R code for POLI502 Lab

Week 4: Individual Exercises

Written by: Conor Craig

1. Exploring a data set ————————————————————————-

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

```
world.data <- read.csv("~/School/Fall 2023/Poli 502/world.csv")
```

```
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 in cluded

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 (under 1m)
##  $ pr_sys          : chr  "No" "No" "Yes" "No" ...
##  $ protact3        : chr  "" "Moderate" "" "" ...
##  $ regime_type3    : chr  "Dictatorship" "Parliamentary democ" "Dictatorship" "Parliamentary democ"
##  $ 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.

```
table(world.data$democ_regime)
```

```
##
##  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.

```
table(world.data$typerel)
```

```
##
##        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

```
religion_table <- table(world.data$typerel)
vert_table <- data.frame(religion_table)
vert_table
```

```
##             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

```
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

```r
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.

To summarize the steps to create a frequency table:

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

Create a frequency table for the typerel variable

```
religion <- data.frame (table(world.data$typerel))
religion$Percent <- round(prop.table(religion$Freq) * 100, digits = 2)
colnames (religion)[colnames(religion) == "Var1"] <- "religion"
religion
```

```
##         religion Freq Percent
## 1        eastern   15    7.85
## 2          Hindu    2    1.05
## 3         Jewish    1    0.52
## 4         Muslim   50   26.18
## 5       Orthodox   13    6.81
## 6          other   12    6.28
## 7     Protestant   35   18.32
## 8 Roman Catholic   63   32.98
```

Which religion is the most "popular" in the world?

That is, what is the mode of the "typerel" variable?

```
relig_data <- data.frame(world.data$typerel)
relig_freq_table <- table (relig_data$world.data.typerel)
mode_values <- names(relig_freq_table[relig_freq_table == max(relig_freq_table)])
cat("Mode of Religion:", paste(mode_values, collapse = ", "), "\n")
```

```
## Mode of Religion: Roman Catholic
```

```
# Roman Catholic is the most popular religion within this sample
```

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

```
relig_data <- data.frame(world.data$typerel)
percent_relig_table <- prop.table (table(relig_data))
(percent_relig_table [c ("Muslim")]) *100
```

```
##   Muslim
## 26.17801
```

Create a frequency table for democ_regime

```r
dem_data <- data.frame(world.data$democ_regime)
freq_dem_table <- table (dem_data)
View(freq_dem_table)
```

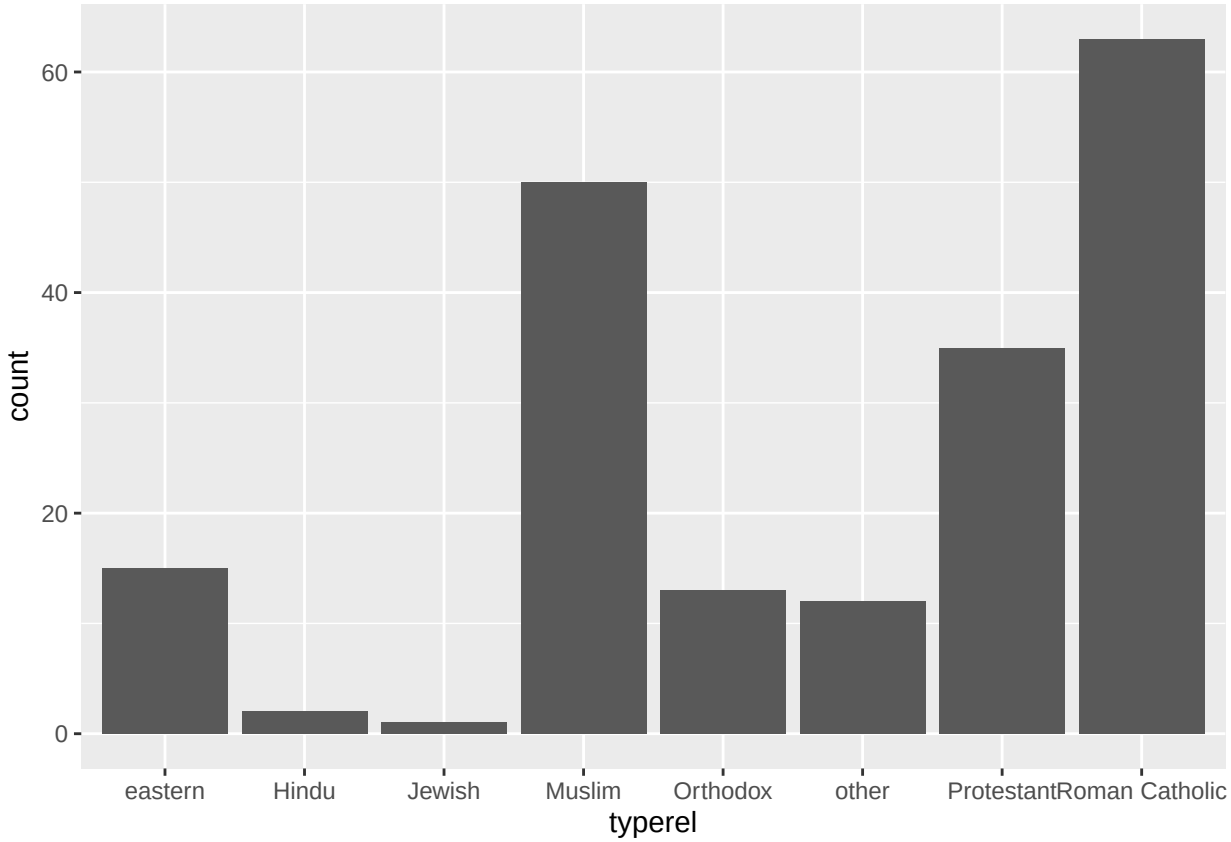
What percentage of countries have a democratic regime?

```r
percent_demo_table <- prop.table (table(dem_data))
(percent_demo_table [c ("Yes")]) *100
```

```
##      Yes
## 60.31746
```

