Jam

Samantha Ream and Josh Jenkins

2025-02-23

```
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   3.5.0     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 become errors
```

```
library(corrplot)
```

```
## corrplot 0.95 loaded
```

```
library(ggplot2)
library(dbplyr)
```

```
##
## Attaching package: 'dbplyr'
##
## The following objects are masked from 'package:dplyr':
##
##     ident, sql
```

```
library(colorspace)
library(tidyr)
library(astsa)
library(maps)
```

```
##
## Attaching package: 'maps'
##
## The following object is masked from 'package:astsa':
##
##     unemp
##
```

```
## The following object is masked from 'package:purrr':
##
##     map
```

```
library(sf)
```

```
## Linking to GEOS 3.11.2, GDAL 3.8.2, PROJ 9.3.1; sf_use_s2() is TRUE
```

```
# data upload
age_consent <- read.csv("data/Age-of-Sexual-Consent.csv")
slavery_index <- read.csv("data/Global_Slavery_Index_2023.csv")
marriage <- read.csv("data/Percentage-of-Females-Married-by-15-years-old.csv")
human_trafficking <- read.csv("data/human-trafficking-victims_new.csv")
inequality <- read.csv("data/Gender_Inequality_Index.csv")
```

```
nrow(age_consent) #201
```

```
## [1] 201
```

```
nrow(slavery_index) # 180
```

```
## [1] 180
```

```
nrow(marriage) #202
```

```
## [1] 202
```

```
nrow(human_trafficking) # 364
```

```
## [1] 364
```

```
head(human_trafficking) # 84
```

```
##         Entity Code Year Detected.victims.of.human.trafficking
## 1 Burkina Faso  BFA 2007                                   289
## 2     Colombia  COL 2007                                     6
## 3      Germany  DEU 2007                                     7
## 4         Mali  MLI 2007                                     5
## 5  Netherlands  NLD 2007                                    16
## 6       Norway  NOR 2007                                    19
```

```
unique(human_trafficking$Entity)
```

```
##  [1] "Burkina Faso"          "Colombia"              "Germany"
##  [4] "Mali"                  "Netherlands"           "Norway"
##  [7] "Philippines"           "Romania"               "Serbia"
## [10] "Tajikistan"            "Togo"                  "Belarus"
## [13] "Ghana"                 "Mexico"                "Qatar"
```

```
## [16] "Armenia"                "Bolivia"               "Nepal"
## [19] "Paraguay"               "Peru"                  "United Kingdom"
## [22] "Argentina"              "Egypt"                 "Ireland"
## [25] "Myanmar"                "Nigeria"               "United States"
## [28] "Bosnia and Herzegovina" "Bulgaria"              "Congo"
## [31] "Dominican Republic"     "Moldova"               "Venezuela"
## [34] "Canada"                 "Czechia"               "Ecuador"
## [37] "Honduras"               "Italy"                 "Jamaica"
## [40] "Mozambique"             "Thailand"              "Uzbekistan"
## [43] "Guinea"                 "Uganda"                "Guatemala"
## [46] "Hungary"                "Laos"                  "Austria"
## [49] "Denmark"                "France"                "Lithuania"
## [52] "Mauritius"              "Niger"                 "Turkey"
## [55] "Ukraine"                "Algeria"               "Cote d'Ivoire"
## [58] "Croatia"                "Finland"               "Greece"
## [61] "Slovakia"               "Tunisia"               "Angola"
## [64] "Benin"                  "Cameroon"              "India"
## [67] "Kazakhstan"             "Malaysia"              "Morocco"
## [70] "Russia"                 "Brazil"                "El Salvador"
## [73] "Estonia"                "Indonesia"             "Namibia"
## [76] "South Africa"           "Spain"                 "Sudan"
## [79] "Costa Rica"             "Iraq"                  "Lebanon"
## [82] "Portugal"               "North Macedonia"       "Sierra Leone"
```

```
head(age_consent)
```

```
##          Country  Age.Of.Consent
## 1    Afghanistan Must be married
## 2        Albania              14
## 3        Algeria              16
## 4 American Samoa              16
## 5        Andorra              16
## 6         Angola              12
```

```
head(slavery_index)
```

```
##               Country    Population                  Region
## 1         Afghanistan   38,928,000     Asia and the Pacific
## 2             Albania    2,878,000  Europe and Central Asia
## 3             Algeria   43,851,000                   Africa
## 4              Angola   32,866,000                   Africa
## 5 Antigua and Barbuda       98,000                 Americas
## 6           Argentina   45,196,000                 Americas
##   Estimated.prevalence.of.modern.slavery.per.1.000.population
## 1                                                        13.0
## 2                                                        11.8
## 3                                                         1.9
## 4                                                         4.1
## 5                                                          NA
## 6                                                         4.2
##   Estimated.number.of.people.in.modern.slavery
## 1                                      505,000
## 2                                       34,000
```

```
## 3                                      84,000
## 4                                     136,000
## 5
## 6                                     189,000
```

```
slavery_index <- slavery_index |>
  rename(Per_1000 = Estimated.prevalence.of.modern.slavery.per.1.000.population) |>
  rename(Num_modern_slavery = Estimated.number.of.people.in.modern.slavery)

head(marriage)
```

```
##     Countries Percentage.of.Females.Married.by.15.years.old
## 1 Afghanistan                                            10
## 2     Albania                                             1
## 3     Algeria                                             0
## 4     Andorra                                             -
## 5      Angola                                             8
## 6    Anguilla                                             -
```

```
marriage <- marriage |>
  rename(Percent_married_15 = Percentage.of.Females.Married.by.15.years.old) |>
  rename(Country = Countries)

head(human_trafficking)
```

```
##         Entity Code Year Detected.victims.of.human.trafficking
## 1 Burkina Faso  BFA 2007                                   289
## 2     Colombia  COL 2007                                     6
## 3      Germany  DEU 2007                                     7
## 4         Mali  MLI 2007                                     5
## 5  Netherlands  NLD 2007                                    16
## 6       Norway  NOR 2007                                    19
```

```
human_trafficking <- human_trafficking |>
  rename(Detected_Number = Detected.victims.of.human.trafficking) |>
  rename(Country = Entity)

#slavery_index |> group_by(Region)
```

```
slavery_index <- left_join(slavery_index, age_consent, by = "Country")

slavery_index <- left_join(slavery_index, marriage, by = "Country")

#slavery_index <- slavery_index |> mutate(across(everything(), ~replace_na(.x, NA)))

head(slavery_index)
```

```
##               Country    Population                  Region Per_1000
## 1         Afghanistan   38,928,000     Asia and the Pacific     13.0
## 2             Albania    2,878,000  Europe and Central Asia     11.8
## 3             Algeria   43,851,000                  Africa      1.9
```

```
## 4              Angola   32,866,000                   Africa      4.1
## 5 Antigua and Barbuda       98,000                 Americas       NA
## 6           Argentina   45,196,000                 Americas      4.2
##   Num_modern_slavery  Age.Of.Consent Percent_married_15
## 1            505,000 Must be married                 10
## 2             34,000              14                  1
## 3             84,000              16                  0
## 4            136,000              12                  8
## 5                                 16                  -
## 6            189,000              18                  2
```

```
# slavery_index <- slavery_index |>
#   mutate(Percent_married_15 = recode(Percent_married_15, - = NA))

#slavery_index[5, "Percent_married_15"]
```

```
# Column Prep

slavery_index$Num_modern_slavery <- replace(slavery_index$Num_modern_slavery,
                                            slavery_index$Num_modern_slavery=="", NA)

slavery_index$Num_modern_slavery <- as.numeric(gsub(",","",slavery_index$Num_modern_slavery))

slavery_index$Population <- as.double(gsub(",","",slavery_index$Population))
