Appendix

```r
# Read in dataset
lifeExpec = read.csv("Life Expectancy Data.csv",header = TRUE)

# Observe dataset in general
dim(lifeExpec)
```

```
## [1] 2938   22
```

```r
str(lifeExpec)
```

```
## 'data.frame':    2938 obs. of  22 variables:
##  $ Country                        : chr  "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" ...
##  $ Year                           : int  2015 2014 2013 2012 2011 2010 2009 2008 2007 2006 ...
##  $ Status                         : chr  "Developing" "Developing" "Developing" "Developing" ...
##  $ Life.expectancy                : num  65 59.9 59.9 59.5 59.2 58.8 58.6 58.1 57.5 57.3 ...
##  $ Adult.Mortality                : int  263 271 268 272 275 279 281 287 295 295 ...
##  $ infant.deaths                  : int  62 64 66 69 71 74 77 80 82 84 ...
##  $ Alcohol                        : num  0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.03 0.02 0.03 ...
##  $ percentage.expenditure         : num  71.3 73.5 73.2 78.2 7.1 ...
##  $ Hepatitis.B                    : int  65 62 64 67 68 66 63 64 63 64 ...
##  $ Measles                        : int  1154 492 430 2787 3013 1989 2861 1599 1141 1990 ...
##  $ BMI                            : num  19.1 18.6 18.1 17.6 17.2 16.7 16.2 15.7 15.2 14.7 ...
##  $ under.five.deaths              : int  83 86 89 93 97 102 106 110 113 116 ...
##  $ Polio                          : int  6 58 62 67 68 66 63 64 63 58 ...
##  $ Total.expenditure              : num  8.16 8.18 8.13 8.52 7.87 9.2 9.42 8.33 6.73 7.43 ...
##  $ Diphtheria                     : int  65 62 64 67 68 66 63 64 63 58 ...
##  $ HIV.AIDS                       : num  0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 ...
##  $ GDP                            : num  584.3 612.7 631.7 670 63.5 ...
##  $ Population                     : num  33736494 327582 31731688 3696958 2978599 ...
##  $ thinness..1.19.years           : num  17.2 17.5 17.7 17.9 18.2 18.4 18.6 18.8 19 19.2 ...
##  $ thinness.5.9.years             : num  17.3 17.5 17.7 18 18.2 18.4 18.7 18.9 19.1 19.3 ...
##  $ Income.composition.of.resources: num  0.479 0.476 0.47 0.463 0.454 0.448 0.434 0.433 0.415 0.405 ...
##  $ Schooling                      : num  10.1 10 9.9 9.8 9.5 9.2 8.9 8.7 8.4 8.1 ...
```

```r
head(lifeExpec)
```

```
##       Country Year     Status Life.expectancy Adult.Mortality infant.deaths
## 1 Afghanistan 2015 Developing            65.0             263            62
## 2 Afghanistan 2014 Developing            59.9             271            64
## 3 Afghanistan 2013 Developing            59.9             268            66
## 4 Afghanistan 2012 Developing            59.5             272            69
## 5 Afghanistan 2011 Developing            59.2             275            71
## 6 Afghanistan 2010 Developing            58.8             279            74
##   Alcohol percentage.expenditure Hepatitis.B Measles  BMI under.five.deaths
## 1    0.01              71.279624          65    1154 19.1                83
## 2    0.01              73.523582          62     492 18.6                86
## 3    0.01              73.219243          64     430 18.1                89
## 4    0.01              78.184215          67    2787 17.6                93
## 5    0.01               7.097109          68    3013 17.2                97
## 6    0.01              79.679367          66    1989 16.7               102
##   Polio Total.expenditure Diphtheria HIV.AIDS       GDP Population
## 1     6              8.16         65      0.1 584.25921   33736494
## 2    58              8.18         62      0.1 612.69651     327582
## 3    62              8.13         64      0.1 631.74498   31731688
## 4    67              8.52         67      0.1 669.95900    3696958
## 5    68              7.87         68      0.1  63.53723    2978599
## 6    66              9.20         66      0.1 553.32894    2883167
##   thinness..1.19.years thinness.5.9.years Income.composition.of.resources
## 1                 17.2               17.3                           0.479
## 2                 17.5               17.5                           0.476
## 3                 17.7               17.7                           0.470
## 4                 17.9               18.0                           0.463
```

```
## 5                18.2              18.2                          0.454
## 6                18.4              18.4                          0.448
##   Schooling
## 1      10.1
## 2      10.0
## 3       9.9
## 4       9.8
## 5       9.5
## 6       9.2
```

```r
# Add continent column to the dataset
lifeExpec$continent <- countrycode(sourcevar = lifeExpec$Country,
                                   origin = "country.name",
                                   destination = "continent")

# Edit 3 country names
lifeExpec$CountrytoMatch <- as.character(lifeExpec$Country)
lifeExpec$CountrytoMatch[lifeExpec$CountrytoMatch == "Côte d'Ivoire"] <- "Cote d'Ivoire"
lifeExpec$CountrytoMatch[lifeExpec$CountrytoMatch == "Cabo Verde"] <- "Cape Verde"
lifeExpec$CountrytoMatch[lifeExpec$CountrytoMatch == "Czechia"] <- "Czech Republic"

# Statistics summary table for all variables
summary(lifeExpec)
```

```
##    Country               Year         Status          Life.expectancy
##  Length:2938        Min.   :2000   Length:2938        Min.   :36.30
##  Class :character   1st Qu.:2004   Class :character   1st Qu.:63.10
##  Mode  :character   Median :2008   Mode  :character   Median :72.10
##                     Mean   :2008                      Mean   :69.22
##                     3rd Qu.:2012                      3rd Qu.:75.70
##                     Max.   :2015                      Max.   :89.00
##                                                       NA's   :10
##  Adult.Mortality infant.deaths       Alcohol        percentage.expenditure
##  Min.   :  1.0   Min.   :   0.0   Min.   : 0.0100   Min.   :    0.000
##  1st Qu.: 74.0   1st Qu.:   0.0   1st Qu.: 0.8775   1st Qu.:    4.685
##  Median :144.0   Median :   3.0   Median : 3.7550   Median :   64.913
##  Mean   :164.8   Mean   :  30.3   Mean   : 4.6029   Mean   :  738.251
##  3rd Qu.:228.0   3rd Qu.:  22.0   3rd Qu.: 7.7025   3rd Qu.:  441.534
##  Max.   :723.0   Max.   :1800.0   Max.   :17.8700   Max.   :19479.912
##  NA's   :10                       NA's   :194
##   Hepatitis.B       Measles               BMI        under.five.deaths
##  Min.   : 1.00   Min.   :     0.0   Min.   : 1.00   Min.   :   0.00
##  1st Qu.:77.00   1st Qu.:     0.0   1st Qu.:19.30   1st Qu.:   0.00
##  Median :92.00   Median :    17.0   Median :43.50   Median :   4.00
##  Mean   :80.94   Mean   :  2419.6   Mean   :38.32   Mean   :  42.04
##  3rd Qu.:97.00   3rd Qu.:   360.2   3rd Qu.:56.20   3rd Qu.:  28.00
##  Max.   :99.00   Max.   :212183.0   Max.   :87.30   Max.   :2500.00
##  NA's   :553                        NA's   :34
##      Polio       Total.expenditure   Diphtheria       HIV.AIDS
##  Min.   : 3.00   Min.   : 0.370    Min.   : 2.00   Min.   : 0.100
##  1st Qu.:78.00   1st Qu.: 4.260    1st Qu.:78.00   1st Qu.: 0.100
##  Median :93.00   Median : 5.755    Median :93.00   Median : 0.100
##  Mean   :82.55   Mean   : 5.938    Mean   :82.32   Mean   : 1.742
##  3rd Qu.:97.00   3rd Qu.: 7.492    3rd Qu.:97.00   3rd Qu.: 0.800
##  Max.   :99.00   Max.   :17.600    Max.   :99.00   Max.   :50.600
##  NA's   :19      NA's   :226       NA's   :19
##       GDP              Population        thinness..1.19.years
##  Min.   :     1.68   Min.   :3.400e+01   Min.   : 0.10
##  1st Qu.:   463.94   1st Qu.:1.958e+05   1st Qu.: 1.60
##  Median :  1766.95   Median :1.387e+06   Median : 3.30
##  Mean   :  7483.16   Mean   :1.275e+07   Mean   : 4.84
##  3rd Qu.:  5910.81   3rd Qu.:7.420e+06   3rd Qu.: 7.20
##  Max.   :119172.74   Max.   :1.294e+09   Max.   :27.70
##  NA's   :448         NA's   :652         NA's   :34
##  thinness.5.9.years Income.composition.of.resources   Schooling
##  Min.   : 0.10      Min.   :0.0000                  Min.   : 0.00
```

```
##  1st Qu.: 1.50      1st Qu.:0.4930                1st Qu.:10.10
##  Median : 3.30      Median :0.6770                Median :12.30
##  Mean   : 4.87      Mean   :0.6276                Mean   :11.99
##  3rd Qu.: 7.20      3rd Qu.:0.7790                3rd Qu.:14.30
##  Max.   :28.60      Max.   :0.9480                Max.   :20.70
##  NA's   :34         NA's   :167                   NA's   :163
##   continent         CountrytoMatch
##  Length:2938        Length:2938
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
##
```