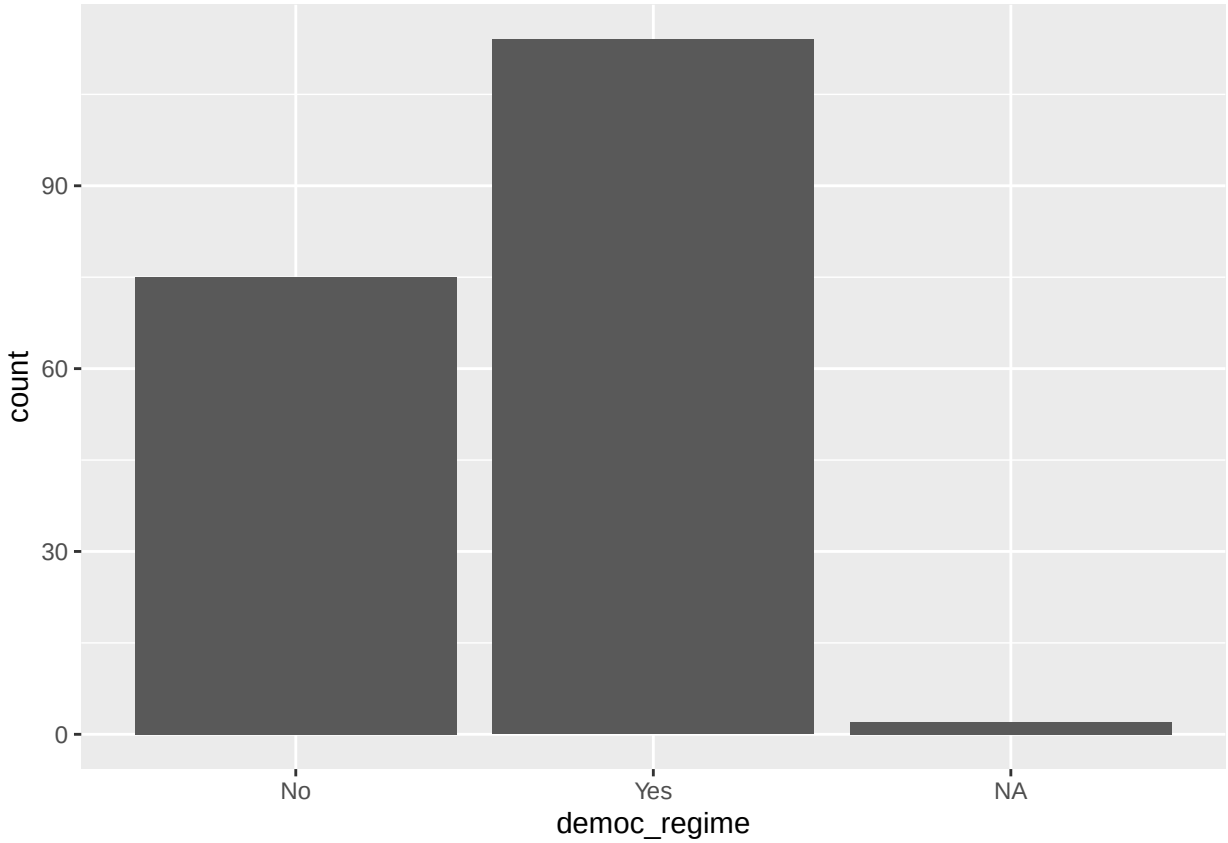
Create a bar chart to summarize the typerel variable

```r
library(ggplot2)
ggplot(world.data, aes(x = typerel)) + geom_bar()
```