```

```
## Warning: NAs introduced by coercion
```

```
slavery_index$Percent_married_15 <- as.double(replace(slavery_index$Percent_married_15, slavery_index$P
```

```
slavery_index |> group_by(Region)
```

```
## # A tibble: 180 x 7
## # Groups:   Region [5]
##    Country          Population Region Per_1000 Num_modern_slavery Age.Of.Consent
##    <chr>                 <dbl> <chr>     <dbl>              <dbl> <chr>
##  1 Afghanistan        38928000 Asia ~     13               505000 Must be marri~
##  2 Albania             2878000 Europ~     11.8              34000 14
##  3 Algeria            43851000 Africa      1.9              84000 16
##  4 Angola             32866000 Africa      4.1             136000 12
##  5 Antigua and Bar~      98000 Ameri~     NA                   NA 16
##  6 Argentina          45196000 Ameri~      4.2             189000 18
##  7 Armenia             2963000 Europ~      8.9              26000 16
##  8 Australia          25500000 Asia ~      1.6              41000 16
##  9 Austria             9006000 Europ~      1.9              17000 14
## 10 Azerbaijan         10139000 Europ~     10.6             107000 16
## # i 170 more rows
## # i 1 more variable: Percent_married_15 <dbl>
```

```
unique(slavery_index$Region)
```

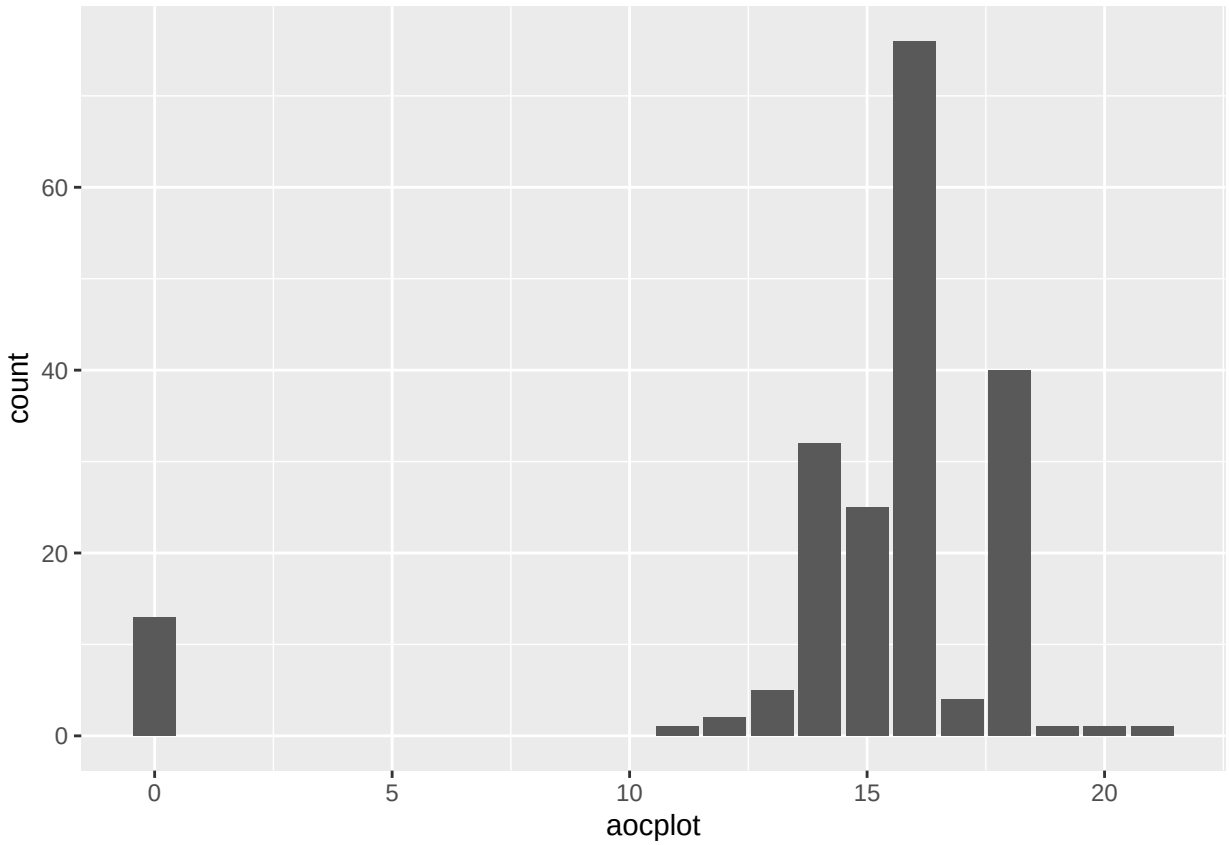
```
## [1] "Asia and the Pacific"    "Europe and Central Asia"
## [3] "Africa"                  "Americas"
## [5] "Arab States"
```

```r
Asia_Pacific_mean <- slavery_index |> filter(Region == "Asia and the Pacific") |>
  summarize(across(Per_1000, mean, na.rm=T))
```

```
## Warning: There was 1 warning in `summarize()`.
## i In argument: `across(Per_1000, mean, na.rm = T)`.
## Caused by warning:
## ! The `...` argument of `across()` is deprecated as of dplyr 1.1.0.
## Supply arguments directly to `.fns` through an anonymous function instead.
##
##   # Previously
##   across(a:b, mean, na.rm = TRUE)
##
##   # Now
##   across(a:b, \(x) mean(x, na.rm = TRUE))
```

```r
Americas_mean <- slavery_index |> filter(Region == "Americas") |> summarize(across(Per_1000, mean, na.r

Euro_Central_Asia_mean <- slavery_index |>
                              filter(Region == "Europe and Central Asia") |>
                              summarize(across(Per_1000, mean, na.rm=T))
Africa_mean <- slavery_index |>
                              filter(Region == "Africa") |>
                              summarize(across(Per_1000, mean, na.rm=T))

Arab_States_mean <- slavery_index |>
                              filter(Region == "Arab States") |>
                              summarize(across(Per_1000, mean, na.rm=T))

Regions <- data.frame(
  Region = c("Asia and the Pacific",
             "Americas", "Europe and Central Asia",
             "Africa", "Arab States"),
  Mean_Per_1000 = c(Asia_Pacific_mean[1,1],
                    Americas_mean[1,1], Euro_Central_Asia_mean[1,1],
                    Africa_mean[1,1], Arab_States_mean[1,1])
)

regions_graph <- Regions |> mutate(Region = as.factor(Region))|>
  mutate(Region = fct_reorder(Region, desc(Mean_Per_1000))) |> ggplot(aes(x = Region, y = Mean_Per_1000
  geom_col(fill = "cornflowerblue", col = "royalblue4") +
  ylab("Average Modern Slavery per 1000 People")
```

```r
aocplot <- as.double(replace(age_consent$Age.Of.Consent, age_consent$Age.Of.Consent=="Must be married",

df1 <- data.frame(x = aocplot, y = 1:201)

ggplot(df1, aes(x=aocplot)) +
  geom_bar()
```




```
country_max <- slavery_index[which.max(slavery_index$Per_1000), ]
country_min <- slavery_index[which.min(slavery_index$Per_1000), ]

slavery_index |> arrange(desc(Per_1000))
```

```
##                          Country Population                  Region
## 1                    North Korea   25779000    Asia and the Pacific
## 2                        Eritrea    3546000                  Africa
## 3                     Mauritania    4650000                  Africa
## 4                   Saudi Arabia   34814000             Arab States
## 5                        Türkiye   84339000 Europe and Central Asia
## 6                     Tajikistan    9538000 Europe and Central Asia
## 7           United Arab Emirates    9890000             Arab States
## 8                    Afghanistan   38928000    Asia and the Pacific
## 9                         Kuwait    4271000             Arab States
## 10                        Russia  145934000 Europe and Central Asia
## 11                       Ukraine   43734000 Europe and Central Asia
## 12              North Macedonia    2083000 Europe and Central Asia
## 13                       Myanmar   54410000    Asia and the Pacific
## 14                  Turkmenistan    6031000 Europe and Central Asia
## 15                       Albania    2878000 Europe and Central Asia
## 16                       Belarus    9449000 Europe and Central Asia
## 17                    Kazakhstan   18777000 Europe and Central Asia
## 18                    Azerbaijan   10139000 Europe and Central Asia
## 19                      Pakistan  220892000    Asia and the Pacific
## 20              Papua New Guinea    8947000    Asia and the Pacific
```

```
## 21                    South Sudan   11194000                  Africa
## 22          Bosnia and Herzegovina    3281000 Europe and Central Asia
## 23                         Jordan   10203000             Arab States
## 24                        Moldova    4034000 Europe and Central Asia
## 25                      Venezuela   28436000                Americas
## 26                        Armenia    2963000 Europe and Central Asia
## 27                     Kyrgyzstan    6524000 Europe and Central Asia
## 28                          Syria   17501000             Arab States
## 29                       Bulgaria    6948000 Europe and Central Asia
## 30                          Haiti   11403000                Americas
## 31                    El Salvador    6486000                Americas
## 32                         Cyprus    1207000 Europe and Central Asia
## 33                          India 1380004000    Asia and the Pacific
## 34                         Kosovo         NA Europe and Central Asia
## 35           Republic of the Congo    5518000                  Africa
## 36                       Colombia   50883000                Americas
## 37               Equatorial Guinea    1403000                  Africa
## 38                        Georgia    3989000 Europe and Central Asia
## 39                      Guatemala   17916000                Americas
## 40                        Nigeria  206140000                  Africa
## 41                    Philippines  109581000    Asia and the Pacific
## 42                       Slovakia    5460000 Europe and Central Asia
## 43                        Ecuador   17643000                Americas
## 44                          Gabon    2226000                  Africa
## 45                        Lebanon    6825000             Arab States
## 46                        Burundi   11891000                  Africa
## 47                        Romania   19238000 Europe and Central Asia
## 48                     Uzbekistan   33469000 Europe and Central Asia
## 49                 Côte d'Ivoire   26378000                  Africa
## 50                        Jamaica    2961000                Americas
## 51                      Nicaragua    6625000                Americas
## 52                        Bolivia   11673000                Americas
## 53                     Bangladesh  164689000    Asia and the Pacific
## 54                       Djibouti     988000                  Africa
## 55                           Iran   83993000    Asia and the Pacific
## 56                           Peru   32972000                Americas
## 57                       Honduras    9905000                Americas
## 58                         Serbia    8737000 Europe and Central Asia
## 59                          Libya    6871000                  Africa
## 60                          Qatar    2881000             Arab States
## 61                        Bahrain    1702000             Arab States
## 62                      Indonesia  273524000    Asia and the Pacific
## 63             Dominican Republic   10848000                Americas
## 64                        Hungary    9660000 Europe and Central Asia
## 65                         Mexico  128933000                Americas
## 66                         Gambia    2417000                  Africa
## 67                           Oman    5107000             Arab States
## 68                      Sri Lanka   21413000    Asia and the Pacific
## 69                         Greece   10423000 Europe and Central Asia
## 70                       Paraguay    7133000                Americas
## 71                       Ethiopia  114964000                  Africa
## 72                       Malaysia   32366000    Asia and the Pacific
## 73                        Somalia   15893000                  Africa
## 74                      Lithuania    2722000 Europe and Central Asia
```