Check and clean up data record for each country

```
unique(lifeExpec$Country) # There are 193 countries in total
```

```
##   [1] "Afghanistan"
##   [2] "Albania"
##   [3] "Algeria"
##   [4] "Angola"
##   [5] "Antigua and Barbuda"
##   [6] "Argentina"
##   [7] "Armenia"
##   [8] "Australia"
##   [9] "Austria"
##  [10] "Azerbaijan"
##  [11] "Bahamas"
##  [12] "Bahrain"
##  [13] "Bangladesh"
##  [14] "Barbados"
##  [15] "Belarus"
##  [16] "Belgium"
##  [17] "Belize"
##  [18] "Benin"
##  [19] "Bhutan"
##  [20] "Bolivia (Plurinational State of)"
##  [21] "Bosnia and Herzegovina"
##  [22] "Botswana"
##  [23] "Brazil"
##  [24] "Brunei Darussalam"
##  [25] "Bulgaria"
##  [26] "Burkina Faso"
##  [27] "Burundi"
##  [28] "Côte d'Ivoire"
##  [29] "Cabo Verde"
##  [30] "Cambodia"
##  [31] "Cameroon"
##  [32] "Canada"
##  [33] "Central African Republic"
##  [34] "Chad"
##  [35] "Chile"
##  [36] "China"
##  [37] "Colombia"
##  [38] "Comoros"
##  [39] "Congo"
##  [40] "Cook Islands"
##  [41] "Costa Rica"
##  [42] "Croatia"
##  [43] "Cuba"
##  [44] "Cyprus"
##  [45] "Czechia"
##  [46] "Democratic People's Republic of Korea"
##  [47] "Democratic Republic of the Congo"
```

```
##  [48] "Denmark"
##  [49] "Djibouti"
##  [50] "Dominica"
##  [51] "Dominican Republic"
##  [52] "Ecuador"
##  [53] "Egypt"
##  [54] "El Salvador"
##  [55] "Equatorial Guinea"
##  [56] "Eritrea"
##  [57] "Estonia"
##  [58] "Ethiopia"
##  [59] "Fiji"
##  [60] "Finland"
##  [61] "France"
##  [62] "Gabon"
##  [63] "Gambia"
##  [64] "Georgia"
##  [65] "Germany"
##  [66] "Ghana"
##  [67] "Greece"
##  [68] "Grenada"
##  [69] "Guatemala"
##  [70] "Guinea"
##  [71] "Guinea-Bissau"
##  [72] "Guyana"
##  [73] "Haiti"
##  [74] "Honduras"
##  [75] "Hungary"
##  [76] "Iceland"
##  [77] "India"
##  [78] "Indonesia"
##  [79] "Iran (Islamic Republic of)"
##  [80] "Iraq"
##  [81] "Ireland"
##  [82] "Israel"
##  [83] "Italy"
##  [84] "Jamaica"
##  [85] "Japan"
##  [86] "Jordan"
##  [87] "Kazakhstan"
##  [88] "Kenya"
##  [89] "Kiribati"
##  [90] "Kuwait"
##  [91] "Kyrgyzstan"
##  [92] "Lao People's Democratic Republic"
##  [93] "Latvia"
##  [94] "Lebanon"
##  [95] "Lesotho"
##  [96] "Liberia"
##  [97] "Libya"
##  [98] "Lithuania"
##  [99] "Luxembourg"
## [100] "Madagascar"
## [101] "Malawi"
## [102] "Malaysia"
## [103] "Maldives"
## [104] "Mali"
## [105] "Malta"
## [106] "Marshall Islands"
## [107] "Mauritania"
## [108] "Mauritius"
## [109] "Mexico"
## [110] "Micronesia (Federated States of)"
## [111] "Monaco"
## [112] "Mongolia"
## [113] "Montenegro"
```

```
## [114] "Morocco"
## [115] "Mozambique"
## [116] "Myanmar"
## [117] "Namibia"
## [118] "Nauru"
## [119] "Nepal"
## [120] "Netherlands"
## [121] "New Zealand"
## [122] "Nicaragua"
## [123] "Niger"
## [124] "Nigeria"
## [125] "Niue"
## [126] "Norway"
## [127] "Oman"
## [128] "Pakistan"
## [129] "Palau"
## [130] "Panama"
## [131] "Papua New Guinea"
## [132] "Paraguay"
## [133] "Peru"
## [134] "Philippines"
## [135] "Poland"
## [136] "Portugal"
## [137] "Qatar"
## [138] "Republic of Korea"
## [139] "Republic of Moldova"
## [140] "Romania"
## [141] "Russian Federation"
## [142] "Rwanda"
## [143] "Saint Kitts and Nevis"
## [144] "Saint Lucia"
## [145] "Saint Vincent and the Grenadines"
## [146] "Samoa"
## [147] "San Marino"
## [148] "Sao Tome and Principe"
## [149] "Saudi Arabia"
## [150] "Senegal"
## [151] "Serbia"
## [152] "Seychelles"
## [153] "Sierra Leone"
## [154] "Singapore"
## [155] "Slovakia"
## [156] "Slovenia"
## [157] "Solomon Islands"
## [158] "Somalia"
## [159] "South Africa"
## [160] "South Sudan"
## [161] "Spain"
## [162] "Sri Lanka"
## [163] "Sudan"
## [164] "Suriname"
## [165] "Swaziland"
## [166] "Sweden"
## [167] "Switzerland"
## [168] "Syrian Arab Republic"
## [169] "Tajikistan"
## [170] "Thailand"
## [171] "The former Yugoslav republic of Macedonia"
## [172] "Timor-Leste"
## [173] "Togo"
## [174] "Tonga"
## [175] "Trinidad and Tobago"
## [176] "Tunisia"
## [177] "Turkey"
## [178] "Turkmenistan"
## [179] "Tuvalu"
```

```
## [180] "Uganda"
## [181] "Ukraine"
## [182] "United Arab Emirates"
## [183] "United Kingdom of Great Britain and Northern Ireland"
## [184] "United Republic of Tanzania"
## [185] "United States of America"
## [186] "Uruguay"
## [187] "Uzbekistan"
## [188] "Vanuatu"
## [189] "Venezuela (Bolivarian Republic of)"
## [190] "Viet Nam"
## [191] "Yemen"
## [192] "Zambia"
## [193] "Zimbabwe"
```

```
unique(lifeExpec$Year) # 16 years of data collection from 2000 to 2015
```

```
##  [1] 2015 2014 2013 2012 2011 2010 2009 2008 2007 2006 2005 2004 2003 2002 2001
## [16] 2000
```

```
# There are 10 countries that do not have 16 years of data.  They all have only 2013 data record
lifeExpec %>% group_by(Country) %>%
  filter(n() != 16)
```

```
## # A tibble: 10 x 24
## # Groups:   Country [10]
##    Country     Year Status Life.expectancy Adult.Mortality infant.deaths Alcohol
##    <chr>      <int> <chr>            <dbl>           <int>         <int>   <dbl>
##  1 Cook Isla…  2013 Devel…              NA              NA             0    0.01
##  2 Dominica    2013 Devel…              NA              NA             0    0.01
##  3 Marshall …  2013 Devel…              NA              NA             0    0.01
##  4 Monaco      2013 Devel…              NA              NA             0    0.01
##  5 Nauru       2013 Devel…              NA              NA             0    0.01
##  6 Niue        2013 Devel…              NA              NA             0    0.01
##  7 Palau       2013 Devel…              NA              NA             0   NA
##  8 Saint Kit…  2013 Devel…              NA              NA             0    8.54
##  9 San Marino  2013 Devel…              NA              NA             0    0.01
## 10 Tuvalu      2013 Devel…              NA              NA             0    0.01
## # … with 17 more variables: percentage.expenditure <dbl>, Hepatitis.B <int>,
## #   Measles <int>, BMI <dbl>, under.five.deaths <int>, Polio <int>,
## #   Total.expenditure <dbl>, Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>,
## #   Population <dbl>, thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>, continent <chr>,
## #   CountrytoMatch <chr>
```

```
# Excluded countries with < 16 years of data collection from the dataset
lifeExpec <- lifeExpec %>%
  group_by(Country) %>%
  filter(n() == 16)
```

```
# Check if there is any country with duplicated year records
lifeExpec %>% group_by(Country, Year) %>%
  filter(n() > 1) %>%
  summarize(n=n()) # There is none
```

```
## `summarise()` has grouped output by 'Country'. You can override using the `.groups` argument.
```

```
## # A tibble: 0 x 3
## # Groups:   Country [0]
## # … with 3 variables: Country <chr>, Year <int>, n <int>
```

```
# Quick boxplot to see if any country have years of data collection differ from 2000 to 2015. --There is none
.
#lifeExpec %>% ggplot(aes(x=Country, y=Year)) +
#  geom_boxplot() +
#  coord_flip()
```

```
# At this point, all 193 - 10 = 183 countries have all 16 years of data record from 2000 to 2015.  Total in 2
,928 (183*16) rows.
# Create summary table
summary(lifeExpec)

##    Country               Year         Status          Life.expectancy
##  Length:2928        Min.   :2000   Length:2928        Min.   :36.30
##  Class :character   1st Qu.:2004   Class :character   1st Qu.:63.10
##  Mode  :character   Median :2008   Mode  :character   Median :72.10
##                     Mean   :2008                      Mean   :69.22
##                     3rd Qu.:2011                      3rd Qu.:75.70
##                     Max.   :2015                      Max.   :89.00
##
##  Adult.Mortality infant.deaths        Alcohol       percentage.expenditure
##  Min.   :  1.0   Min.   :   0.00   Min.   : 0.010   Min.   :    0.000
##  1st Qu.: 74.0   1st Qu.:   0.00   1st Qu.: 0.905   1st Qu.:    4.854
##  Median :144.0   Median :   3.00   Median : 3.770   Median :   65.611
##  Mean   :164.8   Mean   :  30.41   Mean   : 4.615   Mean   :  740.321
##  3rd Qu.:228.0   3rd Qu.:  22.00   3rd Qu.: 7.715   3rd Qu.:  442.614
##  Max.   :723.0   Max.   :1800.00   Max.   :17.870   Max.   :19479.912
##                                    NA's   :193
##   Hepatitis.B       Measles              BMI        under.five.deaths
##  Min.   : 1.00   Min.   :     0.0   Min.   : 1.00   Min.   :   0.00
##  1st Qu.:77.00   1st Qu.:     0.0   1st Qu.:19.30   1st Qu.:   0.00
##  Median :92.00   Median :    17.0   Median :43.35   Median :   4.00
##  Mean   :80.96   Mean   :  2427.9   Mean   :38.24   Mean   :  42.18
##  3rd Qu.:97.00   3rd Qu.:   362.2   3rd Qu.:56.10   3rd Qu.:  28.00
##  Max.   :99.00   Max.   :212183.0   Max.   :77.60   Max.   :2500.00
##  NA's   :553                        NA's   :32
##      Polio       Total.expenditure   Diphtheria       HIV.AIDS
##  Min.   : 3.00   Min.   : 0.37     Min.   : 2.00   Min.   : 0.100
##  1st Qu.:78.00   1st Qu.: 4.26     1st Qu.:78.00   1st Qu.: 0.100
##  Median :93.00   Median : 5.75     Median :93.00   Median : 0.100
##  Mean   :82.55   Mean   : 5.93     Mean   :82.32   Mean   : 1.748
##  3rd Qu.:97.00   3rd Qu.: 7.49     3rd Qu.:97.00   3rd Qu.: 0.800
##  Max.   :99.00   Max.   :17.60     Max.   :99.00   Max.   :50.600
##  NA's   :19      NA's   :226       NA's   :19
##       GDP              Population        thinness..1.19.years
##  Min.   :     1.68   Min.   :3.400e+01   Min.   : 0.100
##  1st Qu.:   463.85   1st Qu.:1.967e+05   1st Qu.: 1.600
##  Median :  1764.97   Median :1.392e+06   Median : 3.300
##  Mean   :  7494.21   Mean   :1.276e+07   Mean   : 4.851
##  3rd Qu.:  5932.90   3rd Qu.:7.427e+06   3rd Qu.: 7.200
##  Max.   :119172.74   Max.   :1.294e+09   Max.   :27.700
##  NA's   :443         NA's   :644         NA's   :32
##  thinness.5.9.years Income.composition.of.resources   Schooling
##  Min.   : 0.100     Min.   :0.0000                  Min.   : 0.0
##  1st Qu.: 1.575     1st Qu.:0.4930                  1st Qu.:10.1
##  Median : 3.400     Median :0.6770                  Median :12.3
##  Mean   : 4.881     Mean   :0.6274                  Mean   :12.0
##  3rd Qu.: 7.200     3rd Qu.:0.7792                  3rd Qu.:14.3
##  Max.   :28.600     Max.   :0.9480                  Max.   :20.7
##  NA's   :32         NA's   :160                     NA's   :160
##   continent         CountrytoMatch
##  Length:2928        Length:2928
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
##
```

Address the missing values

```
# Check for missing value in each column
missing.values_summary <- lifeExpec %>%
```

```
  gather(key = "key", value = "val") %>%
  mutate(is.missing = is.na(val)) %>%
  group_by(key, is.missing) %>%
  summarise(num.missing = n()) %>%
  filter(is.missing==T) %>%
  select(-is.missing) %>%
  arrange(desc(num.missing))
```

```
## `summarise()` has grouped output by 'key'. You can override using the `.groups` argument.
```

```
missing.values_summary
```

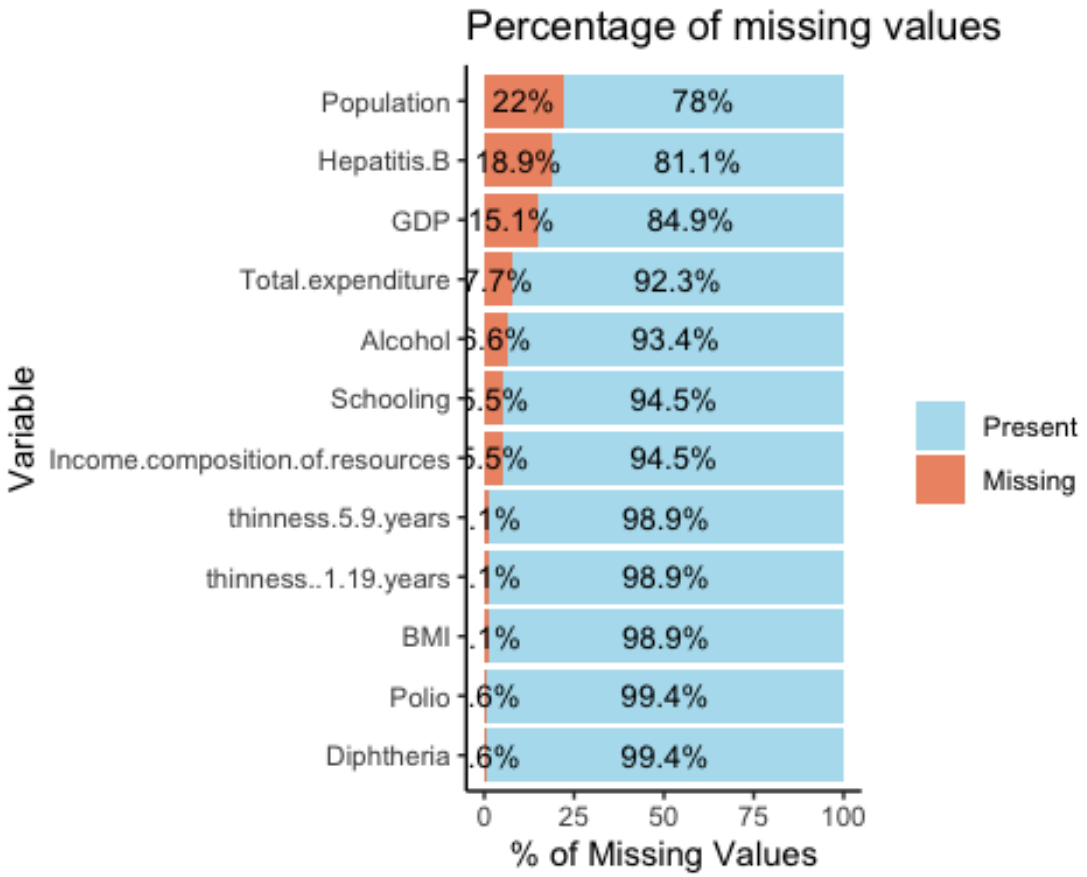
```
## # A tibble: 12 x 2
## # Groups:   key [12]
##    key                              num.missing
##    <chr>                                  <int>
##  1 Population                               644
##  2 Hepatitis.B                              553
##  3 GDP                                      443
##  4 Total.expenditure                        226
##  5 Alcohol                                  193
##  6 Income.composition.of.resources          160
##  7 Schooling                                160
##  8 BMI                                       32
##  9 thinness..1.19.years                      32
## 10 thinness.5.9.years                        32
## 11 Diphtheria                                19
## 12 Polio                                     19
```

```
# Missing values % in each column
missing.values <- lifeExpec %>%
  gather(key = "key", value = "val") %>%
  mutate(isna = is.na(val)) %>%
  group_by(key) %>%
  mutate(total = n()) %>%
  group_by(key, total, isna) %>%
  summarise(num.isna = n()) %>%
  mutate(pct = num.isna / total * 100)
```

```
## `summarise()` has grouped output by 'key', 'total'. You can override using the `.groups` argument.
```

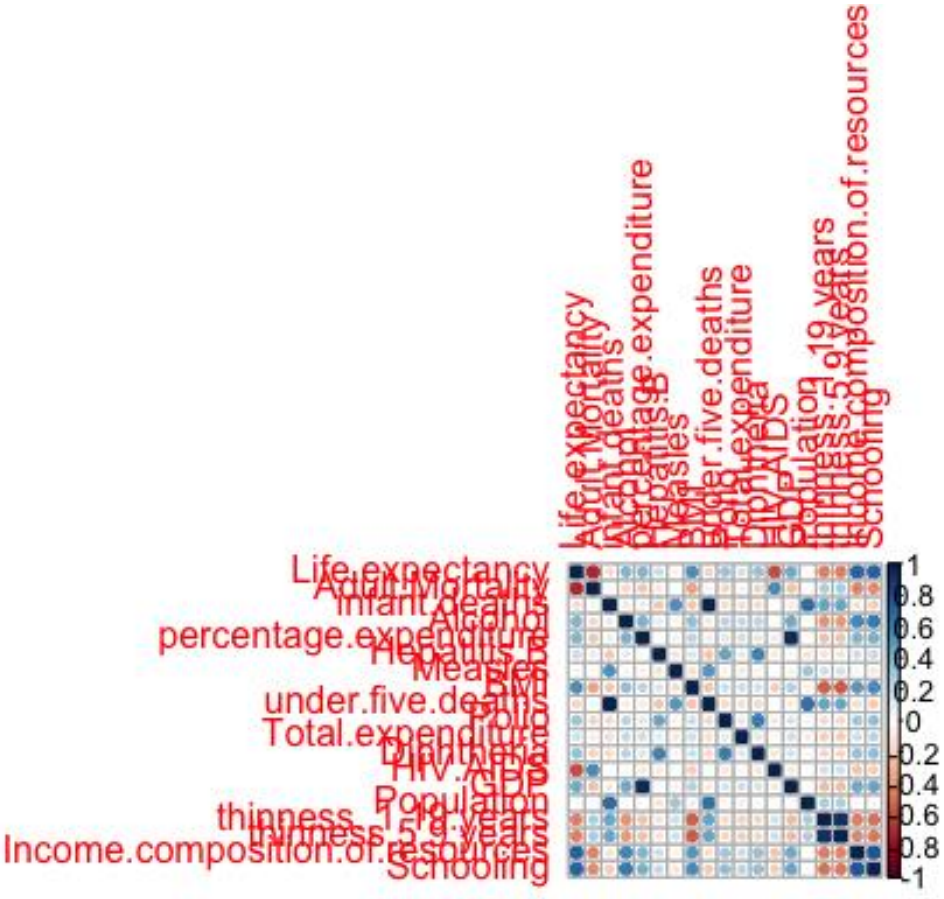
```
mm <- missing.values %>% filter(pct != 100)
mm <- mm %>% group_by(key) %>% mutate(max.per.group = max(as.numeric(pct)))
```

```
mm %>% ggplot(aes(x= reorder(key, desc(max.per.group)), y=pct, fill=isna)) + geom_bar(stat="identity") +
  geom_text(aes(label=paste0(round(pct,1),"%")),
            position = position_stack(vjust = .5), size = 3.5) +
  labs(title = 'Percentage of missing values', x = 'Variable', y = '% of Missing Values') +
  theme_classic() + scale_fill_manual(name = "",
                    values = c('lightblue2', 'lightsalmon2'),
                    labels = c("Present", "Missing")) + coord_flip()
```