Create a bar chart to summarize the democ_regime variable

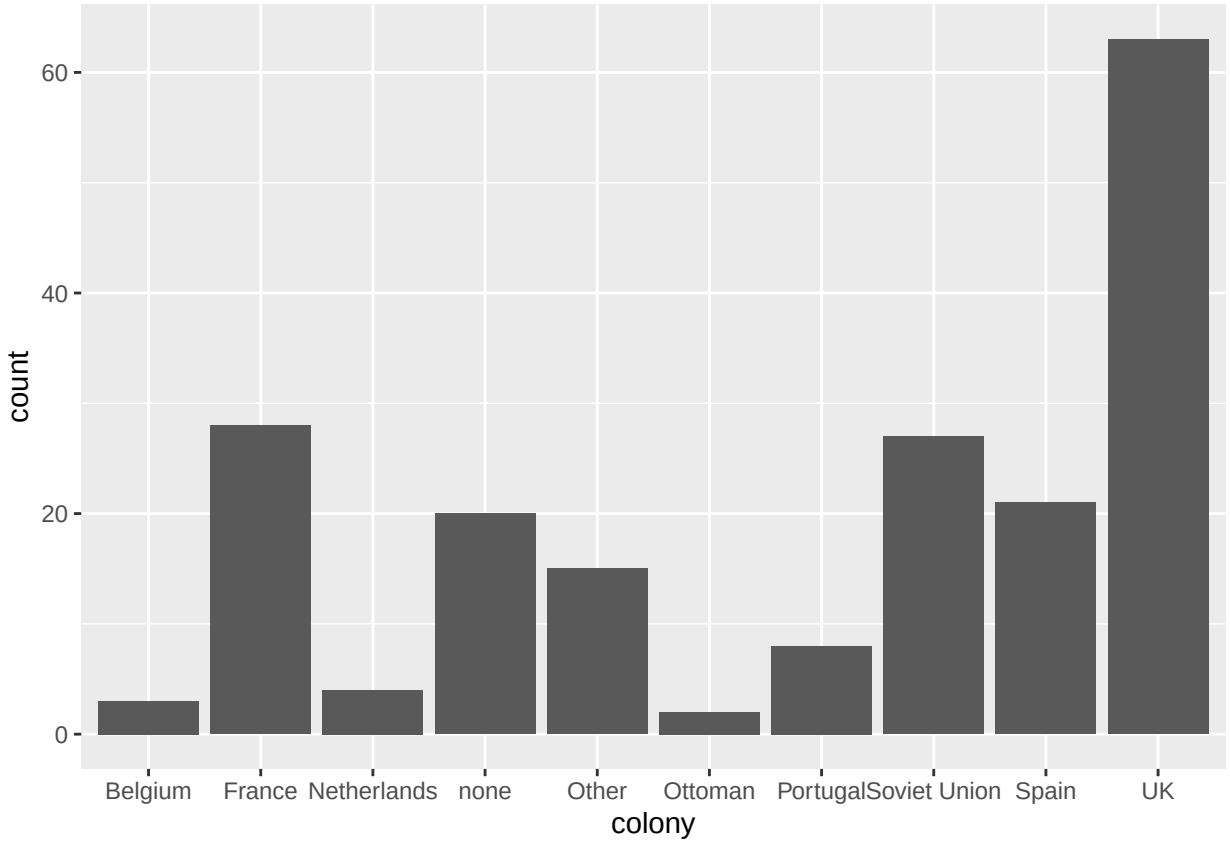
```
ggplot(world.data, aes(x = democ_regime)) + geom_bar()
```