```
## 75                        Timor-Leste    1318000    Asia and the Pacific
## 76                              Yemen   29826000              Arab States
## 77                               Chad   16426000                   Africa
## 78                           Cameroon   26546000                   Africa
## 79                           Thailand   69800000    Asia and the Pacific
## 80                               Iraq   40223000              Arab States
## 81                             Poland   37847000 Europe and Central Asia
## 82                               Cuba   11327000                 Americas
## 83          Central African Republic    4830000                   Africa
## 84                            Croatia    4105000 Europe and Central Asia
## 85                            Lao PDR    7276000    Asia and the Pacific
## 86                               Mali   20251000                   Africa
## 87                             Zambia   18384000                   Africa
## 88                             Brazil  212559000                 Americas
## 89                           Cambodia   16719000    Asia and the Pacific
## 90                              Kenya   53771000                   Africa
## 91                           Zimbabwe   14863000                   Africa
## 92                             Malawi   19130000                   Africa
## 93                             Panama    4315000                 Americas
## 94                Trinidad and Tobago    1399000                 Americas
## 95                         Madagascar   27691000                   Africa
## 96                              Niger   24207000                   Africa
## 97  Democratic Republic of the Congo   89561000                   Africa
## 98                       Guinea-Bissau    1968000                   Africa
## 99                            Slovenia    2079000 Europe and Central Asia
## 100                              Egypt  102334000                   Africa
## 101                             Rwanda   12952000                   Africa
## 102                          Argentina   45196000                 Americas
## 103                            Czechia   10709000 Europe and Central Asia
## 104                             Guyana     787000                 Americas
## 105                             Uganda   45741000                   Africa
## 106                             Angola   32866000                   Africa
## 107                            Estonia    1327000 Europe and Central Asia
## 108                           Viet Nam   97339000    Asia and the Pacific
## 109                              China 1439324000    Asia and the Pacific
## 110                             Guinea   13133000                   Africa
## 111                           Mongolia    3278000    Asia and the Pacific
## 112                              Sudan   43849000                   Africa
## 113                             Israel    8656000 Europe and Central Asia
## 114                           Portugal   10197000 Europe and Central Asia
## 115                       Burkina Faso   20903000                   Africa
## 116                           Eswatini    1160000                   Africa
## 117                        South Korea   51269000    Asia and the Pacific
## 118                             Latvia    1886000 Europe and Central Asia
## 119                       Sierra Leone    7977000                   Africa
## 120                              Italy   60462000 Europe and Central Asia
## 121                              Nepal   29137000    Asia and the Pacific
## 122                               Togo    8279000                   Africa
## 123          United States of America  331003000                 Americas
## 124                              Chile   19116000                 Americas
## 125                         Costa Rica    5094000                 Americas
## 126                            Liberia    5058000                   Africa
## 127                              Benin   12123000                   Africa
## 128                         Mozambique   31255000                   Africa
```

```
## 129                           Ghana   31073000                  Africa
## 130                         Senegal   16744000                  Africa
## 131                        Tanzania   59734000                  Africa
## 132                       Hong Kong    7497000    Asia and the Pacific
## 133                    South Africa   59309000                  Africa
## 134                         Namibia    2541000                  Africa
## 135                         Morocco   36911000                  Africa
## 136                           Spain   46755000 Europe and Central Asia
## 137                         Tunisia   11819000                  Africa
## 138                          France   65274000 Europe and Central Asia
## 139                       Singapore    5850000    Asia and the Pacific
## 140                         Algeria   43851000                  Africa
## 141                         Austria    9006000 Europe and Central Asia
## 142                         Uruguay    3474000                Americas
## 143                        Botswana    2352000                  Africa
## 144                          Canada   37742000                Americas
## 145                  United Kingdom   67886000 Europe and Central Asia
## 146                          Taiwan   23817000    Asia and the Pacific
## 147                       Australia   25500000    Asia and the Pacific
## 148                         Lesotho    2142000                  Africa
## 149                     New Zealand    4822000    Asia and the Pacific
## 150                       Mauritius    1272000                  Africa
## 151                         Finland    5541000 Europe and Central Asia
## 152                         Ireland    4938000 Europe and Central Asia
## 153                           Japan  126476000    Asia and the Pacific
## 154                         Belgium   11590000 Europe and Central Asia
## 155                         Denmark    5792000 Europe and Central Asia
## 156                         Germany   83784000 Europe and Central Asia
## 157                     Netherlands   17135000 Europe and Central Asia
## 158                          Sweden   10099000 Europe and Central Asia
## 159                          Norway    5421000 Europe and Central Asia
## 160                     Switzerland    8655000 Europe and Central Asia
## 161             Antigua and Barbuda      98000                Americas
## 162                         Bahamas     393000                Americas
## 163                        Barbados     287000                Americas
## 164                          Belize     398000                Americas
## 165                Brunei Darussalam     437000    Asia and the Pacific
## 166                       Cape Verde         NA                  Africa
## 167                             Fiji     896000    Asia and the Pacific
## 168                         Iceland     341000 Europe and Central Asia
## 169                   Liechtenstein         NA Europe and Central Asia
## 170                      Luxembourg     626000 Europe and Central Asia
## 171                        Maldives     541000    Asia and the Pacific
## 172                           Malta     442000 Europe and Central Asia
## 173                      Montenegro     628000 Europe and Central Asia
## 174                           Palau         NA    Asia and the Pacific
## 175                     Saint Lucia     184000                Americas
## 176 Saint Vincent and the Grenadines     111000                Americas
## 177                      Seychelles      98000                  Africa
## 178                  Solomon Islands     687000    Asia and the Pacific
## 179                        Suriname     587000                Americas
## 180                         Vanuatu     307000    Asia and the Pacific
##     Per_1000 Num_modern_slavery  Age.Of.Consent Percent_married_15
## 1      104.6            2696000              15                 NA
```