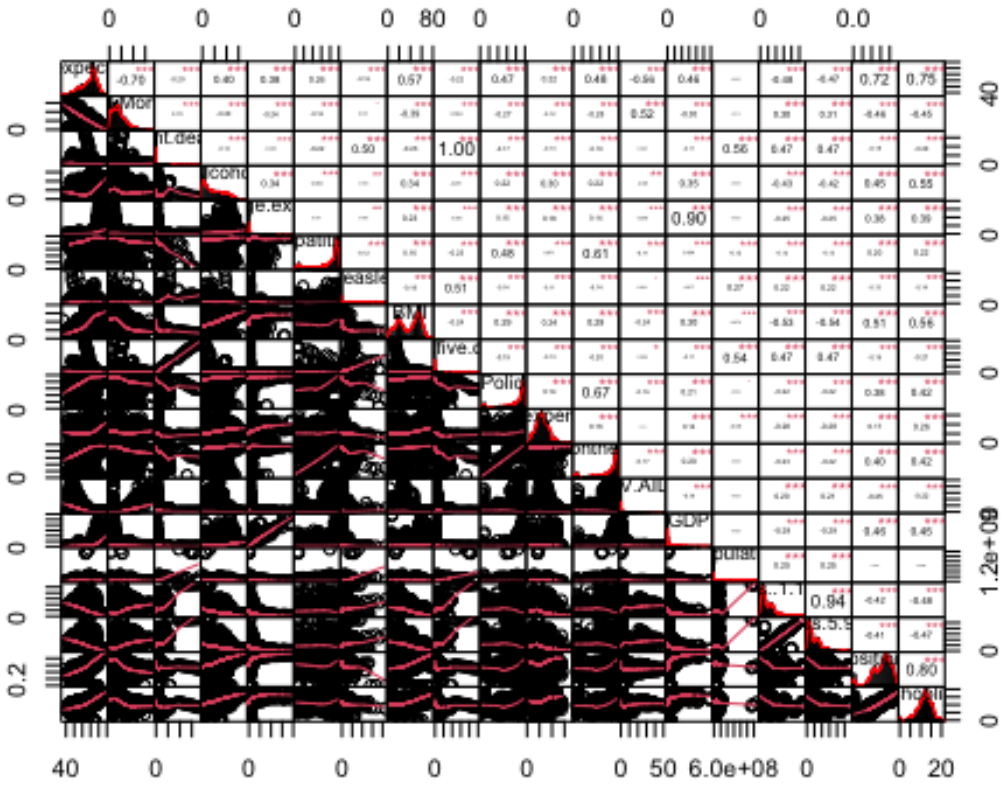


Life expectancy correlation coefficient for numerical variables

```
# Correlation coefficient for numerical columns
num_col <- subset(lifeExpec, select = -c(Year, Country, CountrytoMatch, Status, continent))

M <- cor(num_col, use = "complete.obs")
corrplot(M, use="complete.obs")
```

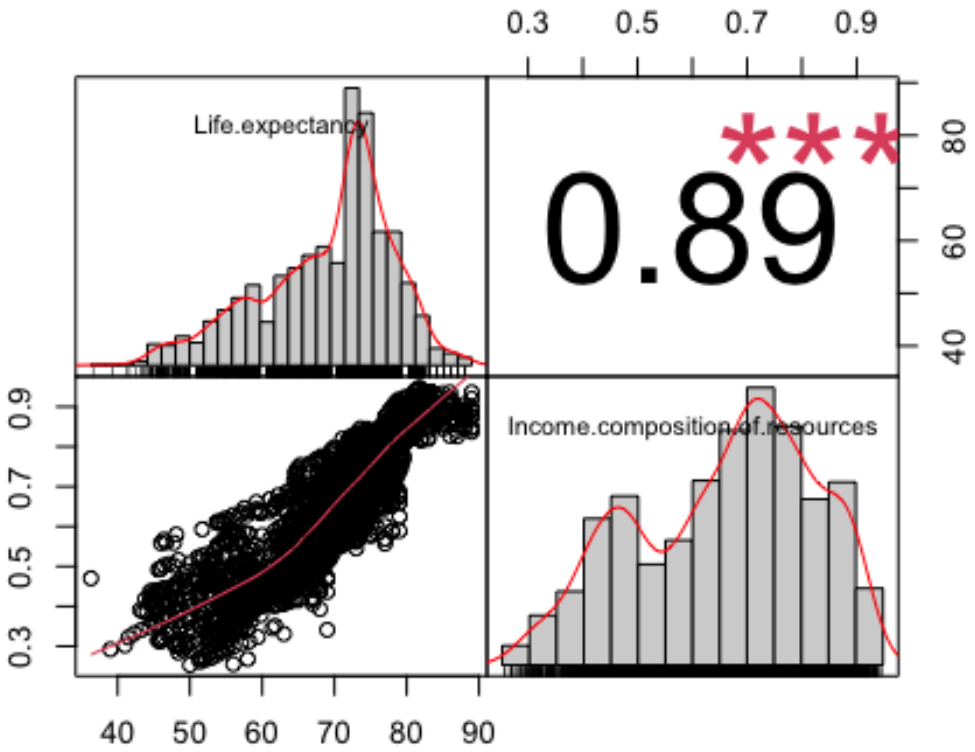



```
chart.Correlation(num_col, histogram=TRUE, pch=19)
```

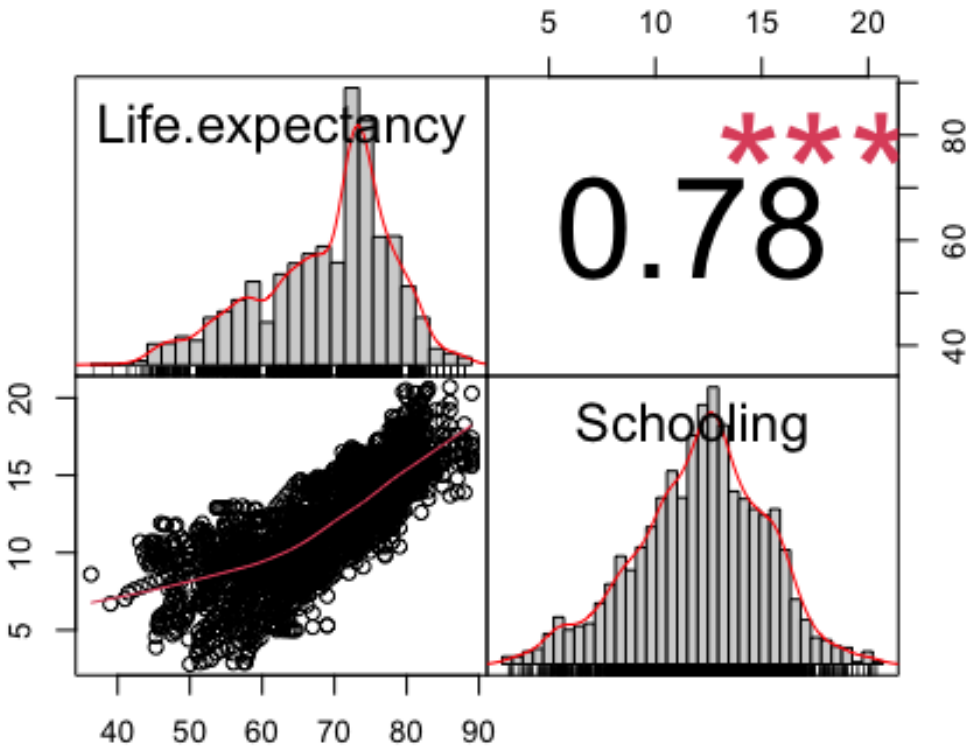


Test on transformation on good candidate variables

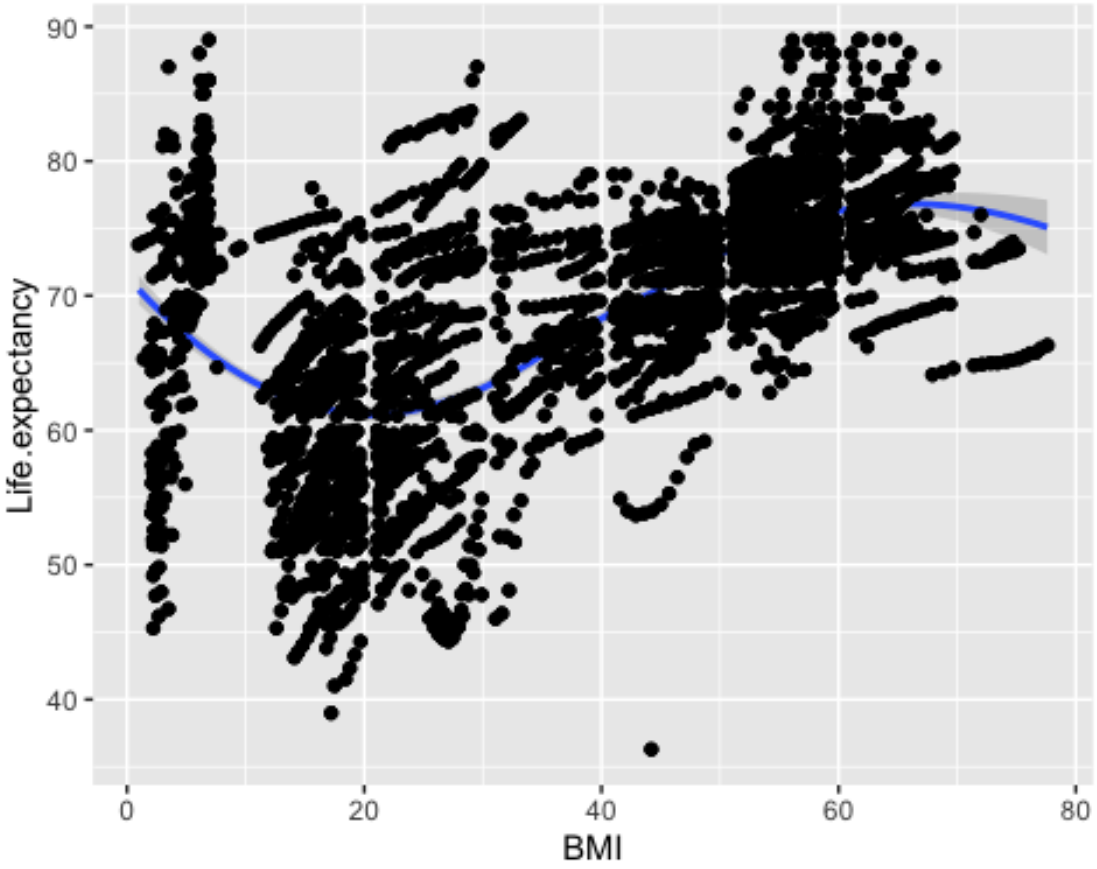
```
# Remove 'zero' from observations for both Income.composition.of.resources and Schooling

income_comp <- subset(lifeExpec, select = c(Life.expectancy, Income.composition.of.resources))
income_comp <- income_comp[income_comp$Income.composition.of.resources != 0, ]

chart.Correlation(income_comp, histogram=TRUE, pch=19)
```




```
# Corr. coefficient between LifeEpactancy and Income.composition.of.resources changed from 0.72 to 0.89

schooling <- subset(lifeExpec, select = c(Life.expectancy, Schooling))
schooling <- schooling[schooling$Schooling != 0, ]

chart.Correlation(schooling, histogram=TRUE, pch=19)
```

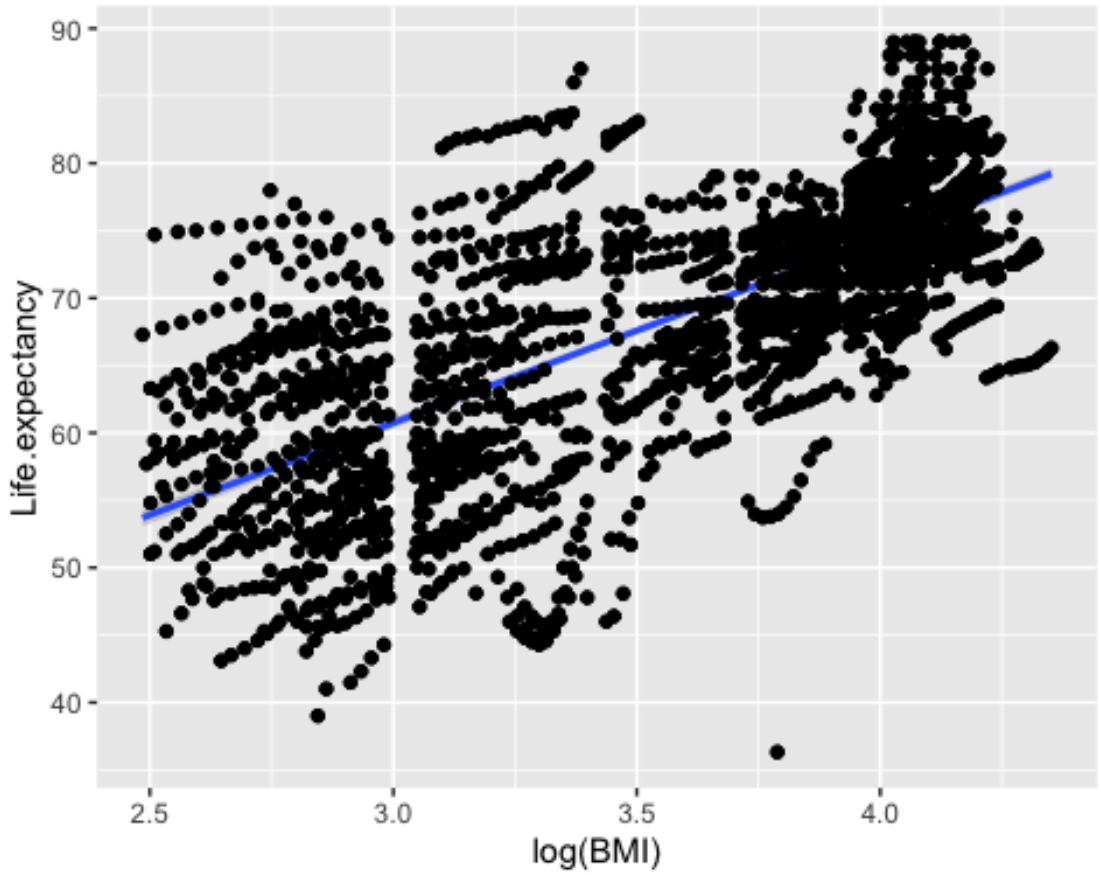



```
# Corr. coefficient between LifeEpactancy and schooling changed from 0.75 to 0.78

# Both Income.composition.of.resources and Schooling are still good candidates

lifeExpec %>% ggplot(aes(x=BMI, y=Life.expectancy)) + geom_point() + geom_smooth(method="loess") + geom_jitte
r()
```