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()
```



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) # Tells R which data frame contains the variable to plot g <- g + aes(x = colony) # Tells R which variable to plot g <- g + geom_bar() # Tells R what type of graph we want g # Tells R

to show the contents of the object 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.

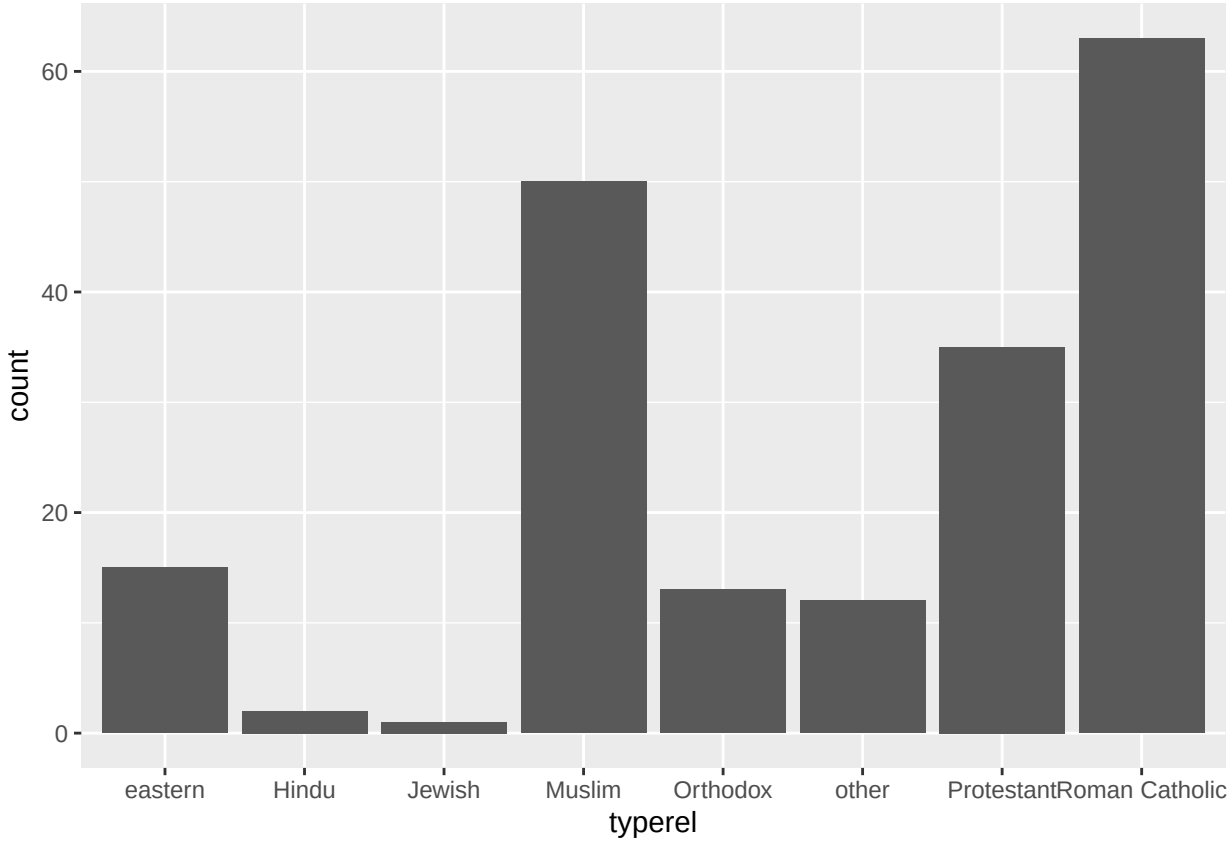
Once you save a graph in a PDF, you can easily embed it in a Word document simply by drag & drop.

To summarize what we have done so far,

g <- ggplot(world.data) g <- g + aes(x = colony) g <- g + geom_bar() g <- g + xlab("Colony of Which Country?") g <- g + ylab("Number of countries") g <- g + theme(axis.text.x = element_text(size = 12)) g ggsave(file = "colony_bar.pdf", width = 10, height = 8)

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

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




```
ggsave(file = "religion_type_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.

```
sum(is.na(world.data$gini04))
```

```
## [1] 65
```

```r
ginio4 <- na.omit(world.data$gini04)
mean(ginio4)
```

```
## [1] 40.13889
```

```r
sd(ginio4)
```

```
## [1] 10.35998
```

Numerically summarize the gini08 variable.

