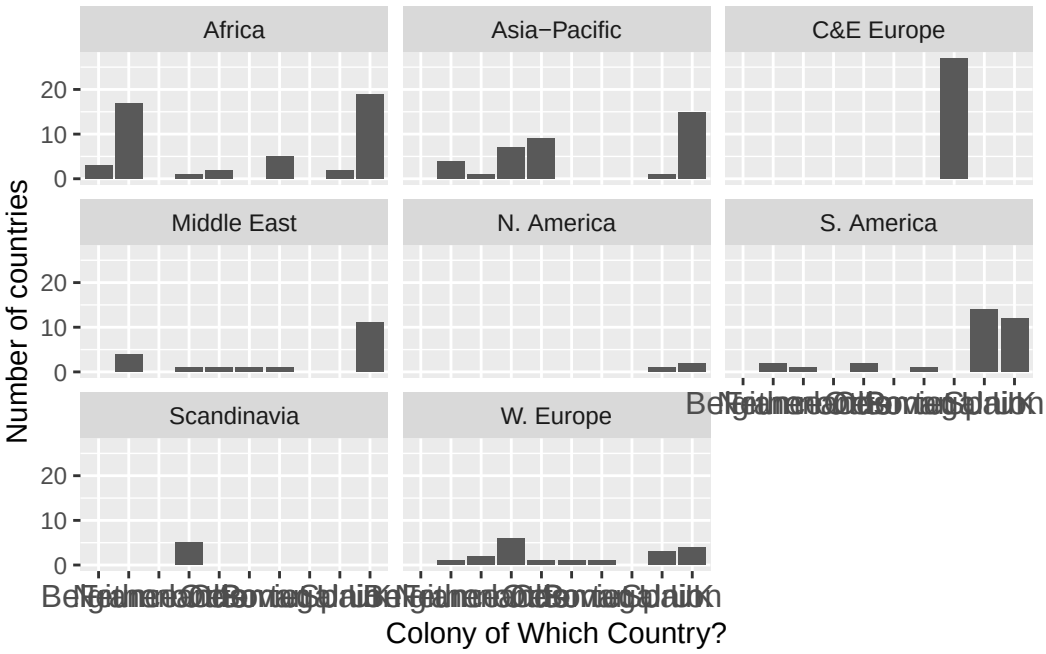


Create separate histograms of women09 for countries in different regions.

```
view(world.data)
women09 <- world.data$women09
women09_clean <- na.omit(world.data$women09)
hist_women09 <- hist(women09_clean, xlab = "Women", ylab = "World Countries", main = "Women 2
```




```
g <- g + facet_wrap( ~ region)
g
```


Africa
Asia−Pacific
C&E Europe
Middle East
N. America
S. America
Scandinavia
W. Europe
Number of countries
0
10
20
Colony of Which Country?

We may want to do the same using numerical methods.

That is, we may want to obtain central tendencies and

dispersions for a numerical variable for different groups.

To do so, we use the by function.

The by function take the following form

by(VARIABLE_YOU_WANT_TO_ANALYZE, GROUP, FUNCTION)

That is, you provide

(1) an interval-level variable you want to summarize first,

(2) a comma

(3) a nominal variable that separates observations into groups

(4) a comma

(5) a function you want to apply (such as summary, mean,

median, sd, etc.)

For example, to obtain numerical summaries of gini04 for

different regions,

we write

```
by(world.data $ gini04, world.data $ region, summary)
```

```
world.data$region: Africa
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  28.90   39.30   47.00   47.31   54.70   70.70      18
------------------------------------------------------------
world.data$region: Asia-Pacific
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  24.90   33.98   36.45   38.23   43.40   50.90      17
------------------------------------------------------------
world.data$region: C&E Europe
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  24.40   28.25   30.85   31.77   35.83   45.60       1
------------------------------------------------------------
world.data$region: Middle East
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  33.40   35.23   37.95   37.75   39.85   43.00      11
------------------------------------------------------------
world.data$region: N. America
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
  33.10   36.95   40.80   42.83   47.70   54.60
------------------------------------------------------------
world.data$region: S. America
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  37.90   44.60   49.10   49.55   55.10   59.10      11
------------------------------------------------------------
world.data$region: Scandinavia
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  24.70   24.93   25.40   25.60   26.07   26.90       1
------------------------------------------------------------
world.data$region: W. Europe
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
  25.00   30.80   32.70   32.83   35.90   38.50       6
```

Calculate the standard deviation of gini04 for different

regions using the by function

Hint: we still need to take care of the missing value problem. # Use the na.rm = TRUE option.

```
by(world.data$gini04, world.data$region, sd, na.rm = TRUE)
```

```
world.data$region: Africa
[1] 11.06417
------------------------------------------------------------
world.data$region: Asia-Pacific
[1] 6.651417
------------------------------------------------------------
world.data$region: C&E Europe
[1] 5.167651
------------------------------------------------------------
world.data$region: Middle East
[1] 3.314901
------------------------------------------------------------
world.data$region: N. America
[1] 10.89327
------------------------------------------------------------
world.data$region: S. America
[1] 6.329504
------------------------------------------------------------
world.data$region: Scandinavia
[1] 0.9831921
------------------------------------------------------------
world.data$region: W. Europe
[1] 3.679761
```

Scandanavia has the smallest dispersion at 0.9831921