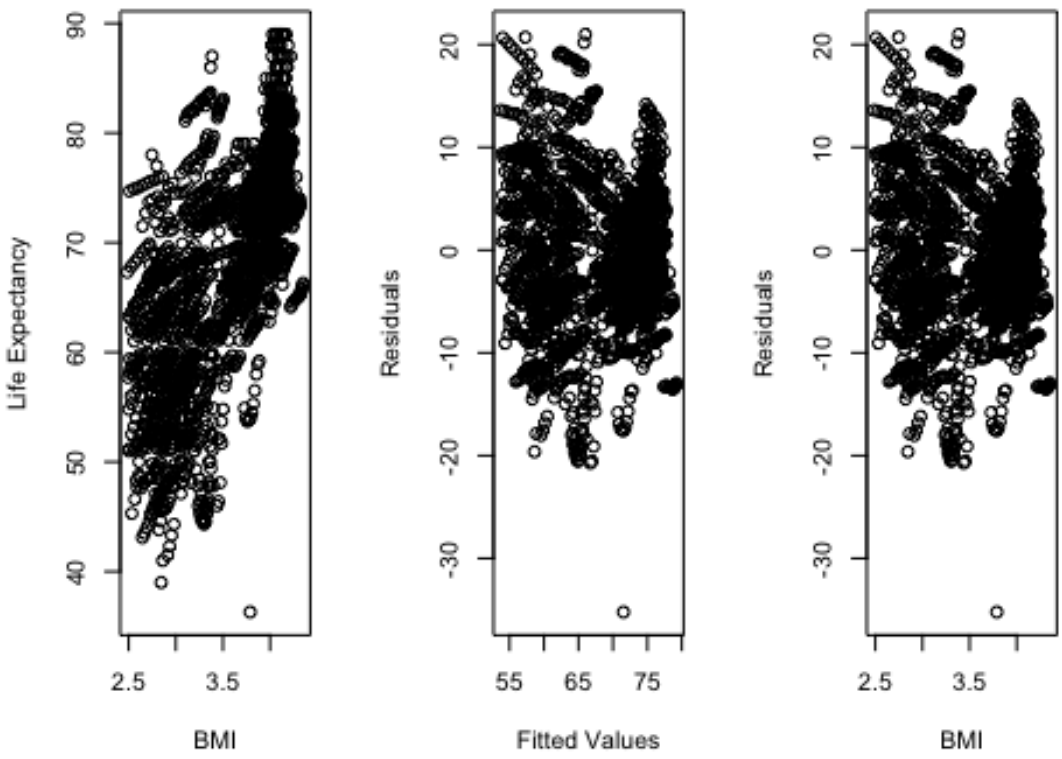



```
summary(lifeExpec$BMI)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    1.00   19.30   43.35   38.24   56.10   77.60      32

# The lowest BMI ever recorded is 7.5.  Mean BMI of 12 is the lower limit for human survival.
lifeExpec %>% filter(BMI<12) %>% select(BMI) %>% arrange(BMI)

## Adding missing grouping variables: `Country`

## # A tibble: 291 x 2
## # Groups:   Country [164]
##    Country                             BMI
##    <chr>                             <dbl>
##  1 Viet Nam                            1
##  2 Bangladesh                          1.4
##  3 Viet Nam                            1.4
##  4 Bangladesh                          1.8
##  5 Viet Nam                            1.9
##  6 Madagascar                          2
##  7 Benin                               2.1
##  8 Comoros                             2.1
##  9 Democratic Republic of the Congo    2.1
## 10 Ghana                               2.1
## # … with 281 more rows

BMI_clean <- lifeExpec %>% filter(BMI>=12) %>% select(Life.expectancy, BMI) %>% arrange(BMI)

## Adding missing grouping variables: `Country`

dim(BMI_clean)

## [1] 2605    3
```

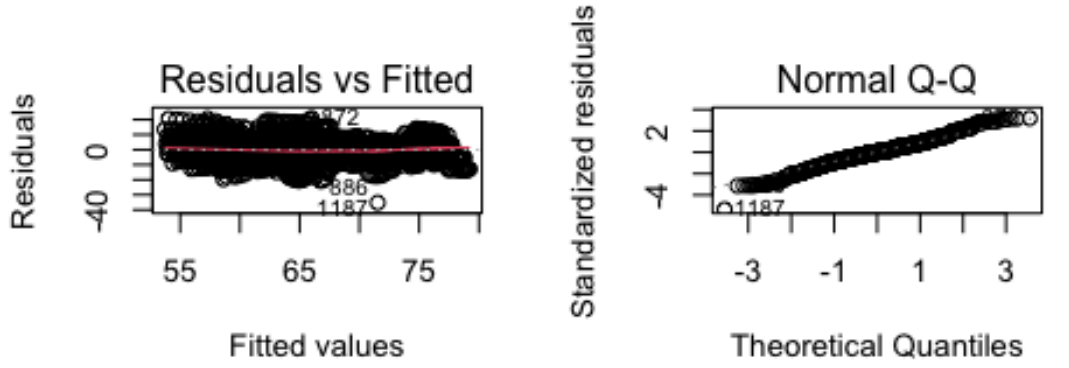
```
BMI_clean %>% ggplot(aes(x=log(BMI), y=Life.expectancy)) + geom_point() + geom_smooth(method="lm") +geom_jitter()

## `geom_smooth()` using formula 'y ~ x'
```

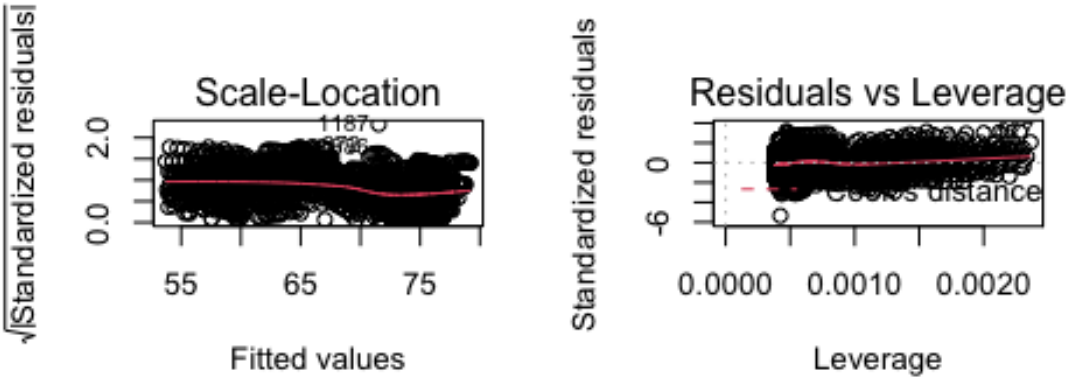



```
attach(BMI_clean)
par(mfrow=c(1,3))
plot(log(BMI), Life.expectancy, xlab="BMI", ylab="Life Expectancy")
BMI.model <-lm(Life.expectancy~log(BMI))
plot(BMI.model$fitted.values,BMI.model$residuals, xlab="Fitted Values", ylab="Residuals")
plot(log(BMI), BMI.model$residuals, xlab="BMI", ylab="Residuals")
```

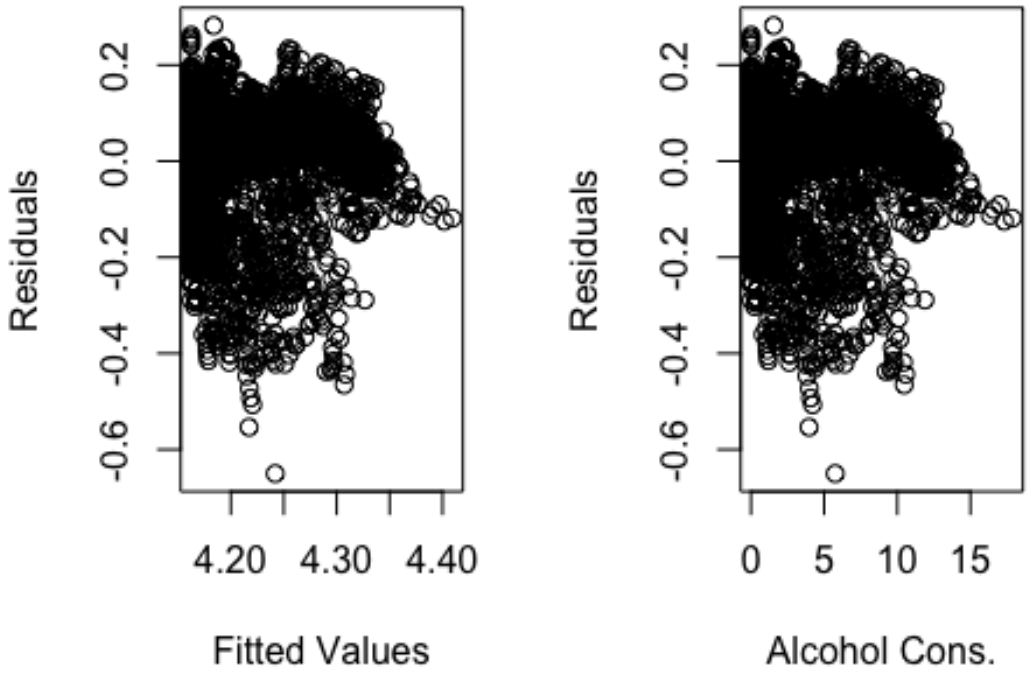



```
par(mfrow=c(2,2))
plot(BMI.model)
```



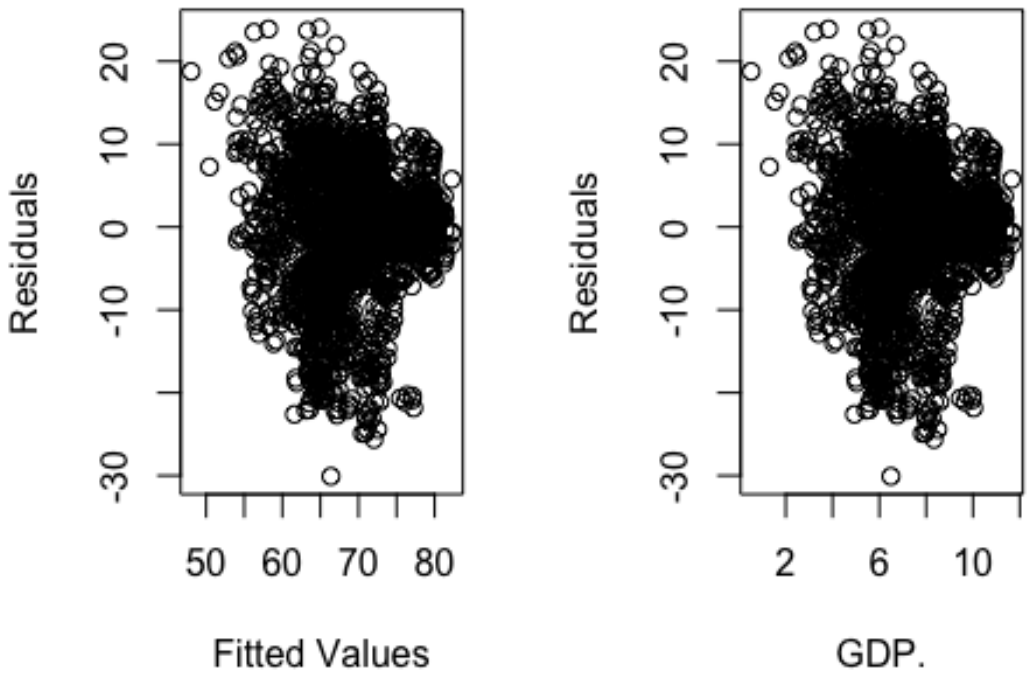



```
cor(log(BMI),Life.expectancy)

## [1] 0.7218619

#BMI Change from .57 to .72

summary(lifeExpec$Alcohol)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   0.010   0.905   3.770   4.615   7.715  17.870     193

#193 NAs
Alcohol_clean <- lifeExpec %>% filter(!is.na(Alcohol)) %>% arrange(Alcohol)
summary(Alcohol_clean$Alcohol)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.010   0.905   3.770   4.615   7.715  17.870

attach(Alcohol_clean)

## The following objects are masked from BMI_clean:
##
##     BMI, Country, Life.expectancy

Alcohol.model <-lm(log(Life.expectancy)~Alcohol)
par(mfrow=c(1,2))
plot(Alcohol.model$fitted.values,Alcohol.model$residuals, xlab="Fitted Values", ylab="Residuals")
plot(Alcohol, Alcohol.model$residuals, xlab="Alcohol Cons.", ylab="Residuals")
```




```
# Alcohol has a nonconstant variance, when both before and after log transformed
# Transforming life expectancy does not help the varaince either.
# Remove Alcohol as a good candidate.

summary(lifeExpec$GDP)

##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.      NA's
##      1.68    463.85   1764.97   7494.21   5932.90 119172.74       443

# 443 NAs
GDP_clean <- lifeExpec %>% filter(!is.na(GDP)) %>% arrange(GDP)
summary(GDP_clean$GDP)

##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.
##      1.68    463.85   1764.97   7494.21   5932.90 119172.74

attach(GDP_clean)

## The following objects are masked from Alcohol_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from BMI_clean:
##
##     BMI, Country, Life.expectancy

GDP.model <- lm(Life.expectancy~log(GDP))
par(mfrow=c(1,2))
```

```r
plot(GDP.model$fitted.values,GDP.model$residuals, xlab="Fitted Values", ylab="Residuals")
plot(log(GDP), GDP.model$residuals, xlab="GDP.", ylab="Residuals")
```



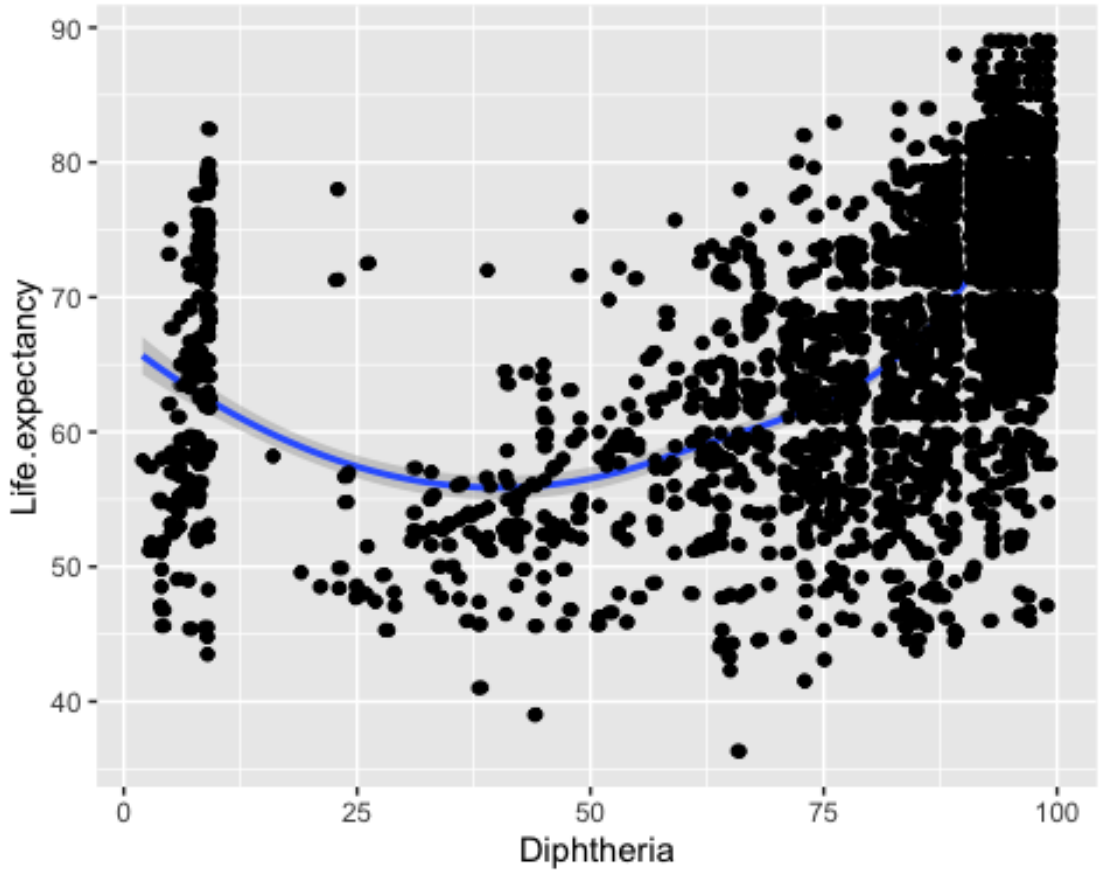

```r
cor(log(GDP), Life.expectancy)
```

```
## [1] 0.5983547
```

```r
# GDP chang from .46 to .598

attach(lifeExpec)
```