That is, calculate and present the measures for central tendency and

those for dispersion.

```r
sum(is.na(world.data$gini08))
```

```
## [1] 64
```

```r
ginio8 <- na.omit(world.data$gini08)
mean(ginio8)
```

```
## [1] 40.74252
```

```r
sd(ginio8)
```

```
## [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?

Note: I'm not asking why it is getting better, worse, or neither;

I'm asking on what basis you can conclude that it's getting better or worse.

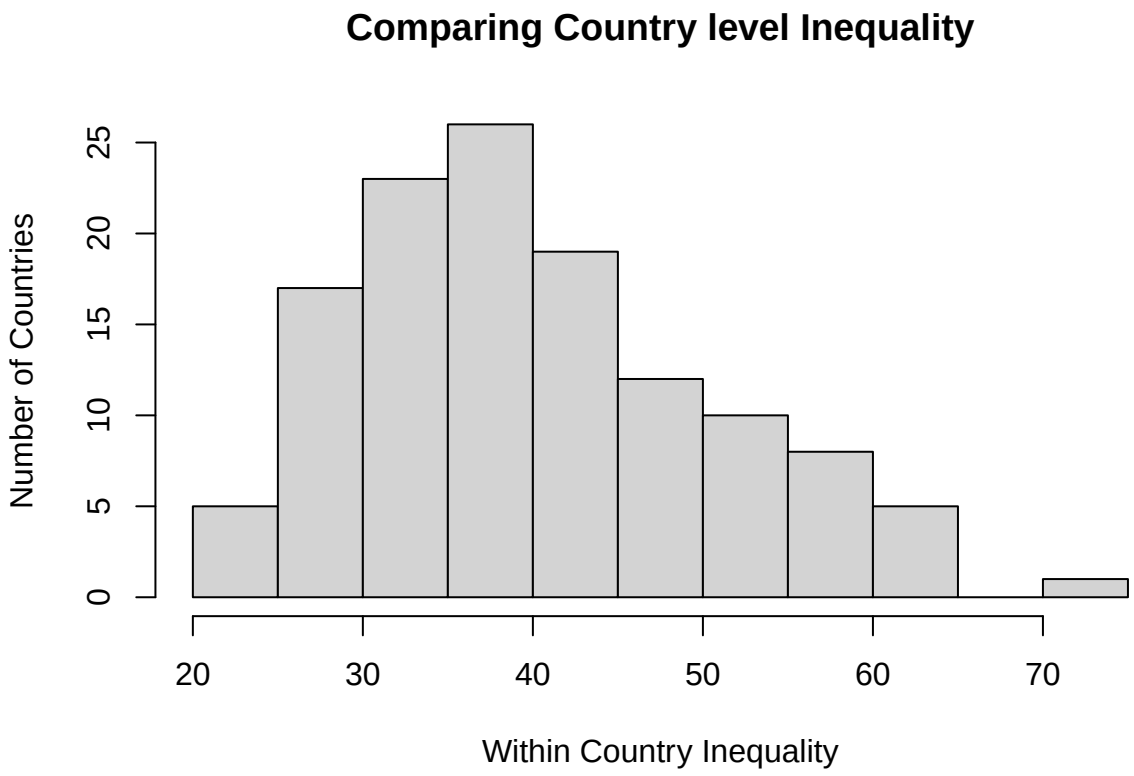
```
# Inequality has changed very little across the four years, though 2004 is
  # slightly better
```

Create a histogram of gini04

Modify the axis labels accordingly to make them informative and intuitive.

Save the graph as a PDF file.

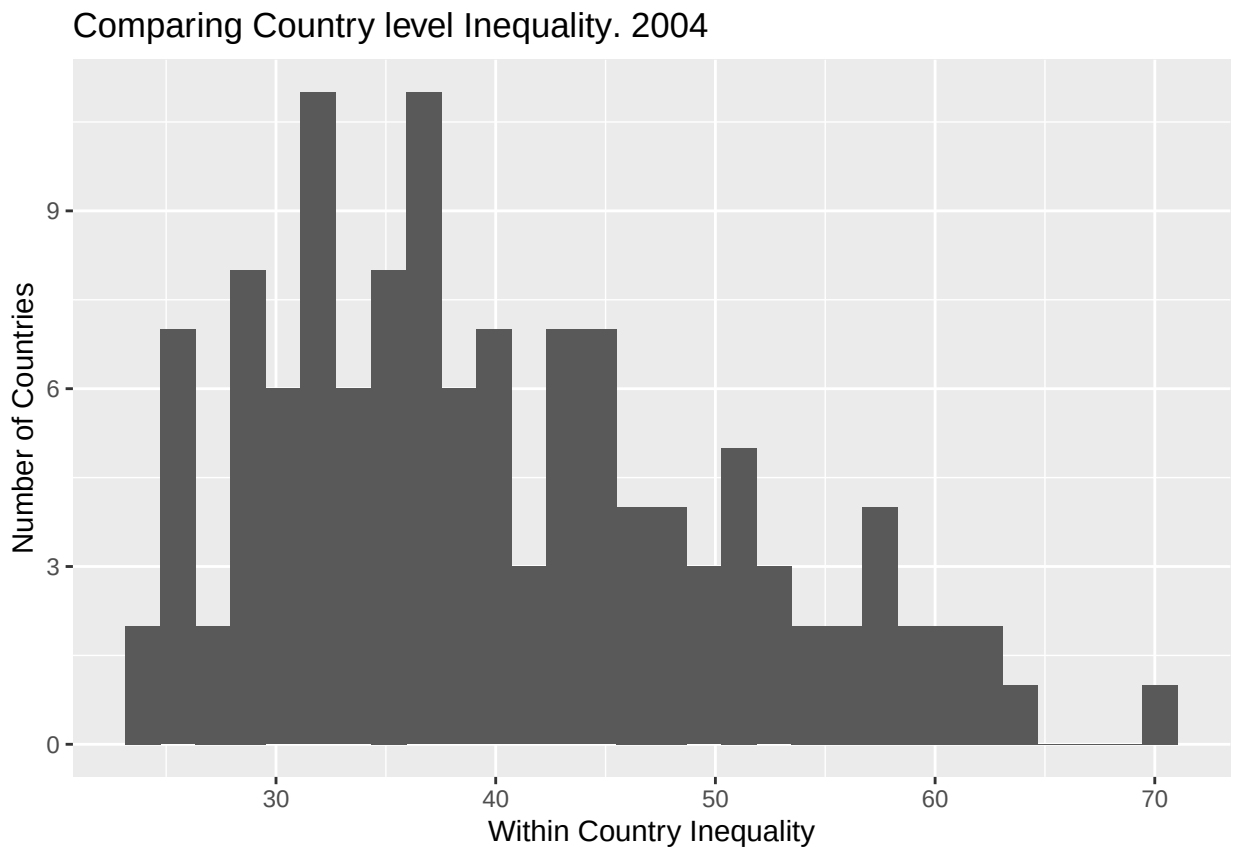
```
hist(world.data$gini04, ylab = "Number of Countries",
  xlab = "Within Country Inequality", main = "Comparing Country level Inequality")
```