```
## 2       90.3            320000             18             13.0
## 3       32.0            149000             16             16.0
## 4       21.3            740000 Must be married              NA
## 5       15.6           1320000           <NA>              2.0
## 6       14.0            133000             16              0.0
## 7       13.4            132000 Must be married              NA
## 8       13.0            505000 Must be married             10.0
## 9       13.0             55000 Must be married              NA
## 10      13.0           1899000             16              NA
## 11      12.8            559000             16              0.0
## 12      12.6             26000           <NA>              0.0
## 13      12.1            657000             14              2.0
## 14      11.9             72000             16              0.0
## 15      11.8             34000             14              1.0
## 16      11.3            107000             16              0.0
## 17      11.1            208000             16              0.0
## 18      10.6            107000             16              2.0
## 19      10.6           2349000 Must be married              4.0
## 20      10.3             93000             16              8.0
## 21      10.3            115000             18              9.0
## 22      10.1             33000           <NA>              0.0
## 23      10.0            102000             16              2.0
## 24       9.5             38000             16              NA
## 25       9.5            270000             16              NA
## 26       8.9             26000             16              0.0
## 27       8.7             57000             16              0.0
## 28       8.7            153000             15              NA
## 29       8.5             59000             14              NA
## 30       8.2             94000             18              2.0
## 31       8.1             52000             18              4.0
## 32       8.0             10000             17              NA
## 33       8.0          11050000             18              5.0
## 34       8.0             14000           <NA>              NA
## 35       8.0             44000             18              NA
## 36       7.8            397000             14              5.0
## 37       7.8             11000             18              9.0
## 38       7.8             31000             16              0.0
## 39       7.8            140000             18              6.0
## 40       7.8           1611000             11             12.0
## 41       7.8            859000             12              2.0
## 42       7.7             42000           <NA>              NA
## 43       7.6            135000             14              4.0
## 44       7.6             17000             18              3.0
## 45       7.6             52000             18              1.0
## 46       7.5             89000             18              3.0
## 47       7.5            145000             15              0.5
## 48       7.4            249000             16              0.0
## 49       7.3            193000           <NA>              7.0
## 50       7.3             22000             16              1.0
## 51       7.3             49000             18             10.0
## 52       7.2             83000             14              NA
## 53       7.1           1162000             14             16.0
## 54       7.1              7000             18              1.0
## 55       7.1            597000 Must be married              NA
```

```
## 56       7.1            234000             14               2.0
## 57       7.0             69000             15               9.0
## 58       7.0             61000             14               1.0
## 59       6.8             47000 Must be married               NA
## 60       6.8             20000 Must be married               0.0
## 61       6.7             11000             21                NA
## 62       6.7           1833000             16               2.0
## 63       6.6             72000             18               9.0
## 64       6.6             63000             14                NA
## 65       6.6            850000             17               4.0
## 66       6.5             16000             18               6.0
## 67       6.5             33000 Must be married               1.0
## 68       6.5            139000             16               1.0
## 69       6.4             66000             15                NA
## 70       6.4             46000             14               4.0
## 71       6.3            727000             18              14.0
## 72       6.3            202000             16                NA
## 73       6.2             98000             18               8.0
## 74       6.1             17000             16               0.0
## 75       6.1              8000           <NA>               3.0
## 76       6.0            180000 Must be married               7.0
## 77       5.9             97000             14              24.0
## 78       5.8            155000             16              11.0
## 79       5.7            401000             15               6.0
## 80       5.5            221000             18               7.0
## 81       5.5            209000             15                NA
## 82       5.4             61000             16               5.0
## 83       5.2             25000           <NA>              26.0
## 84       5.2             22000             15                NA
## 85       5.2             38000           <NA>                NA
## 86       5.2            106000             18              16.0
## 87       5.1             94000             16               5.0
## 88       5.0           1053000             14               6.0
## 89       5.0             83000             15               2.0
## 90       5.0            269000             18               2.0
## 91       5.0             74000             16               5.0
## 92       4.9             93000             14               8.0
## 93       4.7             20000             18               7.0
## 94       4.7              7000             16               1.0
## 95       4.6            127000             14              13.0
## 96       4.6            112000             13              28.0
## 97       4.5            407000             14               8.0
## 98       4.5              9000           <NA>               8.0
## 99       4.4              9000             15                NA
## 100      4.3            442000             18               2.0
## 101      4.3             55000             18               0.0
## 102      4.2            189000             18               2.0
## 103      4.2             45000           <NA>                NA
## 104      4.2              3000           <NA>               6.0
## 105      4.2            190000             18               7.0
## 106      4.1            136000             12               8.0
## 107      4.1              5000             14                NA
## 108      4.1            396000           <NA>               1.0
## 109      4.0           5771000             14               0.0
```

```