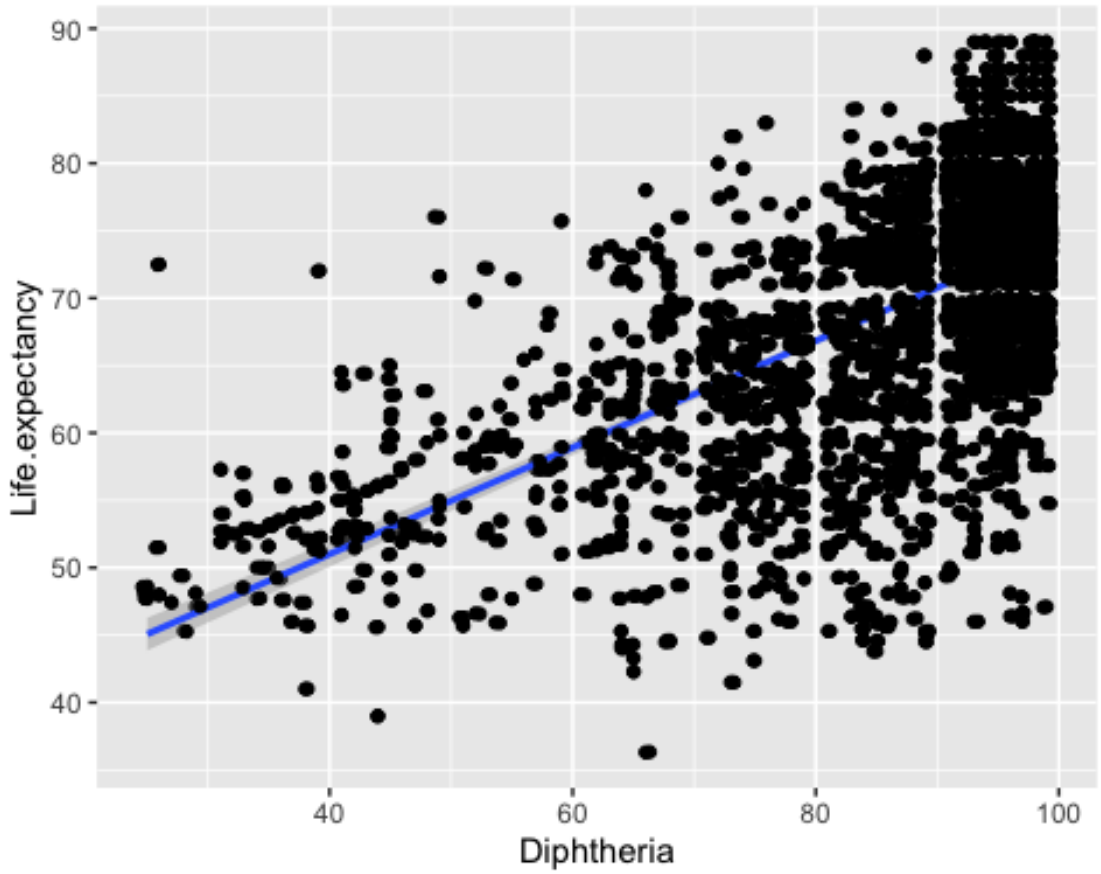
```
## The following objects are masked from GDP_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from Alcohol_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from BMI_clean:
##
##     BMI, Country, Life.expectancy
```

```
lifeExpec %>% ggplot(aes(x=Diphtheria, y=Life.expectancy)) + geom_point() + geom_smooth(method="loess") + geo
m_jitter()
```



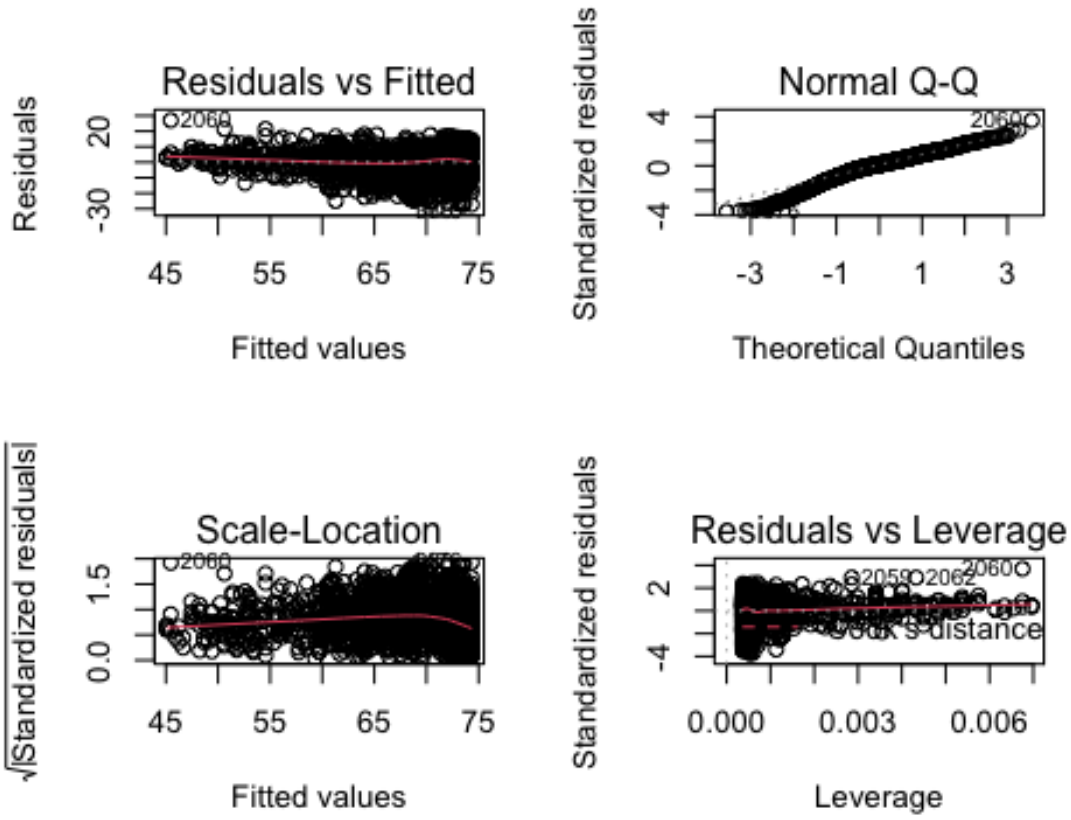

```
oglm <- lm(Life.expectancy~Diphtheria, data = lifeExpec)
summary(oglm)

##
## Call:
## lm(formula = Life.expectancy ~ Diphtheria, data = lifeExpec)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -29.851  -4.888   1.204   5.088  27.294
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 53.477505   0.558390   95.77   <2e-16 ***
## Diphtheria   0.192029   0.006518   29.46   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.333 on 2907 degrees of freedom
##   (19 observations deleted due to missingness)
## Multiple R-squared:  0.2299, Adjusted R-squared:  0.2297
## F-statistic: 867.9 on 1 and 2907 DF,  p-value: < 2.2e-16

str(lifeExpec$Diphtheria)

##  int [1:2928] 65 62 64 67 68 66 63 64 63 58 ...

summary(lifeExpec$Diphtheria)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    2.00   78.00   93.00   82.32   97.00   99.00      19
```

```
# With diphtheria we are looking at vaccination rates. Anything below 25% would not be enough to impact a sig
nificant portion of the population. Thus these were removed.
DIP_clean <- lifeExpec %>% filter(Diphtheria>=25) %>% select(Life.expectancy, Diphtheria)

## Adding missing grouping variables: `Country`

dim(DIP_clean)

## [1] 2730    3

DIP_clean %>% ggplot(aes(x=Diphtheria, y=Life.expectancy)) + geom_point() + geom_smooth(method="lm") +geom_ji
tter()

## `geom_smooth()` using formula 'y ~ x'
```




```
attach(DIP_clean)

## The following objects are masked from lifeExpec:
##
##     Country, Diphtheria, Life.expectancy

## The following objects are masked from GDP_clean:
##
##     Country, Diphtheria, Life.expectancy

## The following objects are masked from Alcohol_clean:
##
##     Country, Diphtheria, Life.expectancy

## The following objects are masked from BMI_clean:
##
##     Country, Life.expectancy
```

```r
DIPlm <- lm(Life.expectancy~Diphtheria, data = DIP_clean)
par(mfrow=c(2,2))
plot(DIPlm)
```



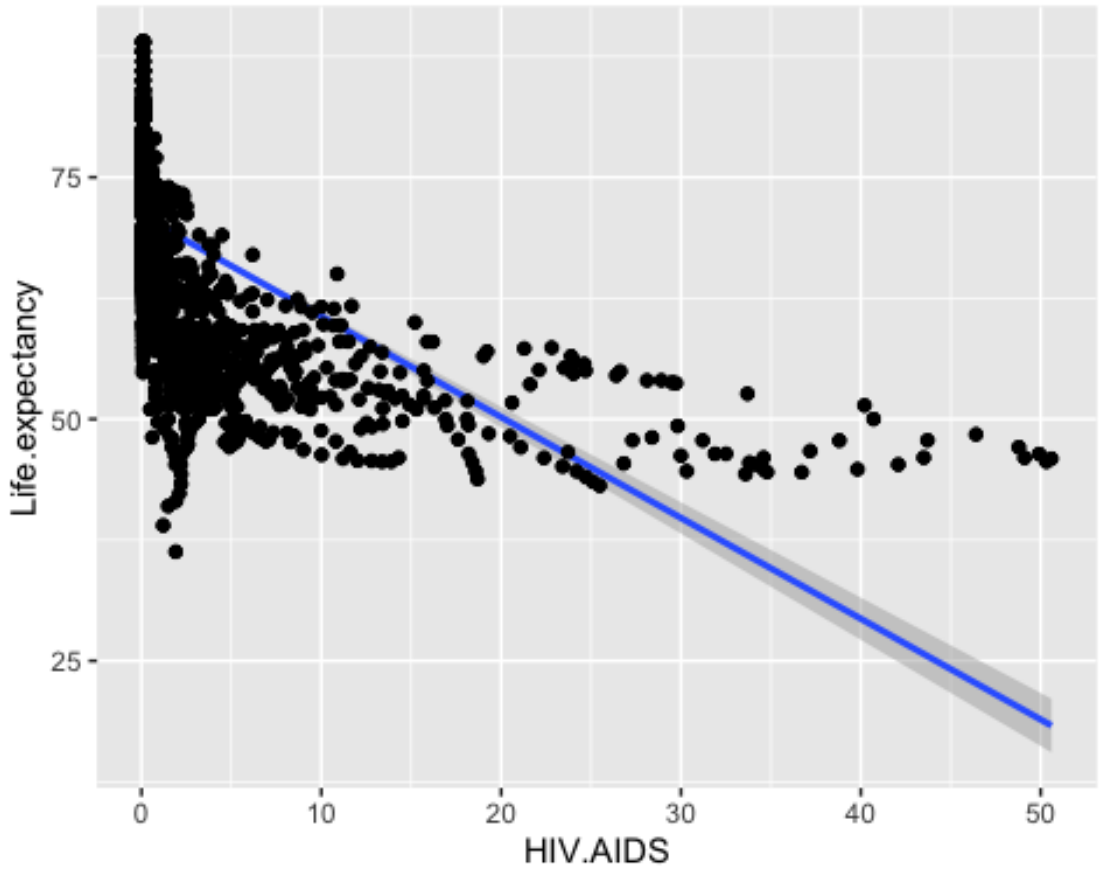

```r
summary(DIPlm)
```

```
##
## Call:
## lm(formula = Life.expectancy ~ Diphtheria, data = DIP_clean)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -27.5490  -3.6487   0.8532   4.7187  27.0321
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 35.184640   0.849772   41.41   <2e-16 ***
## Diphtheria   0.395509   0.009613   41.14   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.358 on 2728 degrees of freedom
## Multiple R-squared:  0.3829, Adjusted R-squared:  0.3827
## F-statistic:  1693 on 1 and 2728 DF,  p-value: < 2.2e-16
```