```
ggplot (world.data, aes(gini04)) + geom_histogram() +
labs (x = "Within Country Inequality", y = "Number of Countries",
title = "Comparing Country level Inequality. 2004")
```

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

```
## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).
```




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

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

```
## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).
```

Create a histogram of gini08

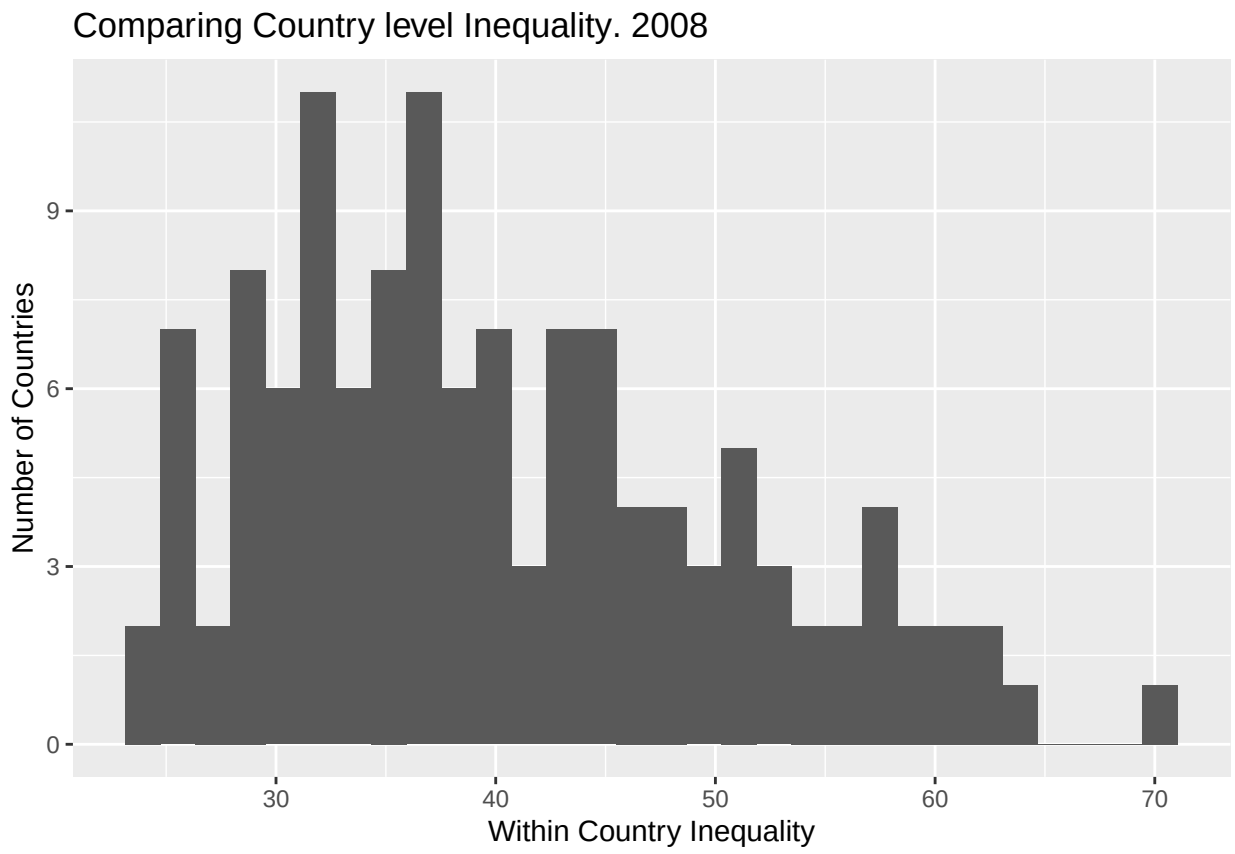
Modify the axis labels accordingly to make them informative and intuitive.

Save the graph as a PDF file.