## 110      4.0             53000             15             17.0
## 111      4.0             13000             16              1.0
## 112      4.0            174000 Must be married             12.0
## 113      3.8             33000             16               NA
## 114      3.8             39000             14               NA
## 115      3.7             77000             13              9.0
## 116      3.6              4000           <NA>              0.0
## 117      3.5            180000             20               NA
## 118      3.4              6000             16               NA
## 119      3.4             27000             18              9.0
## 120      3.3            197000             14               NA
## 121      3.3             97000             16              6.0
## 122      3.3             28000             16              6.0
## 123      3.3           1091000           <NA>               NA
## 124      3.2             61000             18               NA
## 125      3.2             16000             15              2.0
## 126      3.1             16000             18              6.0
## 127      3.0             37000             18              6.0
## 128      3.0             93000           <NA>             17.0
## 129      2.9             91000             16              3.0
## 130      2.9             49000             16              9.0
## 131      2.9            171000             18               NA
## 132      2.8             21000           <NA>               NA
## 133      2.7            158000             16              1.0
## 134      2.4              6000             16              2.0
## 135      2.3             85000           <NA>              1.0
## 136      2.3            108000             16               NA
## 137      2.3             27000             18              0.0
## 138      2.1            135000             15               NA
## 139      2.1             12000             16              0.0
## 140      1.9             84000             16              0.0
## 141      1.9             17000             14               NA
## 142      1.9              7000             15              1.0
## 143      1.8              4000             16               NA
## 144      1.8             69000             16               NA
## 145      1.8            122000             16               NA
## 146      1.7             40000             16               NA
## 147      1.6             41000             16               NA
## 148      1.6              4000             16              1.0
## 149      1.6              8000             16               NA
## 150      1.5              2000             14               NA
## 151      1.4              8000             16               NA
## 152      1.1              5000             17               NA
## 153      1.1            144000             13               NA
## 154      1.0             11000             16              0.0
## 155      0.6              4000             15               NA
## 156      0.6             47000             14               NA
## 157      0.6             10000             16               NA
## 158      0.6              6000             15               NA
## 159      0.5              3000             16              0.0
## 160      0.5              4000             16               NA
## 161       NA                NA             16               NA
## 162       NA                NA             16               NA
## 163       NA                NA             16              8.0
```

```
## 164       NA                 NA              16                6.0
## 165       NA                 NA            <NA>                 NA
## 166       NA                 NA              14                 NA
## 167       NA                 NA              16                0.0
## 168       NA                 NA              15                 NA
## 169       NA                 NA              14                 NA
## 170       NA                 NA              16                 NA
## 171       NA                 NA Must be married                0.0
## 172       NA                 NA              18                 NA
## 173       NA                 NA              14                2.0
## 174       NA                 NA              16                 NA
## 175       NA                 NA              16                4.0
## 176       NA                 NA              15                 NA
## 177       NA                 NA              18                 NA
## 178       NA                 NA              15                6.0
## 179       NA                 NA              16                9.0
## 180       NA                 NA              16                3.0
```

```
slavery_index |> filter(Region == "Asia and the Pacific") |> arrange(desc(Per_1000))
```

```
##              Country Population               Region Per_1000
## 1        North Korea   25779000 Asia and the Pacific    104.6
## 2        Afghanistan   38928000 Asia and the Pacific     13.0
## 3            Myanmar   54410000 Asia and the Pacific     12.1
## 4           Pakistan  220892000 Asia and the Pacific     10.6
## 5   Papua New Guinea    8947000 Asia and the Pacific     10.3
## 6              India 1380004000 Asia and the Pacific      8.0
## 7        Philippines  109581000 Asia and the Pacific      7.8
## 8         Bangladesh  164689000 Asia and the Pacific      7.1
## 9               Iran   83993000 Asia and the Pacific      7.1
## 10         Indonesia  273524000 Asia and the Pacific      6.7
## 11         Sri Lanka   21413000 Asia and the Pacific      6.5
## 12          Malaysia   32366000 Asia and the Pacific      6.3
## 13       Timor-Leste    1318000 Asia and the Pacific      6.1
## 14          Thailand   69800000 Asia and the Pacific      5.7
## 15           Lao PDR    7276000 Asia and the Pacific      5.2
## 16          Cambodia   16719000 Asia and the Pacific      5.0
## 17          Viet Nam   97339000 Asia and the Pacific      4.1
## 18             China 1439324000 Asia and the Pacific      4.0
## 19          Mongolia    3278000 Asia and the Pacific      4.0
## 20       South Korea   51269000 Asia and the Pacific      3.5
## 21             Nepal   29137000 Asia and the Pacific      3.3
## 22         Hong Kong    7497000 Asia and the Pacific      2.8
## 23         Singapore    5850000 Asia and the Pacific      2.1
## 24            Taiwan   23817000 Asia and the Pacific      1.7
## 25         Australia   25500000 Asia and the Pacific      1.6
## 26       New Zealand    4822000 Asia and the Pacific      1.6
## 27             Japan  126476000 Asia and the Pacific      1.1
## 28 Brunei Darussalam     437000 Asia and the Pacific       NA
## 29              Fiji     896000 Asia and the Pacific       NA
## 30          Maldives     541000 Asia and the Pacific       NA
## 31             Palau         NA Asia and the Pacific       NA
## 32   Solomon Islands     687000 Asia and the Pacific       NA
## 33           Vanuatu     307000 Asia and the Pacific       NA
```

```
##    Num_modern_slavery  Age.Of.Consent Percent_married_15
## 1             2696000              15                 NA
## 2              505000 Must be married                 10
## 3              657000              14                  2
## 4             2349000 Must be married                  4
## 5               93000              16                  8
## 6            11050000              18                  5
## 7              859000              12                  2
## 8             1162000              14                 16
## 9              597000 Must be married                 NA
## 10            1833000              16                  2
## 11             139000              16                  1
## 12             202000              16                 NA
## 13               8000            <NA>                  3
## 14             401000              15                  6
## 15              38000            <NA>                 NA
## 16              83000              15                  2
## 17             396000            <NA>                  1
## 18            5771000              14                  0
## 19              13000              16                  1
## 20             180000              20                 NA
## 21              97000              16                  6
## 22              21000            <NA>                 NA
## 23              12000              16                  0
## 24              40000              16                 NA
## 25              41000              16                 NA
## 26               8000              16                 NA
## 27             144000              13                 NA
## 28                 NA            <NA>                 NA
## 29                 NA              16                  0
## 30                 NA Must be married                  0
## 31                 NA              16                 NA
## 32                 NA              15                  6
## 33                 NA              16                  3
```

```
# population of top 20
# area for top 20


top_20 <- slavery_index |> arrange(desc(Per_1000)) |> head(n=20)
bottom_20 <- slavery_index |> arrange(Per_1000) |> head(n=20)
```

```
highest_pop <- slavery_index |> arrange(desc(Population))
#cutoff <- quantile(slavery_index$Population, probs = 0.992, na.rm = T)
# outliers <- slavery_index %>% filter(Population > cutoff)

lowest_pop <- slavery_index |> arrange(Population) |> filter(!is.na(Per_1000))