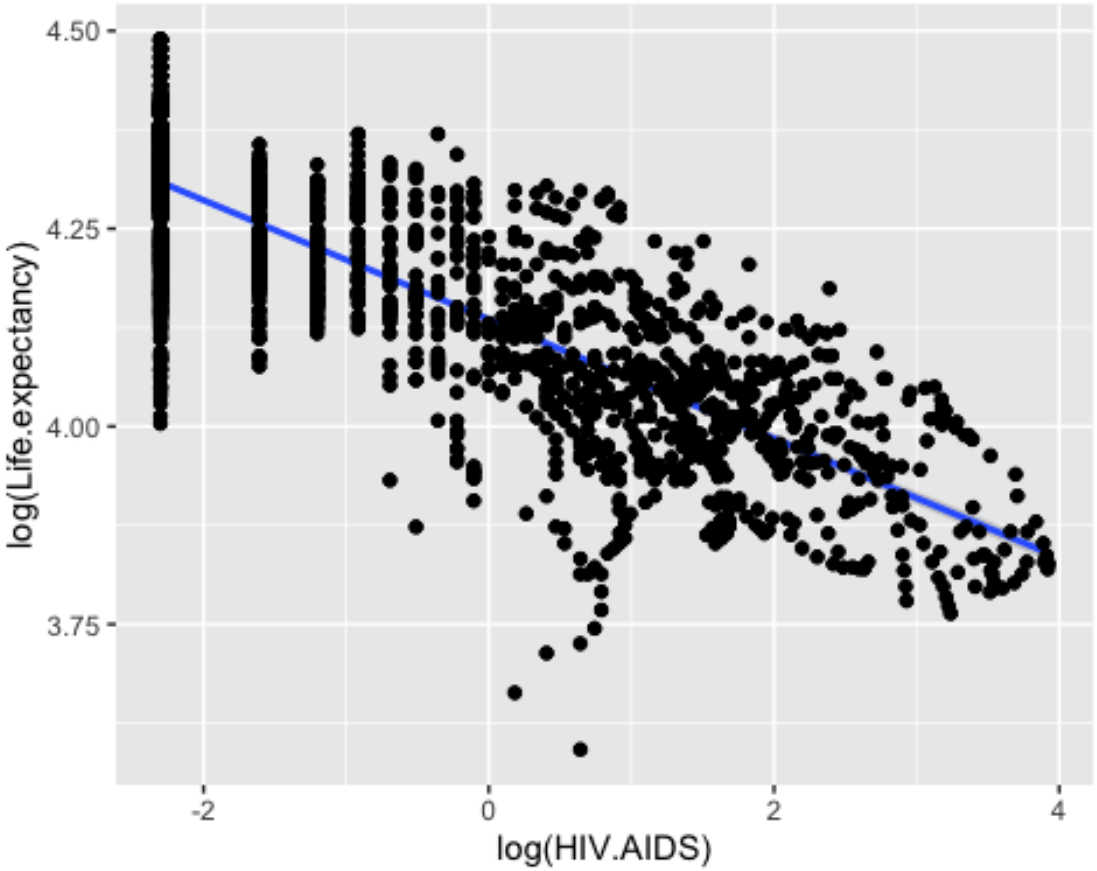
```r
# Tried additional transformations but none seemed to improve statistics beyond what we see in final model,
# adj R-squared changed from .22 to .38

# HIV deaths per 1000 in under 5 range starting correlation
HIV <- lifeExpec %>% filter(!is.na(HIV.AIDS))
summary(HIV$HIV.AIDS)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.100   0.100   0.100   1.748   0.800  50.600
```

```
HIV %>% ggplot(aes(x=HIV.AIDS, y = Life.expectancy)) +geom_point() + geom_smooth(method = "lm") + geom_jitter
()

## `geom_smooth()` using formula 'y ~ x'
```



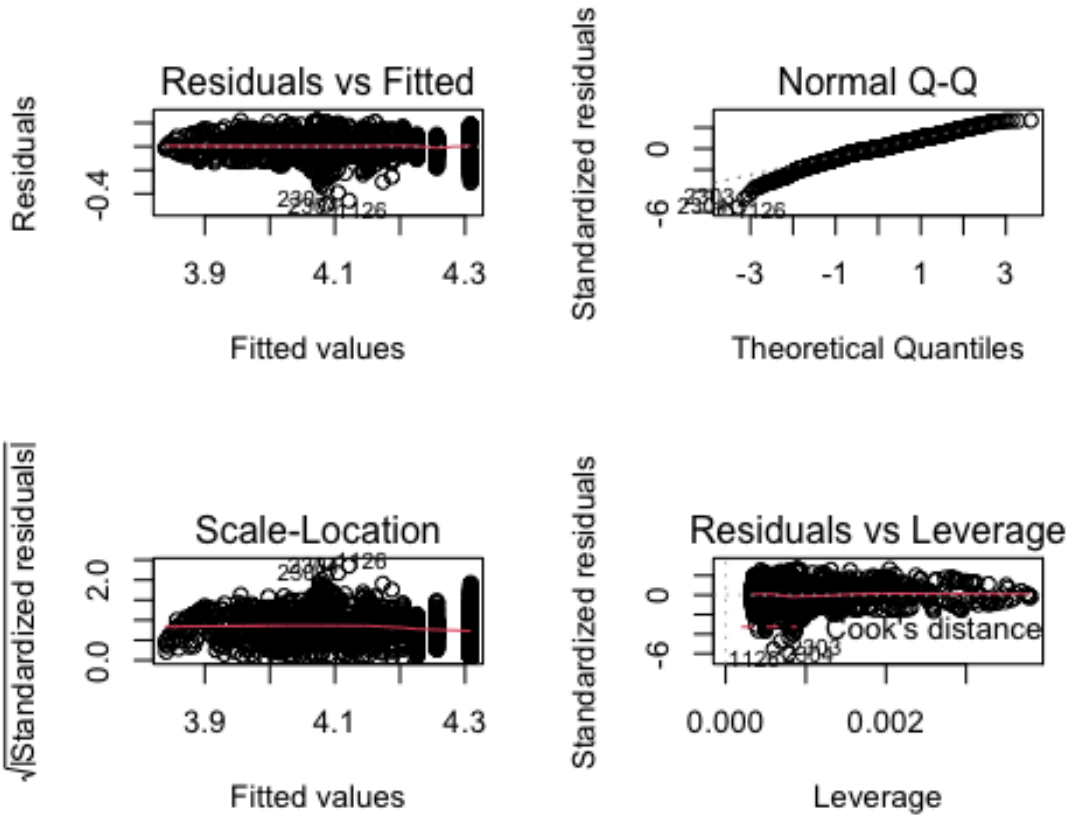

```
HIV %>% ggplot(aes(x=log(HIV.AIDS), y = log(Life.expectancy))) +geom_point() + geom_smooth(method = "lm") + g
eom_jitter()

## `geom_smooth()` using formula 'y ~ x'
```




```
HIVoglm <- lm(Life.expectancy~HIV.AIDS, data = lifeExpec)
summary(HIVoglm)

##
## Call:
## lm(formula = Life.expectancy ~ HIV.AIDS, data = lifeExpec)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -32.766  -5.442   1.658   5.058  27.593
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 71.04654    0.15465  459.40   <2e-16 ***
## HIV.AIDS    -1.04228    0.02876  -36.24   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.914 on 2926 degrees of freedom
## Multiple R-squared:  0.3098, Adjusted R-squared:  0.3095
## F-statistic:  1313 on 1 and 2926 DF,  p-value: < 2.2e-16

attach(HIV)

## The following objects are masked from DIP_clean:
##
##     Country, Diphtheria, Life.expectancy

## The following objects are masked from lifeExpec:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
```

```
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from GDP_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from Alcohol_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from BMI_clean:
##
##     BMI, Country, Life.expectancy
```

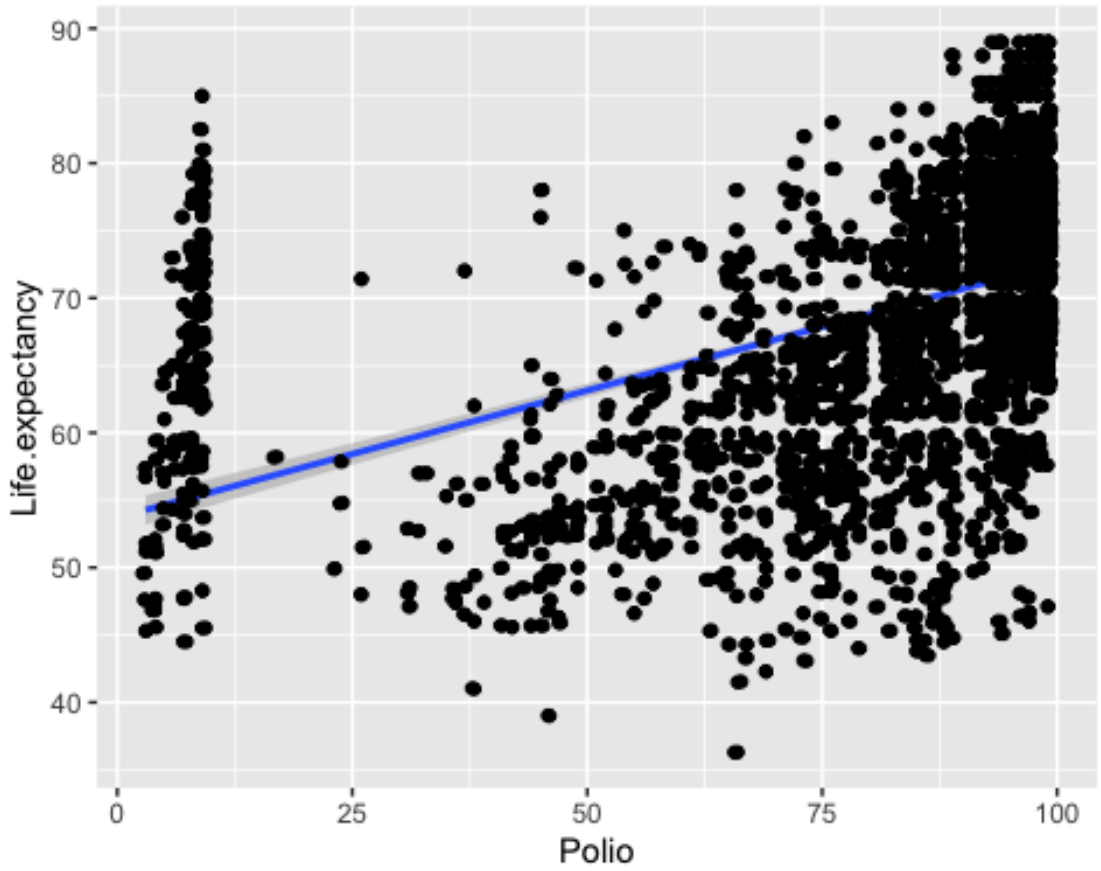
```
HIVlm <-lm(log(Life.expectancy)~log(HIV.AIDS))
plot(HIVlm)
```




```
summary(HIVlm)
```

```
##
## Call:
## lm(formula = log(Life.expectancy) ~ log(HIV.AIDS))
##
```

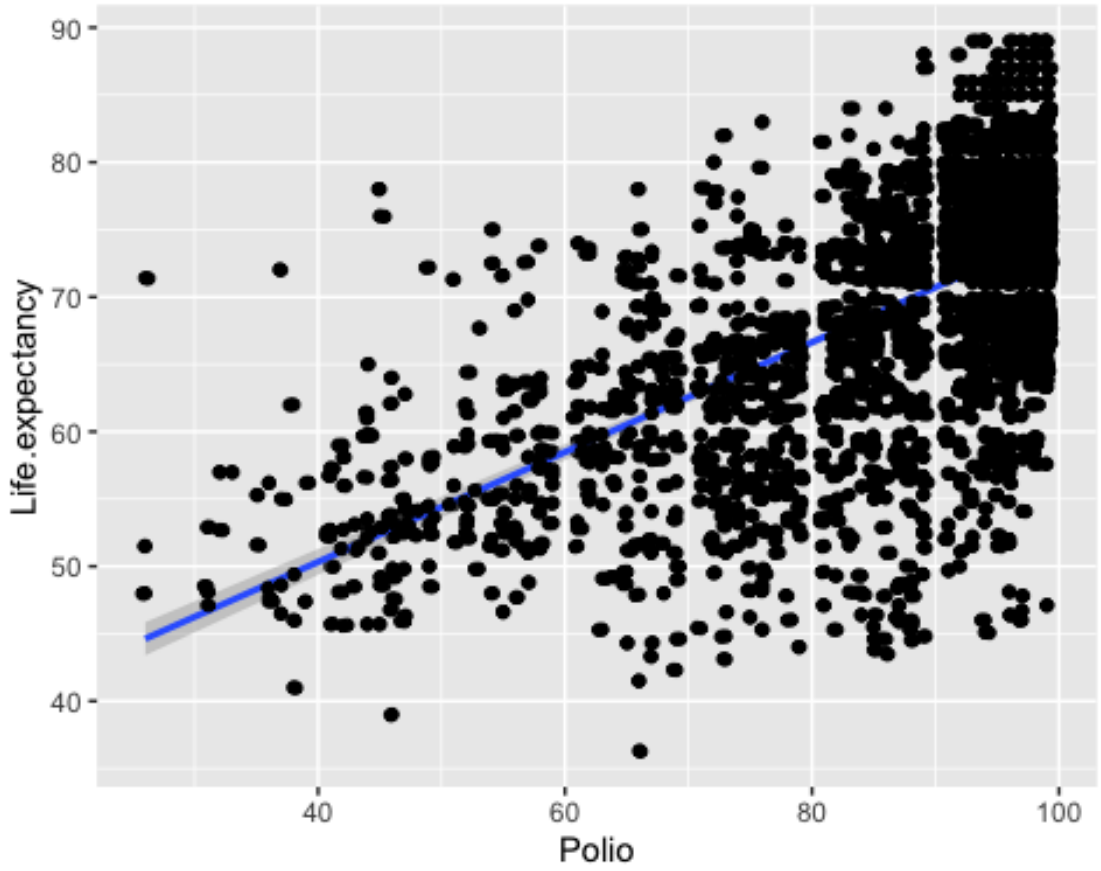
```
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.49518 -0.04038  0.00212  0.05570  0.22195
##
## Coefficients:
##                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)    4.1353235  0.0019156  2158.7   <2e-16 ***
## log(HIV.AIDS) -0.0752888  0.0009471   -79.5   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.08275 on 2926 degrees of freedom
## Multiple R-squared:  0.6835, Adjusted R-squared:  0.6834
## F-statistic:  6320 on 1 and 2926 DF,  p-value: < 2.2e-16

# transformation of both x and y variables allows residual tables to look best.
# Adj R-squared looks much better going from .31 to .68


# Polio
Polio1 <- lifeExpec %>% filter(!is.na(Polio))
summary(Polio1$Polio)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    3.00   78.00   93.00   82.55   97.00   99.00

Polio1 %>% ggplot(aes(x=Polio, y = Life.expectancy)) +geom_point() + geom_smooth(method = "lm") + geom_jitter
()

## `geom_smooth()` using formula 'y ~ x'
```




```
#similar to Diphtheria vaccination rates nothing below 25 should have a reasonable effect on total population
.
Polio_clean <- Polio1 %>% filter(Polio >= 25)
```

```
Polio_clean %>% ggplot(aes(x=Polio, y = Life.expectancy)) +geom_point() + geom_smooth(method = "lm") + geom_j
itter()
```

```
## `geom_smooth()` using formula 'y ~ x'
```




```
polioglm <- lm(Life.expectancy~Polio, data = lifeExpec)
summary(polioglm)
```