```
ggplot (world.data, aes(gini04)) + geom_histogram() +
labs (x = "Within Country Inequality", y = "Number of Countries",
title = "Comparing Country level Inequality. 2008")
```

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

```
## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).
```




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

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

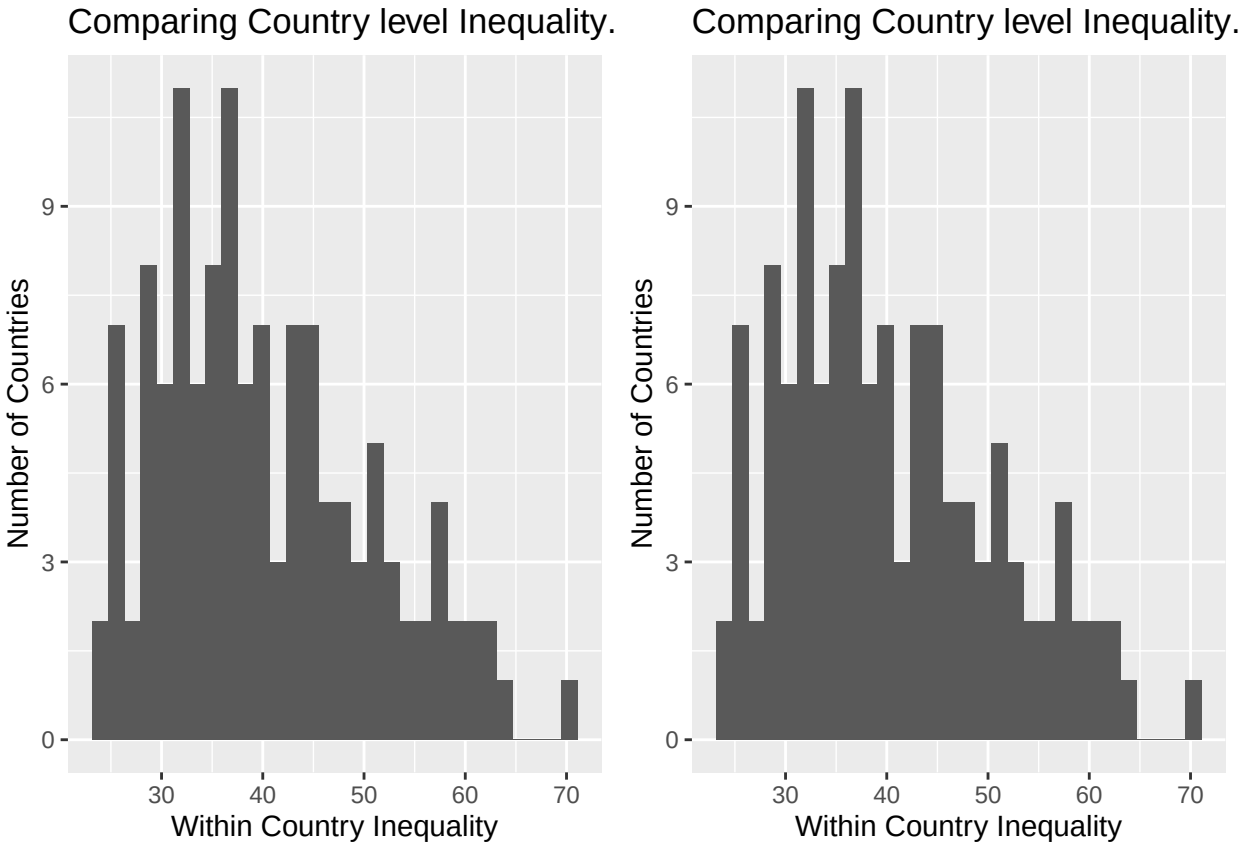
```
## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).
```

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?

```
library(gridExtra)
gini_04_hist <- ggplot (world.data, aes(gini04)) + geom_histogram() +
labs (x = "Within Country Inequality", y = "Number of Countries",
title = "Comparing Country level Inequality. 2004")

gini_08_hist <- ggplot (world.data, aes(gini04)) + geom_histogram() +
labs (x = "Within Country Inequality", y = "Number of Countries",
title = "Comparing Country level Inequality. 2008")

grid.arrange(gini_04_hist, gini_08_hist, ncol = 2)
```

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

## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).

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

## Warning: Removed 65 rows containing non-finite values (`stat_bin()`).
```




```
# Yes. The graphs are very similar.
```

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.