# biggest countries - don't use
biggest_pop_graph <- head(highest_pop, n=10) |> mutate(Country = as.factor(Country)) |>
  mutate(Country = fct_reorder(Country, Population, .desc = T)) |> ggplot(aes(x = Country, y = Per_1000
  geom_col(fill = "cornflowerblue", col = "royalblue4")

# lowest pop - don't use
```

```r
lowest_pop_graph <- head(lowest_pop, n=10) |> mutate(Country = as.factor(Country)) |>
  mutate(Country = fct_reorder(Country, Population)) |>
  ggplot(aes(x = Country, y = Per_1000)) +
  geom_col(fill = "cornflowerblue", col = "royalblue4")

# top 20
top_20_graph <- top_20 |> mutate(Country = as.factor(Country))|>
  mutate(Country = fct_reorder(Country, Per_1000)) |>
  ggplot(aes(x = Country, y = Per_1000, fill = Region)) +
  geom_col() +
  coord_flip() +
  ylab("Modern Slavery per 1000 People") +
  labs(title = "Top 20 Countries")

# bottom 20
bottom_20_graph <- bottom_20 |> mutate(Country = as.factor(Country))|>
  mutate(Country = fct_reorder(Country, Per_1000)) |>
  ggplot(aes(x = Country, y = Per_1000, fill = Region)) +
  geom_col() +
  coord_flip() +
  ylab("Modern Slavery per 1000 People") +
  labs(title = "Bottom 20 Countries")

# population
population_graph <- slavery_index |> ggplot(aes(x=Population, y=Per_1000)) +
  geom_point() +
  geom_point(col = "darkslategray") +
  ylab("Modern Slavery per 1000 People")

population_without_outliers_graph <- slavery_index |> filter(!(Country == "China" |
                                        Country == "India" | Country == "Eritrea" |
                                          Country == "North Korea")) |>
  ggplot(aes(x=Population, y=Per_1000)) +
  geom_point(col = "darkslategray") +
  ylab("Modern Slavery per 1000 People")

# Age of Consent
age_consent_graph <- slavery_index |> ggplot(aes(x=Age.Of.Consent, y=Per_1000, col = Region)) +
  geom_point() +
  xlab("Age of Consent") +
  ylab("Modern Slavery per 1000 People")

# Percent married before 15
percent_married_15_graph <- slavery_index |> ggplot(aes(x=Percent_married_15, y=Per_1000)) +
  geom_col(fill = "darkseagreen") +
  xlab("Percent of Females Married before age 15") +
  ylab("Modern Slavery per 1000 People")


# all countries w/ values w/o country labels
all_countries_per_1000 <- slavery_index |> filter(!is.na(Per_1000)) |> mutate(Country = as.factor(Counti
  mutate(Country = fct_reorder(Country, Per_1000)) |>
  ggplot(aes(x = Country, y = Per_1000, fill = Region)) +
```

```
  geom_col() +
  coord_flip() +
  theme(
    axis.ticks.y = element_blank(),
    axis.text.y = element_blank()
  ) +
  ylab("Modern Slavery per 1000 People")
```

```
# correlation

x_mx <- slavery_index[, !(names(slavery_index) %in% c("Country", "Region"))] |>
  filter(!(Age.Of.Consent == "Must be married")) |> apply(2, as.double)
corr_mx <- cor(x_mx, use = "pairwise.complete.obs")

sorted_corr <- sort(corr_mx[, "Per_1000"])
```

```
slavery_index |> filter(Country == "United Kingdom")
```

```
##          Country Population                  Region Per_1000 Num_modern_slavery
## 1 United Kingdom   67886000 Europe and Central Asia      1.8             122000
##   Age.Of.Consent Percent_married_15
## 1             16                 NA
```

forced labour, forced marriage, debt bondage, human trafficking, and child exploitation

```
climate_change <- read.csv("data/climate_change_indicators.csv")

head(climate_change)
```

```
##   ObjectId                      Country ISO2 ISO3
## 1        1 Afghanistan, Islamic Rep. of   AF  AFG
## 2        2                      Albania   AL  ALB
## 3        3                      Algeria   DZ  DZA
## 4        4               American Samoa   AS  ASM
## 5        5     Andorra, Principality of   AD  AND
## 6        6                       Angola   AO  AGO
##                                                                                 Indicator
## 1 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
## 2 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
## 3 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
## 4 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
## 5 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
## 6 Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
##             Unit
## 1 Degree Celsius
## 2 Degree Celsius
## 3 Degree Celsius
## 4 Degree Celsius
## 5 Degree Celsius
## 6 Degree Celsius
##
## 1 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
```

```
## 2 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
## 3 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
## 4 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
## 5 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
## 6 Food and Agriculture Organization of the United Nations (FAO). 2022. FAOSTAT Climate Change, Clima
##   CTS_Code                   CTS_Name
## 1     ECCS Surface Temperature Change
## 2     ECCS Surface Temperature Change
## 3     ECCS Surface Temperature Change
## 4     ECCS Surface Temperature Change
## 5     ECCS Surface Temperature Change
## 6     ECCS Surface Temperature Change
##                                                                CTS_Full_Descriptor
## 1 Environment, Climate Change, Climate Indicators, Surface Temperature Change
## 2 Environment, Climate Change, Climate Indicators, Surface Temperature Change
## 3 Environment, Climate Change, Climate Indicators, Surface Temperature Change
## 4 Environment, Climate Change, Climate Indicators, Surface Temperature Change
## 5 Environment, Climate Change, Climate Indicators, Surface Temperature Change
## 6 Environment, Climate Change, Climate Indicators, Surface Temperature Change
##    F1961  F1962  F1963  F1964  F1965 F1966  F1967  F1968  F1969  F1970  F1971
## 1 -0.113 -0.164  0.847 -0.764 -0.244 0.226 -0.371 -0.423 -0.539  0.813  0.619
## 2  0.627  0.326  0.075 -0.166 -0.388 0.559 -0.074  0.081 -0.013 -0.106 -0.195
## 3  0.164  0.114  0.077  0.250 -0.100 0.433 -0.026 -0.067  0.291  0.116 -0.385
## 4  0.079 -0.042  0.169 -0.140 -0.562 0.181 -0.368 -0.187  0.132 -0.047 -0.477
## 5  0.736  0.112 -0.752  0.308 -0.490 0.415  0.637  0.018 -0.137  0.121 -0.326
## 6  0.041 -0.152 -0.190 -0.229 -0.196 0.175 -0.081 -0.193  0.188  0.248 -0.097
##    F1972  F1973  F1974  F1975  F1976  F1977  F1978 F1979  F1980  F1981  F1982
## 1 -1.124  0.232 -0.489 -0.445 -0.286  0.513  0.129 0.361  0.600  0.483 -0.346
## 2 -0.069 -0.288 -0.139 -0.211 -0.683  0.545 -0.814 0.203 -0.414 -0.351  0.173
## 3 -0.348 -0.015 -0.503 -0.539 -0.782  0.504  0.012 0.654  0.232  0.215  0.399
## 4 -0.067  0.330 -0.308 -0.118 -0.177  0.156  0.092 0.341  0.350  0.179  0.280
## 5 -0.499  0.025 -0.371  0.246 -0.045 -0.093 -0.163 0.058 -0.188  0.178  1.044
## 6 -0.035  0.475 -0.158 -0.029 -0.313  0.272  0.037 0.291  0.279 -0.071  0.164
##    F1983  F1984  F1985  F1986  F1987 F1988  F1989 F1990  F1991  F1992  F1993
## 1  0.164  0.145  0.283 -0.141  0.391 0.919 -0.205 0.730 -0.168 -0.294  0.220
## 2 -0.128 -0.270 -0.103  0.569 -0.106 0.370 -0.066 0.795 -0.269  0.106  0.076
## 3  0.560 -0.004  0.508  0.296  0.975 1.304  0.386 1.266  0.031 -0.312  0.552
## 4  0.313  0.277  0.256  0.394  0.354 0.509  0.143 0.497  0.641  0.344 -0.069
## 5  0.859 -0.157  0.059  0.387  0.397 0.883  1.162 1.736  0.231  0.386  0.174
## 6  0.487  0.631  0.694  0.176  0.689 0.572 -0.055 0.687  0.341  0.466  0.256
##   F1994  F1995  F1996 F1997 F1998 F1999 F2000 F2001 F2002 F2003 F2004 F2005
## 1 0.430  0.359 -0.116 0.471 0.675 1.198 0.993 1.311 1.365 0.587 1.373 0.401
## 2 1.330 -0.172 -0.038 0.075 0.795 0.670 1.065 1.532 0.492 0.970 0.444 0.189
## 3 0.732  0.595  0.846 1.059 1.109 1.476 0.820 1.856 1.258 1.585 0.988 1.264
## 4 0.189  0.755  0.784    NA    NA 0.242 0.626 0.904 1.152 0.716 0.191 0.801
## 5 1.508  1.279  0.570 1.788 1.018 1.055 1.050 1.480 0.835 1.949 0.936 0.851
## 6 0.212  0.753  0.370 0.107 1.064 0.417 0.169 0.295 0.735 0.889 0.414 1.021
##   F2006 F2007 F2008 F2009 F2010 F2011 F2012 F2013 F2014 F2015 F2016 F2017 F2018
## 1 1.720 0.675 0.704 0.895 1.613 1.397 0.223 1.281 0.456 1.093 1.555 1.540 1.544
## 2 0.345 1.316 0.978 0.910 1.191 1.055 1.487 1.333 1.198 1.569 1.464 1.121 2.028
## 3 1.395 1.220 1.185 0.945 2.265 1.398 1.147 1.192 1.690 1.121 1.757 1.512 1.210
## 4 0.403 1.032 0.670    NA 1.311 0.854 0.924 1.257 1.170 1.009 1.539 1.435 1.189
## 5 1.485 1.024 0.946 1.413 0.471 1.677 1.265 0.831 1.946 1.690 1.990 1.925 1.919
## 6 0.561 0.885 0.501 0.708 1.194 0.880 0.552 1.044 0.828 1.331 1.609 0.870 1.395
```

```
##   F2019 F2020 F2021 F2022
## 1 0.910 0.498 1.327 2.012
## 2 1.675 1.498 1.536 1.518
## 3 1.115 1.926 2.330 1.688
## 4 1.539 1.430 1.268 1.256
## 5 1.964 2.562 1.533 3.243
## 6 1.752 1.162 1.553 1.212
```