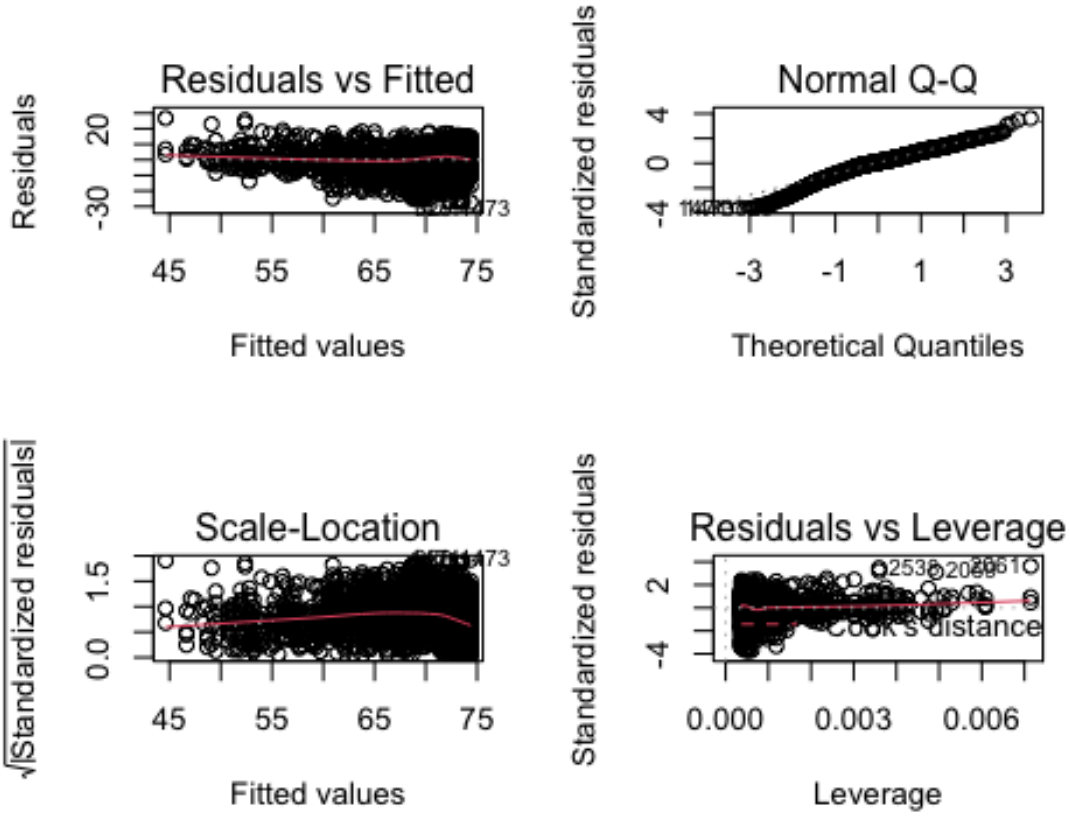
```
##
## Call:
## lm(formula = Life.expectancy ~ Polio, data = lifeExpec)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -29.862  -4.870   1.275   5.309  29.597
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 53.704164   0.571041   94.05   <2e-16 ***
## Polio        0.188756   0.006655   28.36   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 8.404 on 2907 degrees of freedom
##   (19 observations deleted due to missingness)
## Multiple R-squared:  0.2167, Adjusted R-squared:  0.2165
## F-statistic: 804.4 on 1 and 2907 DF,  p-value: < 2.2e-16
```

```
attach(Polio_clean)
```

```
## The following objects are masked from HIV:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
```

```
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from DIP_clean:
##
##     Country, Diphtheria, Life.expectancy

## The following objects are masked from lifeExpec:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from GDP_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from Alcohol_clean:
##
##     Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,
##     Diphtheria, GDP, Hepatitis.B, HIV.AIDS,
##     Income.composition.of.resources, infant.deaths, Life.expectancy,
##     Measles, percentage.expenditure, Polio, Population, Schooling,
##     Status, thinness..1.19.years, thinness.5.9.years,
##     Total.expenditure, under.five.deaths, Year

## The following objects are masked from BMI_clean:
##
##     BMI, Country, Life.expectancy
```

```r
poliolm <-lm(Life.expectancy~Polio, data = Polio_clean)
plot(poliolm)
```




```
summary(poliolm)

##
## Call:
## lm(formula = Life.expectancy ~ Polio, data = Polio_clean)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -27.5679  -3.9944   0.6668   4.7244  26.7789
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 34.020834   0.879453   38.68   <2e-16 ***
## Polio        0.407701   0.009939   41.02   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 7.403 on 2732 degrees of freedom
## Multiple R-squared:  0.3811, Adjusted R-squared:  0.3809
## F-statistic:  1683 on 1 and 2732 DF,  p-value: < 2.2e-16

#No drastic improvements adj R-Squared went from .22 to .38

#EDA for the life expectancy data

data <- lifeExpec
str(data)

## grouped_df [2,928 × 24] (S3: grouped_df/tbl_df/tbl/data.frame)
##  $ Country                        : chr [1:2928] "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" .
..
##  $ Year                           : int [1:2928] 2015 2014 2013 2012 2011 2010 2009 2008 2007 2006 ...
##  $ Status                         : chr [1:2928] "Developing" "Developing" "Developing" "Developing" ...
##  $ Life.expectancy                : num [1:2928] 65 59.9 59.9 59.5 59.2 58.8 58.6 58.1 57.5 57.3 ...
```

```
##  $ Adult.Mortality                : int [1:2928] 263 271 268 272 275 279 281 287 295 295 ...
##  $ infant.deaths                  : int [1:2928] 62 64 66 69 71 74 77 80 82 84 ...
##  $ Alcohol                        : num [1:2928] 0.01 0.01 0.01 0.01 0.01 0.01 0.01 0.03 0.02 0.03 ...
##  $ percentage.expenditure         : num [1:2928] 71.3 73.5 73.2 78.2 7.1 ...
##  $ Hepatitis.B                    : int [1:2928] 65 62 64 67 68 66 63 64 63 64 ...
##  $ Measles                        : int [1:2928] 1154 492 430 2787 3013 1989 2861 1599 1141 1990 ...
##  $ BMI                            : num [1:2928] 19.1 18.6 18.1 17.6 17.2 16.7 16.2 15.7 15.2 14.7 ...
##  $ under.five.deaths              : int [1:2928] 83 86 89 93 97 102 106 110 113 116 ...
##  $ Polio                          : int [1:2928] 6 58 62 67 68 66 63 64 63 58 ...
##  $ Total.expenditure              : num [1:2928] 8.16 8.18 8.13 8.52 7.87 9.2 9.42 8.33 6.73 7.43 ...
##  $ Diphtheria                     : int [1:2928] 65 62 64 67 68 66 63 64 63 58 ...
##  $ HIV.AIDS                       : num [1:2928] 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 0.1 ...
##  $ GDP                            : num [1:2928] 584.3 612.7 631.7 670 63.5 ...
##  $ Population                     : num [1:2928] 33736494 327582 31731688 3696958 2978599 ...
##  $ thinness..1.19.years           : num [1:2928] 17.2 17.5 17.7 17.9 18.2 18.4 18.6 18.8 19 19.2 ...
##  $ thinness.5.9.years             : num [1:2928] 17.3 17.5 17.7 18 18.2 18.4 18.7 18.9 19.1 19.3 ...
##  $ Income.composition.of.resources: num [1:2928] 0.479 0.476 0.47 0.463 0.454 0.448 0.434 0.433 0.415 0.40
5 ...
##  $ Schooling                      : num [1:2928] 10.1 10 9.9 9.8 9.5 9.2 8.9 8.7 8.4 8.1 ...
##  $ continent                      : chr [1:2928] "Asia" "Asia" "Asia" "Asia" ...
##  $ CountrytoMatch                 : chr [1:2928] "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" .
..
##  - attr(*, "groups")= tibble [183 × 2] (S3: tbl_df/tbl/data.frame)
##   ..$ Country: chr [1:183] "Afghanistan" "Albania" "Algeria" "Angola" ...
##   ..$ .rows  : list<int> [1:183]
##   .. ..$ : int [1:16] 1 2 3 4 5 6 7 8 9 10 ...
##   .. ..$ : int [1:16] 17 18 19 20 21 22 23 24 25 26 ...
##   .. ..$ : int [1:16] 33 34 35 36 37 38 39 40 41 42 ...
##   .. ..$ : int [1:16] 49 50 51 52 53 54 55 56 57 58 ...
##   .. ..$ : int [1:16] 65 66 67 68 69 70 71 72 73 74 ...
##   .. ..$ : int [1:16] 81 82 83 84 85 86 87 88 89 90 ...
##   .. ..$ : int [1:16] 97 98 99 100 101 102 103 104 105 106 ...
##   .. ..$ : int [1:16] 113 114 115 116 117 118 119 120 121 122 ...
##   .. ..$ : int [1:16] 129 130 131 132 133 134 135 136 137 138 ...
##   .. ..$ : int [1:16] 145 146 147 148 149 150 151 152 153 154 ...
##   .. ..$ : int [1:16] 161 162 163 164 165 166 167 168 169 170 ...
##   .. ..$ : int [1:16] 177 178 179 180 181 182 183 184 185 186 ...
##   .. ..$ : int [1:16] 193 194 195 196 197 198 199 200 201 202 ...
##   .. ..$ : int [1:16] 209 210 211 212 213 214 215 216 217 218 ...
##   .. ..$ : int [1:16] 225 226 227 228 229 230 231 232 233 234 ...
##   .. ..$ : int [1:16] 241 242 243 244 245 246 247 248 249 250 ...
##   .. ..$ : int [1:16] 257 258 259 260 261 262 263 264 265 266 ...
##   .. ..$ : int [1:16] 273 274 275 276 277 278 279 280 281 282 ...
##   .. ..$ : int [1:16] 289 290 291 292 293 294 295 296 297 298 ...
##   .. ..$ : int [1:16] 305 306 307 308 309 310 311 312 313 314 ...
##   .. ..$ : int [1:16] 321 322 323 324 325 326 327 328 329 330 ...
##   .. ..$ : int [1:16] 337 338 339 340 341 342 343 344 345 346 ...
##   .. ..$ : int [1:16] 353 354 355 356 357 358 359 360 361 362 ...
##   .. ..$ : int [1:16] 369 370 371 372 373 374 375 376 377 378 ...
##   .. ..$ : int [1:16] 385 386 387 388 389 390 391 392 393 394 ...
##   .. ..$ : int [1:16] 401 402 403 404 405 406 407 408 409 410 ...
##   .. ..$ : int [1:16] 417 418 419 420 421 422 423 424 425 426 ...
##   .. ..$ : int [1:16] 449 450 451 452 453 454 455 456 457 458 ...
##   .. ..$ : int [1:16] 465 466 467 468 469 470 471 472 473 474 ...
##   .. ..$ : int [1:16] 481 482 483 484 485 486 487 488 489 490 ...
##   .. ..$ : int [1:16] 497 498 499 500 501 502 503 504 505 506 ...
##   .. ..$ : int [1:16] 513 514 515 516 517 518 519 520 521 522 ...
##   .. ..$ : int [1:16] 529 530 531 532 533 534 535 536 537 538 ...
##   .. ..$ : int [1:16] 545 546 547 548 549 550 551 552 553 554 ...
##   .. ..$ : int [1:16] 561 562 563 564 565 566 567 568 569 570 ...
##   .. ..$ : int [1:16] 577 578 579 580 581 582 583 584 585 586 ...
##   .. ..$ : int [1:16] 593 594 595 596 597 598 599 600 601 602 ...
##   .. ..$ : int [1:16] 609 610 611 612 613 614 615 616 617 618 ...
##   .. ..$ : int [1:16] 625 626 627 628 629 630 631 632 633 634 ...
##   .. ..$ : int [1:16] 433 434 435 436 437 438 439 440 441 442 ...
##   .. ..$ : int [1:16] 641 642 643 644 645 646 647 648 649 650 ...
```

```
##   .. ..$ : int [1:16] 657 658 659 660 661 662 663 664 665 666 ...
##   .. ..$ : int [1:16] 673 674 675 676 677 678 679 680 681 682 ...
##   .. ..$ : int [1:16] 689 690 691 692 693 694 695 696 697 698 ...
##   .. ..$ : int [1:16] 705 706 707 708 709 710 711 712 713 714 ...
##   .. ..$ : int [1:16] 721 722 723 724 725 726 727 728 729 730 ...
##   .. ..$ : int [1:16] 737 738 739 740 741 742 743 744 745 746 ...
##   .. ..$ : int [1:16] 753 754 755 756 757 758 759 760 761 762 ...
##   .. ..$ : int [1:16] 769 770 771 772 773 774 775 776 777 778 ...
##   .. ..$ : int [1:16] 785 786 787 788 789 790 791 792 793 794 ...
##   .. ..$ : int [1:16] 801 802 803 804 805 806 807 808 809 810 ...
##   .. ..$ : int [1:16] 817 818 819 820 821 822 823 824 825 826 ...
##   .. ..$ : int [1:16] 833 834 835 836 837 838 839 840 841 842 ...
##   .. ..$ : int [1:16] 849 850 851 852 853 854 855 856 857 858 ...
##   .. ..$ : int [1:16] 865 866 867 868 869 870 871 872 873 874 ...
##   .. ..$ : int [1:16] 881 882 883 884 885 886 887 888 889 890 ...
##   .. ..$ : int [1:16] 897 898 899 900 901 902 903 904 905 906 ...
##   .. ..$ : int [1:16] 913 914 915 916 917 918 919 920 921 922 ...
##   .. ..$ : int [1:16] 929 930 931 932 933 934 935 936 937 938 ...
##   .. ..$ : int [1:16] 945 946 947 948 949 950 951 952 953 954 ...
##   .. ..$ : int [1:16] 961 962 963 964 965 966 967 968 969 970 ...
##   .. ..$ : int [1:16] 977 978 979 980 981 982 983 984 985 986 ...
##   .. ..$ : int [1:16] 993 994 995 996 997 998 999 1000 1001 1002 ...
##   .. ..$ : int [1:16] 1009 1010 1011 1012 1013 1014 1015 1016 1017 1018 ...
##   .. ..$ : int [1:16] 1025 1026 1027 1028 1029 1030 1031 1032 1033 1034 ...
##   .. ..$ : int [1:16] 1041 1042 1043 1044 1045 1046 1047 1048 1049 1050 ...
##   .. ..$ : int [1:16] 1057 1058 1059 1060 1061 1062 1063 1064 1065 1066 ...
##   .. ..$ : int [1:16] 1073 1074 1075 1076 1077 1078 1079 1080 1081 1082 ...
##   .. ..$ : int [1:16] 1089 1090 1091 1092 1093 1094 1095 1096 1097 1098 ...
##   .. ..$ : int [1:16] 1105 1106 1107 1108 1109 1110 1111 1112 1113 1114 ...
##   .. ..$ : int [1:16] 1121 1122 1123 1124 1125 1126 1127 1128 1129 1130 ...
##   .. ..$ : int [1:16] 1137 1138 1139 1140 1141 1142 1143 1144 1145 1146 ...
##   .. ..$ : int [1:16] 1153 1154 1155 1156 1157 1158 1159 1160 1161 1162 ...
##   .. ..$ : int [1:16] 1169 1170 1171 1172 1173 1174 1175 1176 1177 1178 ...
##   .. ..$ : int [1:16] 1185 1186 1187 1188 1189 1190 1191 1192 1193 1194 ...
##   .. ..$ : int [1:16] 1201 1202 1203 1204 1205 1206 1207 1208 1209 1210 ...
##   .. ..$ : int [1:16] 1217 1218 1219 1220 1221 1222 1223 1224 1225 1226 ...
##   .. ..$ : int [1:16] 1233 1234 1235 1236 1237 1238 1239 1240 1241 1242 ...
##   .. ..$ : int [1:16] 1249 1250 1251 1252 1253 1254 1255 1256 1257 1258 ...
##   .. ..$ : int [1:16] 1265 1266 1267 1268 1269 1270 1271 1272 1273 1274 ...
##   .. ..$ : int [1:16] 1281 1282 1283 1284 1285 1286 1287 1288 1289 1290 ...
##   .. ..$ : int [1:16] 1297 1298 1299 1300 1301 1302 1303 1304 1305 1306 ...
##   .. ..$ : int [1:16] 1313 1314 1315 1316 1317 1318 1319 1320 1321 1322 ...
##   .. ..$ : int [1:16] 1329 1330 1331 1332 1333 1334 1335 1336 1337 1338 ...
##   .. ..$ : int [1:16] 1345 1346 1347 1348 1349 1350 1351 1352 1353 1354 ...
##   .. ..$ : int [1:16] 1361 1362 1363 1364 1365 1366 1367 1368 1369 1370 ...
##   .. ..$ : int [1:16] 1377 1378 1379 1380 1381 1382 1383 1384 1385 1386 ...
##   .. ..$ : int [1:16] 1393 1394 1395 1396 1397 1398 1399 1400 1401 1402 ...
##   .. ..$ : int [1:16] 1409 1410 1411 1412 1413 1414 1415 1416 1417 1418 ...
##   .. ..$ : int [1:16] 1425 1426 1427 1428 1429 1430 1431 1432 1433 1434 ...
##   .. ..$ : int [1:16] 1441 1442 1443 1444 1445 1446 1447 1448 1449 1450 ...
##   .. ..$ : int [1:16] 1457 1458 1459 1460 1461 1462 1463 1464 1465 1466 ...
##   .. ..$ : int [1:16] 1473 1474 1475 1476 1477 1478 1479 1480 1481 1482 ...
##   .. ..$ : int [1:16] 1489 1490 1491 1492 1493 1494 1495 1496 1497 1498 ...
##   .. ..$ : int [1:16] 1505 1506 1507 1508 1509 1510 1511 1512 1513 1514 ...
##   .. ..$ : int [1:16] 1521 1522 1523 1524 1525 1526 1527 1528 1529 1530 ...
##   .. ..$ : int [1:16] 1537 1538 1539 1540 1541 1542 1543 1544 1545 1546 ...
##   .. ..$ : int [1:16] 1553 1554 1555 1556 1557 1558 1559 1560 1561 1562 ...
##   .. ..$ : int [1:16] 1569 1570 1571 1572 1573 1574 1575 1576 1577 1578 ...
##   .. .. [list output truncated]
##   .. ..@ ptype: int(0)
##   ..- attr(*, ".drop")= logi TRUE

summary(data)

##    Country               Year         Status          Life.expectancy
##  Length:2928        Min.   :2000   Length:2928        Min.   :36.30
##  Class :character   1st Qu.:2004   Class :character   1st Qu.:63.10
```

```
##  Mode  :character   Median :2008   Mode  :character   Median :72.10
##                     Mean   :2008                     Mean   :69.22
##                     3rd Qu.:2011                     3rd Qu.:75.70
##                     Max.   :2015                     Max.   :89.00
##
##  Adult.Mortality infant.deaths        Alcohol       percentage.expenditure
##  Min.   :  1.0   Min.   :   0.00   Min.   : 0.010   Min.   :    0.000
##  1st Qu.: 74.0   1st Qu.:   0.00   1st Qu.: 0.905   1st Qu.:    4.854
##  Median :144.0   Median :   3.00   Median : 3.770   Median :   65.611
##  Mean   :164.8   Mean   :  30.41   Mean   : 4.615   Mean   :  740.321
##  3rd Qu.:228.0   3rd Qu.:  22.00   3rd Qu.: 7.715   3rd Qu.:  442.614
##  Max.   :723.0   Max.   :1800.00   Max.   :17.870   Max.   :19479.912
##                                    NA's   :193
##   Hepatitis.B       Measles              BMI        under.five.deaths
##  Min.   : 1.00   Min.   :     0.0   Min.   : 1.00   Min.   :   0.00
##  1st Qu.:77.00   1st Qu.:     0.0   1st Qu.:19.30   1st Qu.:   0.00
##  Median :92.00   Median :    17.0   Median :43.35   Median :   4.00
##  Mean   :80.96   Mean   :  2427.9   Mean   :38.24   Mean   :  42.18
##  3rd Qu.:97.00   3rd Qu.:   362.2   3rd Qu.:56.10   3rd Qu.:  28.00
##  Max.   :99.00   Max.   :212183.0   Max.   :77.60   Max.   :2500.00
##  NA's   :553                        NA's   :32
##      Polio       Total.expenditure   Diphtheria       HIV.AIDS
##  Min.   : 3.00   Min.   : 0.37     Min.   : 2.00   Min.   : 0.100
##  1st Qu.:78.00   1st Qu.: 4.26     1st Qu.:78.00   1st Qu.: 0.100
##  Median :93.00   Median : 5.75     Median :93.00   Median : 0.100
##  Mean   :82.55   Mean   : 5.93     Mean   :82.32   Mean   : 1.748
##  3rd Qu.:97.00   3rd Qu.: 7.49     3rd Qu.:97.00   3rd Qu.: 0.800
##  Max.   :99.00   Max.   :17.60     Max.   :99.00   Max.   :50.600
##  NA's   :19      NA's   :226       NA's   :19
##       GDP              Population        thinness..1.19.years
##  Min.   :     1.68   Min.   :3.400e+01   Min.   : 0.100
##  1st Qu.:   463.85   1st Qu.:1.967e+05   1st Qu.: 1.600
##  Median :  1764.97   Median :1.392e+06   Median : 3.300
##  Mean   :  7494.21   Mean   :1.276e+07   Mean   : 4.851
##  3rd Qu.:  5932.90   3rd Qu.:7.427e+06   3rd Qu.: 7.200
##  Max.   :119172.74   Max.   :1.294e+09   Max.   :27.700
##  NA's   :443         NA's   :644         NA's   :32
##  thinness.5.9.years Income.composition.of.resources   Schooling
##  Min.   : 0.100     Min.   :0.0000                  Min.   : 0.0
##  1st Qu.: 1.575     1st Qu.:0.4930                  1st Qu.:10.1
##  Median : 3.400     Median :0.6770                  Median :12.3
##  Mean   : 4.881     Mean   :0.6274                  Mean   :12.0
##  3rd Qu.: 7.200     3rd Qu.:0.7792                  3rd Qu.:14.3
##  Max.   :28.600     Max.   :0.9480                  Max.   :20.7
##  NA's   :32         NA's   :160                     NA's   :160
##   continent         CountrytoMatch
##  Length:2928        Length:2928
##  Class :character   Class :character
##  Mode  :character   Mode  :character
##
##
##
##
```

```
head(data, 5)
```

```
## # A tibble: 5 x 24
## # Groups:   Country [1]
##   Country    Year Status   Life.expectancy Adult.Mortality infant.deaths Alcohol
##   <chr>     <int> <chr>              <dbl>           <int>         <int>   <dbl>
## 1 Afghanis…  2015 Develop…            65              263            62    0.01
## 2 Afghanis…  2014 Develop…            59.9            271            64    0.01
## 3 Afghanis…  2013 Develop…            59.9            268            66    0.01
## 4 Afghanis…  2012 Develop…            59.5            272            69    0.01
## 5 Afghanis…  2011 Develop…            59.2            275            71    0.01
## # … with 17 more variables: percentage.expenditure <dbl>, Hepatitis.B <int>,
## #   Measles <int>, BMI <dbl>, under.five.deaths <int>, Polio <int>,
```