COPY & PASTE THE CODE YOU WROTE TO PRODUCE HISTOGRAM FOR gini04 HERE

g <- g + facet_wrap(~ region) g

We can see that Scandinavian countries and Western European countries

have, on average, lower Gini coefficients (= they are more egalitarian),

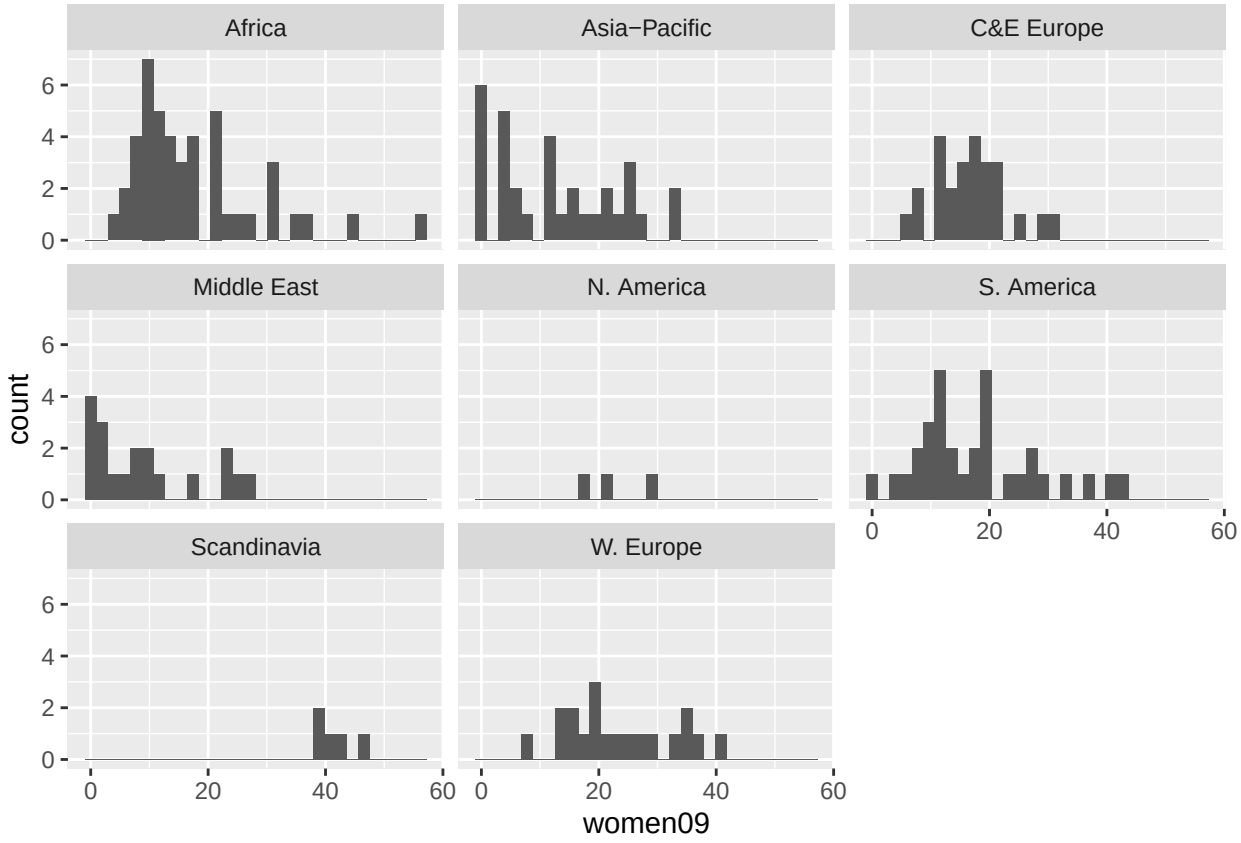
whereas countries in South America have relatively high values.

Create separate histograms of women09 for countries in different regions.

```
ggplot (world.data, aes(women09)) + geom_histogram() + facet_wrap( ~ region)
```

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

```
## Warning: Removed 11 rows containing non-finite values (`stat_bin()`).
```



```
# Unsure what this variable is measuring which is why I did not include labels
```

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)

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
```

Which region has the smallest dispersion?

```
inequality_dispersion <- by(world.data$gini04, world.data$region, sd, na.rm = TRUE)
sd_results <- unlist(inequality_dispersion)
min_index <- which.min(sd_results)
min_sd_region <- names(inequality_dispersion)[min_index]
cat("Region with Minimum Standard Deviation:", min_sd_region, "\n")
```

```
## Region with Minimum Standard Deviation: Scandinavia
```

```
#Scandinavia is the region with the smallest dispersion
```

End of file