```
# Temperature change with respect to a baseline climatology, corresponding to the period 1951-1980
# celcius

climate_change <- climate_change |> select(!c(Source, Unit,
                                               Indicator, ISO2, CTS_Code, CTS_Name, CTS_Full_Descriptor))

climate_2022 <- climate_change |> select(c(Country, ISO3, F2022))

nrow(climate_2022)
```

```
## [1] 225
```

```
climate_2022 |> arrange(desc(F2022))
```

```
##                                Country ISO3  F2022
## 1              Andorra, Principality of  AND  3.243
## 2                                France  FRA  2.929
## 3                            Luxembourg  LUX  2.926
## 4                               Belgium  BEL  2.807
## 5                           Switzerland  CHE  2.798
## 6                                Monaco  MCO  2.737
## 7                    Kazakhstan, Rep. of  KAZ  2.712
## 8                            Kyrgyz Rep.  KGZ  2.619
## 9                    Uzbekistan, Rep. of  UZB  2.607
## 10                      Netherlands, The  NLD  2.601
## 11                               Germany  DEU  2.596
## 12                         Liechtenstein  LIE  2.534
## 13                          Turkmenistan  TKM  2.528
## 14                               Austria  AUT  2.498
## 15                                 Spain  ESP  2.489
## 16                    Slovenia, Rep. of  SVN  2.435
## 17                        New Caledonia  NCL  2.421
## 18                           Czech Rep.  CZE  2.394
## 19                  Iran, Islamic Rep. of  IRN  2.370
## 20                              Portugal  PRT  2.318
## 21                               Morocco  MAR  2.303
## 22                               Tunisia  TUN  2.291
## 23                                Kuwait  KWT  2.275
## 24                   Russian Federation  RUS  2.261
## 25                             Gibraltar  GIB  2.228
## 26                               Denmark  DNK  2.219
## 27                     Croatia, Rep. of  HRV  2.209
## 28                              Mongolia  MNG  2.197
## 29                                  Iraq  IRQ  2.147
## 30                     Moldova, Rep. of  MDA  2.143
```

```
## 31                             Hungary  HUN  2.142
## 32                               Italy  ITA  2.135
## 33                  San Marino, Rep. of  SMR  2.115
## 34                              Sweden  SWE  2.110
## 35               Bosnia and Herzegovina  BIH  2.091
## 36                  Azerbaijan, Rep. of  AZE  2.080
## 37                  Tajikistan, Rep. of  TJK  2.074
## 38                              Finland  FIN  2.062
## 39                      Poland, Rep. of  POL  2.056
## 40                             Holy See  VAT  2.028
## 41                         Slovak Rep.   SVK  2.018
## 42                  Bahrain, Kingdom of  BHR  2.017
## 43         Afghanistan, Islamic Rep. of  AFG  2.012
## 44                       Western Sahara  ESH  1.970
## 45                     Estonia, Rep. of  EST  1.961
## 46                             Lithuania  LTU  1.960
## 47                                 Malta  MLT  1.955
## 48                               Latvia   LVA  1.953
## 49                               Romania  ROU  1.949
## 50            Saint Pierre and Miquelon  SPM  1.944
## 51                       Serbia, Rep. of  SRB  1.938
## 52                               Ukraine  UKR  1.931
## 53                     Belarus, Rep. of   BLR  1.922
## 54                               Norway   NOR  1.918
## 55                        United Kingdom  GBR  1.911
## 56                 China, P.R.: Mainland  CHN  1.906
## 57                             Montenegro  MNE  1.865
## 58                                 Qatar  QAT  1.855
## 59                             Cabo Verde  CPV  1.853
## 60                             Isle of Man  IMN  1.840
## 61                                Bulgaria  BGR  1.831
## 62                                Ireland  IRL  1.764
## 63                           Saudi Arabia  SAU  1.745
## 64          Mauritania, Islamic Rep. of  MRT  1.711
## 65                      Armenia, Rep. of  ARM  1.707
## 66                                Algeria  DZA  1.688
## 67                             Saint Helena  SHN  1.686
## 68                           Palau, Rep. of  PLW  1.672
## 69                           Korea, Rep. of  KOR  1.659
## 70         Korea, Dem. People's Rep. of  PRK  1.610
## 71                                Liberia  LBR  1.556
## 72                               Djibouti  DJI  1.547
## 73                      Syrian Arab Rep.   SYR  1.535
## 74                                 Bhutan  BTN  1.523
## 75                                 Albania  ALB  1.518
## 76                                 Georgia  GEO  1.510
## 77                  United Arab Emirates  ARE  1.482
## 78                           Bahamas, The  BHS  1.480
## 79               Congo, Dem. Rep. of the  COD  1.480
## 80                                 Vanuatu  VUT  1.479
## 81   Ethiopia, The Federal Dem. Rep. of  ETH  1.455
## 82                                 Somalia  SOM  1.449
## 83                    Brunei Darussalam  BRN  1.446
## 84                                  Cuba  CUB  1.437
```

```
## 85                              Myanmar  MMR  1.436
## 86                China, P.R.: Hong Kong  HKG  1.432
## 87                    China, P.R.: Macao  MAC  1.432
## 88                               Uganda  UGA  1.416
## 89                            Greenland  GRL  1.413
## 90                          Philippines  PHL  1.405
## 91                              Senegal  SEN  1.405
## 92        North Macedonia, Republic of   MKD  1.404
## 93                         Faroe Islands  FRO  1.396
## 94                                 World  WLD  1.394
## 95                              Pakistan  PAK  1.389
## 96              Taiwan Province of China  TWN  1.383
## 97                   Lesotho, Kingdom of  LSO  1.372
## 98                  Eswatini, Kingdom of  SWZ  1.371
## 99                              Malaysia  MYS  1.367
## 100                               Jordan  JOR  1.358
## 101                       Fiji, Rep. of  FJI  1.346
## 102                               Japan  JPN  1.335
## 103                        Sierra Leone  SLE  1.328
## 104                         Gambia, The  GMB  1.323
## 105 São Tomé and Príncipe, Dem. Rep. of  STP  1.321
## 106                          New Zealand  NZL  1.319
## 107           Timor-Leste, Dem. Rep. of  TLS  1.315
## 108                            Singapore  SGP  1.311
## 109                             Suriname  SUR  1.296
## 110                        Guinea-Bissau  GNB  1.295
## 111                              Lebanon  LBN  1.290
## 112                                Kenya  KEN  1.280
## 113                               Canada  CAN  1.268
## 114                       American Samoa  ASM  1.256
## 115                               Mexico  MEX  1.249
## 116          Equatorial Guinea, Rep. of  GNQ  1.247
## 117                       Congo, Rep. of  COG  1.245
## 118                               Cyprus  CYP  1.237
## 119                       Norfolk Island  NFK  1.225
## 120                     Papua New Guinea  PNG  1.221
## 121                        United States  USA  1.217
## 122                           Bangladesh  BGD  1.216
## 123                               Angola  AGO  1.212
## 124                              Iceland  ISL  1.201
## 125                               Guinea  GIN  1.195
## 126                                Samoa  WSM  1.156
## 127                              Jamaica  JAM  1.140
## 128                                Nepal  NPL  1.132
## 129             Lao People's Dem. Rep.  LAO  1.112
## 130                                Haiti  HTI  1.095
## 131                         South Africa  ZAF  1.094
## 132                            Indonesia  IDN  1.085
## 133                               Israel  ISR  1.079
## 134                  West Bank and Gaza  PSE  1.074
## 135                               Guyana  GUY  1.066
## 136                                 Oman  OMN  1.055
## 137                              Cameroon  CMR  1.044
## 138                               Greece  GRC  1.040
```

```
## 139                    Solomon Islands  SLB  1.038
## 140                            Vietnam  VNM  1.033
## 141               Central African Rep.  CAF  1.032
## 142                             Belize  BLZ  1.031
## 143                           Thailand  THA  1.014
## 144                          Sri Lanka  LKA  1.004
## 145                              Ghana  GHA  0.996
## 146                              Gabon  GAB  0.994
## 147               South Sudan, Rep. of  SSD  0.983
## 148                     Dominican Rep.  DOM  0.982
## 149                               Togo  TGO  0.975
## 150                     Cayman Islands  CYM  0.974
## 151          Wallis and Futuna Islands  WLF  0.951
## 152                            Cambodia  KHM  0.948
## 153           Turks and Caicos Islands  TCA  0.944
## 154                             Brazil  BRA  0.926
## 155                          Guatemala  GTM  0.916
## 156           Tanzania, United Rep. of  TZA  0.911
## 157       United States Virgin Islands  VIR  0.894
## 158                               Mali  MLI  0.887
## 159                              Benin  BEN  0.884
## 160                               Peru  PER  0.878
## 161             British Virgin Islands  VGB  0.875
## 162                           Colombia  COL  0.874
## 163                         Seychelles  SYC  0.872
## 164               Madagascar, Rep. of  MDG  0.860
## 165                        Puerto Rico  PRI  0.848
## 166                              Tonga  TON  0.846
## 167                          Nicaragua  NIC  0.842
## 168                           Anguilla  AIA  0.839
## 169               Mozambique, Rep. of  MOZ  0.834
## 170                             Malawi  MWI  0.816
## 171                       Burkina Faso  BFA  0.802
## 172                            Nigeria  NGA  0.791
## 173                              India  IND  0.790
## 174                           Maldives  MDV  0.784
## 175                         Guadeloupe  GLP  0.773
## 176                              Sudan  SDN  0.773
## 177               Antigua and Barbuda  ATG  0.770
## 178                         Montserrat  MSR  0.770
## 179               St. Kitts and Nevis  KNA  0.770
## 180                          Australia  AUS  0.754
## 181                               Chad  TCD  0.738
## 182                            Ecuador  ECU  0.736
## 183                             Panama  PAN  0.728
## 184                           Honduras  HND  0.723
## 185               Trinidad and Tobago  TTO  0.714
## 186                            Grenada  GRD  0.698
## 187     St. Vincent and the Grenadines  VCT  0.698
## 188                          St. Lucia  LCA  0.689
## 189                           Dominica  DMA  0.688
## 190                             Zambia  ZMB  0.686
## 191                          Martinique  MTQ  0.684
## 192                             Mayotte  MYT  0.678
```

```
## 193                             Tuvalu  TUV  0.663
## 194                        El Salvador  SLV  0.658
## 195                Egypt, Arab Rep. of  EGY  0.655
## 196                           Paraguay  PRY  0.649
## 197                            Bolivia  BOL  0.644
## 198                          Argentina  ARG  0.643
## 199    Micronesia, Federated States of  FSM  0.627
## 200                          Mauritius  MUS  0.595
## 201                              Libya  LBY  0.559
## 202     Venezuela, Rep. Bolivariana de  VEN  0.533
## 203               Eritrea, The State of  ERI  0.530
## 204               Comoros, Union of the  COM  0.521
## 205                       Cook Islands  COK  0.479
## 206                              Niger  NER  0.428
## 207                              Chile  CHL  0.407
## 208                            Uruguay  URY  0.382
## 209                   French Polynesia  PYF  0.359
## 210                            Namibia  NAM  0.239
## 211      Marshall Islands, Rep. of the  MHL  0.007
## 212                           Zimbabwe  ZWE -0.490
## 213                           Botswana  BWA -1.305
## 214   Aruba, Kingdom of the Netherlands  ABW     NA
## 215                           Barbados  BRB     NA
## 216                            Burundi  BDI     NA
## 217                         Costa Rica  CRI     NA
## 218        Falkland Islands (Malvinas)  FLK     NA
## 219                           Kiribati  KIR     NA
## 220                     Nauru, Rep. of  NRU     NA
## 221                               Niue  NIU     NA
## 222                    Pitcairn Islands  PCN     NA
## 223                             Rwanda  RWA     NA
## 224                            Tokelau  TKL     NA
## 225                      Yemen, Rep. of  YEM     NA
```

```
climate_10_20 <- climate_change |> select(Country, ISO3, F2010:F2020) |> rowwise() |>
  mutate(mean_10_20 = mean(c_across(F2010:F2020)))

climate_10_20 |> arrange(desc(mean_10_20))
```

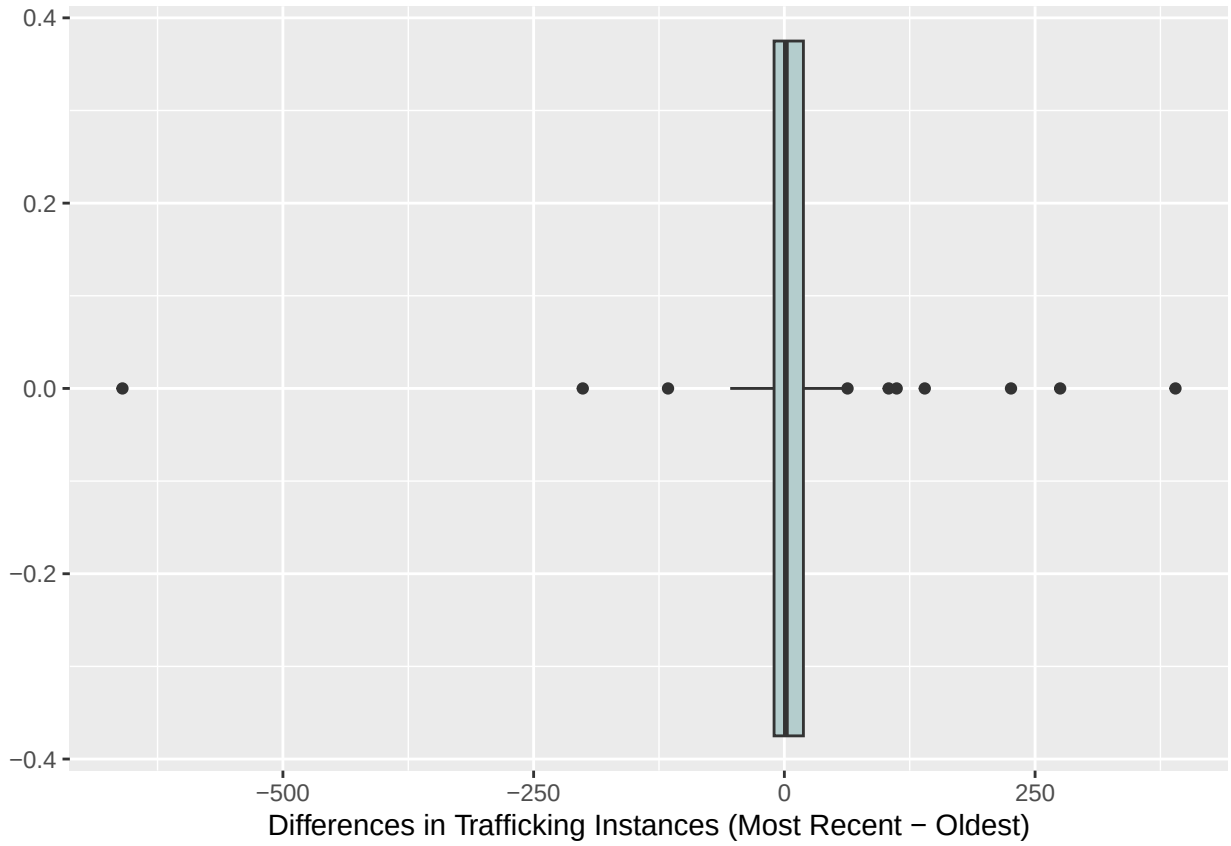
```
## # A tibble: 225 x 14
## # Rowwise:
##    Country     ISO3  F2010 F2011 F2012 F2013 F2014 F2015 F2016 F2017 F2018 F2019
##    <chr>       <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
##  1 Russian Fe~ RUS   0.88  1.70   1.93 1.17   1.75  2.25  2.46  2.13  2.04  2.18
##  2 Belarus, R~ BLR   1.46  1.02   1.56 1.21   2.18  2.25  2.20  1.59  2.34  2.69
##  3 Estonia, R~ EST   0.554 1.30   1.47 1.18   2.45  2.38  1.94  1.50  2.41  2.22
##  4 Ukraine     UKR   1.65  0.581  1.96 1.52   1.72  2.08  2.11  1.42  2.24  2.37
##  5 Latvia      LVA   0.704 1.15   1.41 1.08   2.33  2.17  1.95  1.50  2.36  2.46
##  6 Slovenia, ~ SVN   0.769 1.35   1.93 1.23   2.43  2.12  2.05  1.72  2.41  2.34
##  7 Austria     AUT   0.656 1.37   1.78 1.10   2.41  2.17  2.10  1.74  2.52  2.37
##  8 Bahrain, K~ BHR   2.29  1.43   1.38 1.40   1.69  2.24  1.60  2.08  2.25  2.11
##  9 Lithuania   LTU   0.766 0.957  1.37 0.967  2.24  2.10  1.94  1.54  2.43  2.64
## 10 Finland     FIN   0.242 1.35   1.54 1.42   2.59  2.61  2.15  1.49  2.16  1.45
## # i 215 more rows
```

```
## # i 2 more variables: F2020 <dbl>, mean_10_20 <dbl>
```

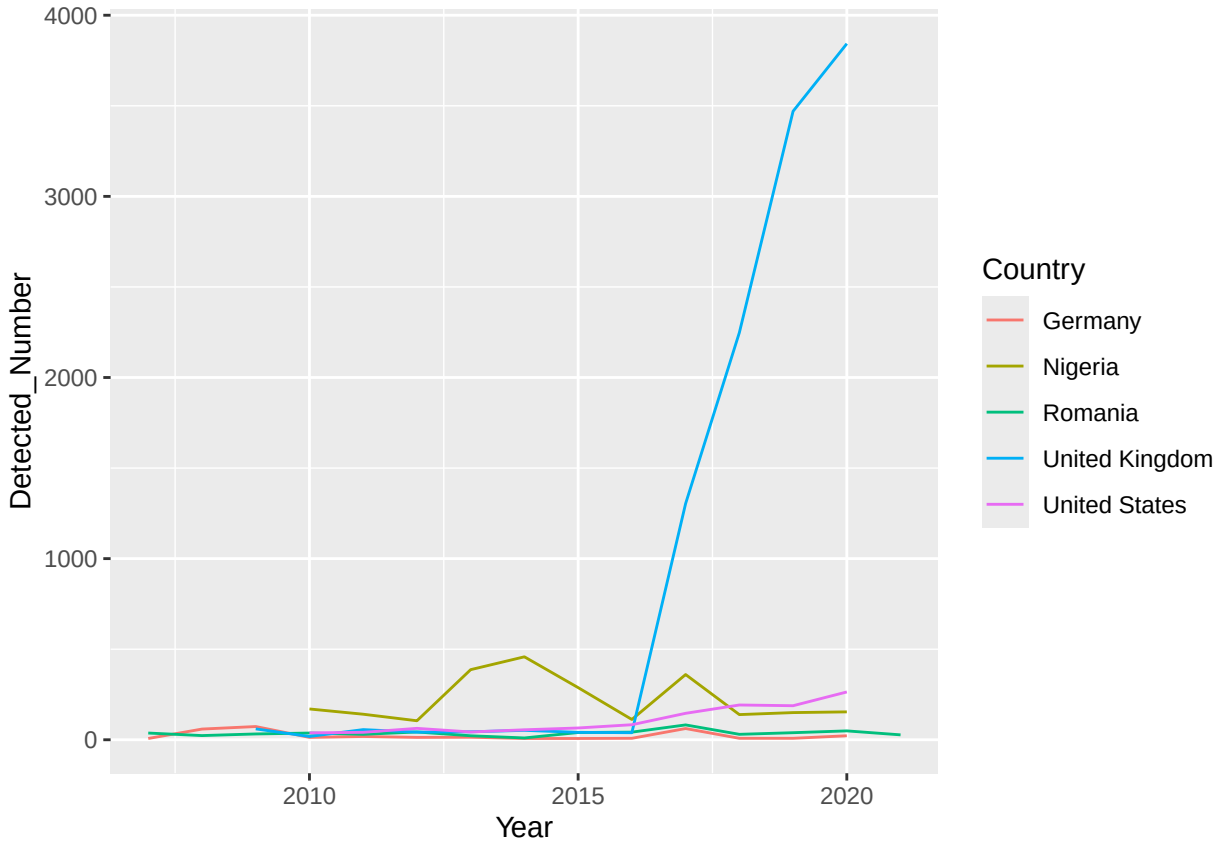
```
climate_10_20 <- climate_10_20 |> rowwise() |>
  mutate(sum_10_20 = sum(c_across(F2010:F2020)))

climate_10_20 |> arrange(desc(sum_10_20))
```

```
## # A tibble: 225 x 15
## # Rowwise:
##    Country     ISO3  F2010 F2011 F2012 F2013 F2014 F2015 F2016 F2017 F2018 F2019
##    <chr>       <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
##  1 Russian Fe~ RUS   0.88  1.70   1.93 1.17   1.75  2.25  2.46  2.13  2.04  2.18
##  2 Belarus, R~ BLR   1.46  1.02   1.56 1.21   2.18  2.25  2.20  1.59  2.34  2.69
##  3 Estonia, R~ EST   0.554 1.30   1.47 1.18   2.45  2.38  1.94  1.50  2.41  2.22
##  4 Ukraine     UKR   1.65  0.581  1.96 1.52   1.72  2.08  2.11  1.42  2.24  2.37
##  5 Latvia      LVA   0.704 1.15   1.41 1.08   2.33  2.17  1.95  1.50  2.36  2.46
##  6 Slovenia, ~ SVN   0.769 1.35   1.93 1.23   2.43  2.12  2.05  1.72  2.41  2.34
##  7 Austria     AUT   0.656 1.37   1.78 1.10   2.41  2.17  2.10  1.74  2.52  2.37
##  8 Bahrain, K~ BHR   2.29  1.43   1.38 1.40   1.69  2.24  1.60  2.08  2.25  2.11
##  9 Lithuania   LTU   0.766 0.957  1.37 0.967  2.24  2.10  1.94  1.54  2.43  2.64
## 10 Finland     FIN   0.242 1.35   1.54 1.42   2.59  2.61  2.15  1.49  2.16  1.45
## # i 215 more rows
## # i 3 more variables: F2020 <dbl>, mean_10_20 <dbl>, sum_10_20 <dbl>
```

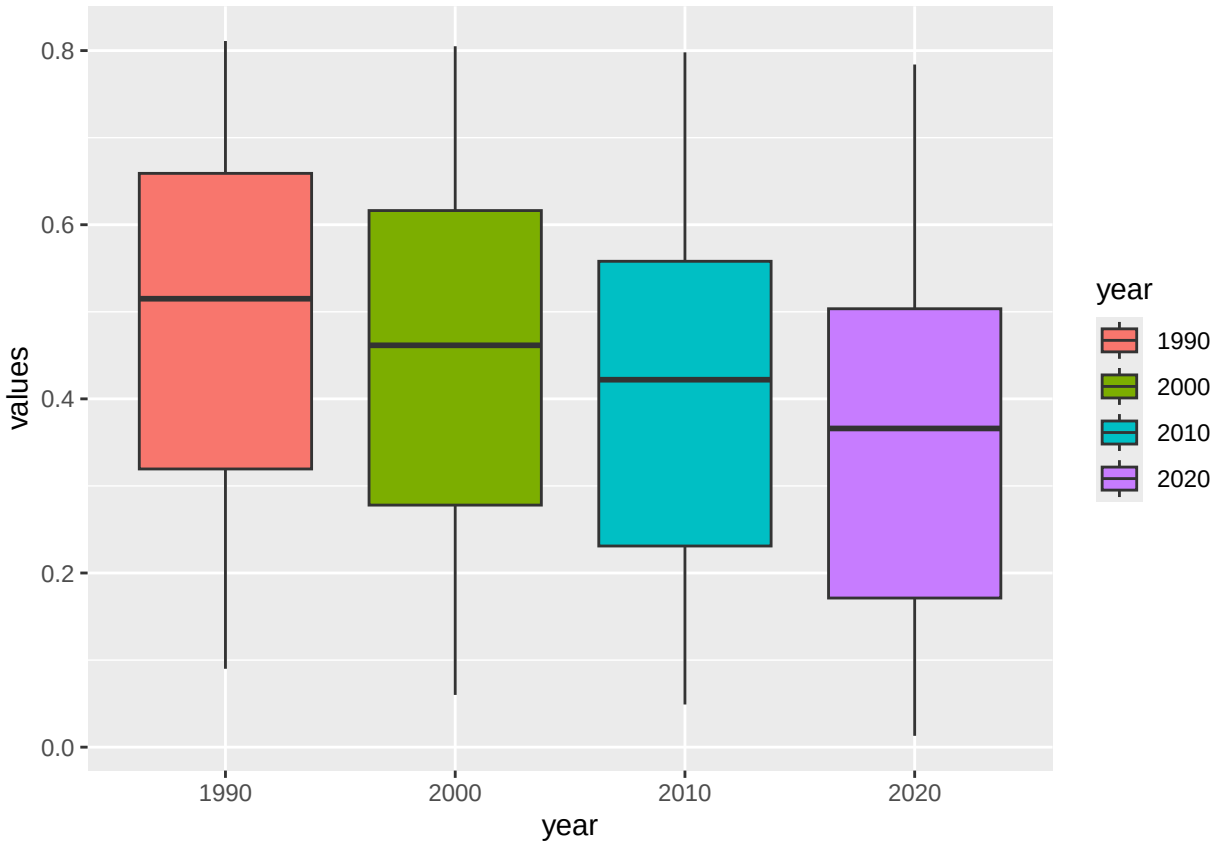
```
pivot <- pivot_wider(human_trafficking, names_from = Year, values_from= Detected_Number)

first <- c()
last <- c()

for(i in 1:nrow(pivot)) {
  pivmin <- pivot[i,]
  pivmin2 <- as.vector(pivmin[-c(1,2)])
  first[i] <- pivot[i, 2 + which(!is.na(pivmin2))[1]]
  last[i] <- tail(pivmin2[!is.na(pivmin2)], 1)
}

last <- as.numeric(last)
first <- as.numeric(first)
diffs <- last - first
diffs.noz <- if(length(which(diffs==0)!=0)) diffs[-which(diffs==0)]
diffs.df <- data.frame(diffs.noz[-16])

ggplot(diffs.df, aes(x = diffs.noz[-16])) +
  geom_boxplot(fill = "lightcyan3") +
  xlab("Differences in Trafficking Instances (Most Recent - Oldest)")
```




```
human_trafficking %>%
  filter(Code %in% c("USA", "GBR", "DEU", "ROU", "NGA")) %>%
  drop_na() %>%
  ggplot() +
    geom_line(aes(x=Year, y = Detected_Number, col = Country,))
```




```
corr <- left_join(slavery_index, inequality, by="Country")

temp <- data.frame(year = rep(c("1990", "2000", "2010", "2020"), each = nrow(inequality)),
                   values = c(inequality$Gender.Inequality.Index..1990., inequality$Gender.Inequality.I

ggplot(temp, aes(x = year, y = values, fill = year)) +
  geom_boxplot()
```


0.8
0.6
0.4
0.2
0.0
values
1990
2000
2010
2020
year
year
1990
2000
2010
2020