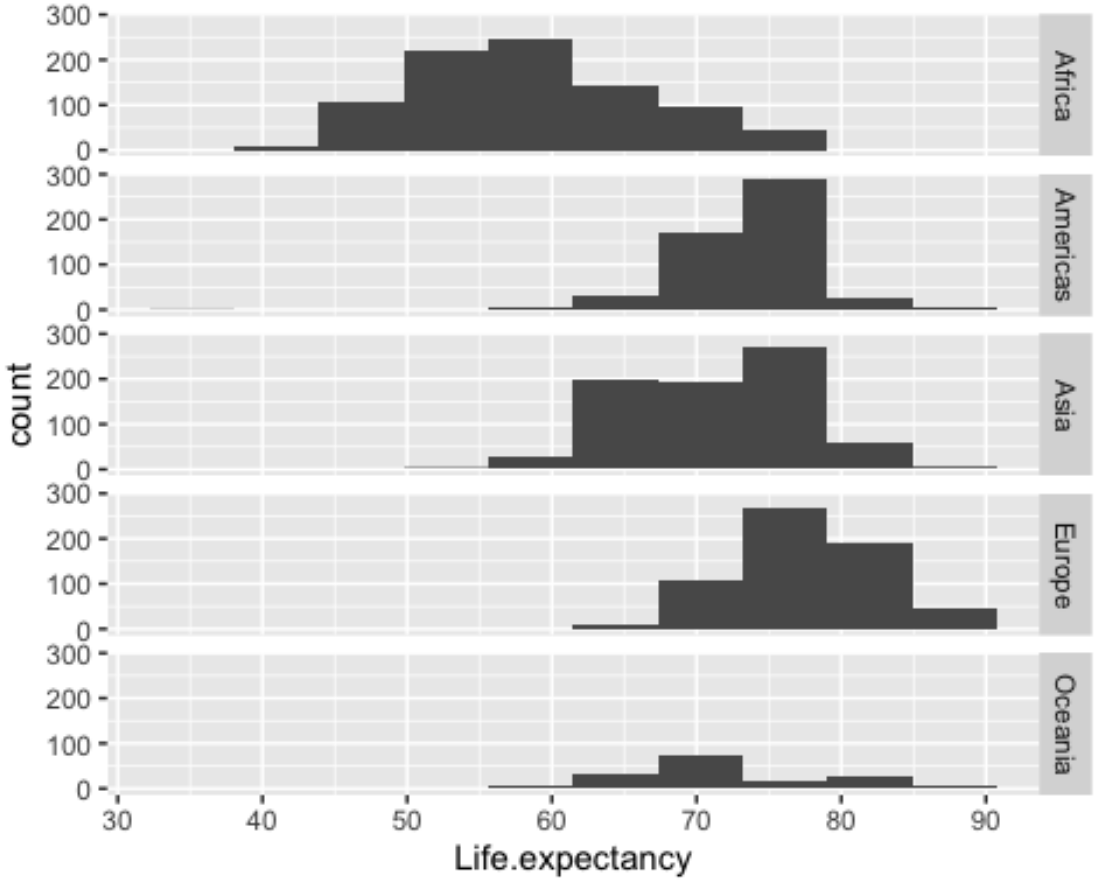
```
## #   Total.expenditure <dbl>, Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>,
## #   Population <dbl>, thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>, continent <chr>,
## #   CountrytoMatch <chr>

#check NA's
table(is.na(data))

##
## FALSE  TRUE
## 67759  2513

rowSums(is.na(data))

##    [1] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0
##   [38] 0 0 0 0 0 0 0 1 1 1 1 2 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 1
##   [75] 1 1 1 1 1 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0
##  [112] 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0
##  [149] 0 0 0 0 0 0 0 0 0 0 1 1 4 2 2 2 2 2 2 2 2 2 2 2 2 2 3 3 1 1 1 1 1 1 1 1
##  [186] 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3 1 1 1 1 1 1 1 1 1 1 1 1
##  [223] 1 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0
##  [260] 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0
##  [297] 0 0 0 0 0 0 0 0 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 0 0 0 0 0 0 0 0 0 0 1
##  [334] 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 1
##  [371] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0
##  [408] 0 0 0 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 1 1 1 1 6 4 4 4 4 4 4 4 4 4 4 4
##  [445] 4 4 4 5 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 2
##  [482] 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0
##  [519] 0 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 1
##  [556] 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
##  [593] 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 4 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 2 0 0 0 0
##  [630] 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 1 1
##  [667] 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 6 4 4 4 4 4 4 4 4 4 4 4 4 5
##  [704] 5 6 5 5 5 5 5 5 5 5 5 5 5 5 6 6 6 6 4 4 4 4 4 4 4 4 5 5 5 5 5 5 5 3 1 1 1
##  [741] 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0
##  [778] 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 2 2 2 2 2 2 2 2 2 2 2 2
##  [815] 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 1 1 1 1 1 1 1 1 1 1 1 1 1 4 2 2
##  [852] 2 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 2 0 0 0 0 0 0 0
##  [889] 0 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 1 1 1 1 1 1 1 1 1 1 1 1
##  [926] 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 4 2
##  [963] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0
## [1000] 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0
## [1037] 0 0 0 0 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 0 0 0 0 0 0 0 0 0 1 1 1 1 1 2
## [1074] 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 2 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 0 0 0 0 0
## [1111] 0 0 0 0 0 0 0 0 0 1 2 0 0 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0
## [1148] 0 0 0 0 0 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1
## [1185] 2 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 2 2 2 2
## [1222] 2 2 2 2 2 2 2 2 2 2 2 2 0 0 0 0 0 0 0 0 0 0 1 2 2 2 2 0 0 0 0 1 1 1 1
## [1259] 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0
## [1296] 0 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0
## [1333] 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
## [1370] 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 1 1 1 1 1 1 1 1 1 1 1
## [1407] 1 1 4 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 2 2 2 2 2 2 2 2 2 2 3 3 3 2 0 0
## [1444] 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
## [1481] 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 4 2 2 2 1 1 1 1 1 1 1 1
## [1518] 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0
## [1555] 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0
## [1592] 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0
## [1629] 0 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 2
## [1666] 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 2 2 2 2 2
## [1703] 2 2 2 2 2 2 2 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 4
## [1740] 3 3 3 3 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
## [1777] 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 0 0 0 0
## [1814] 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1
## [1851] 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 1 1 1 1 1 1 1 1
## [1888] 1 2 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 3 1 1 1
## [1925] 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0 0 0 0
```

```
## [1962] 0 0 0 0 0 0 1 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 1
## [1999] 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0
## [2036] 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 1 1 1 1 1 1 1
## [2073] 1 1 1 1 1 1 1 6 4 4 4 4 4 4 4 4 4 4 4 4 4 4 6 4 4 4 4 4 4 4 4 4 4 4 4
## [2110] 4 4 4 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 2 0
## [2147] 0 0 0 0 0 0 0 0 0 0 0 1 1 4 2 2 2 2 2 2 2 2 2 2 2 2 3 3 4 2 2 2 2 2 2
## [2184] 2 2 2 2 2 2 3 3 3 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
## [2221] 0 1 1 2 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 1 1 1 1 2
## [2258] 0 0 0 0 0 0 0 0 0 0 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0
## [2295] 0 0 0 1 1 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1 4 2 2 2 2 2 2 2 2 2 2
## [2332] 2 2 2 2 2 3 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0
## [2369] 5 4 4 6 6 6 6 6 6 6 6 6 6 6 6 6 2 0 0 0 0 0 0 0 0 0 0 0 0 0 5 5 5 5 6
## [2406] 8 8 8 9 9 9 9 9 9 9 2 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0
## [2443] 0 0 0 1 1 1 5 3 3 3 3 3 3 3 3 3 4 4 4 4 4 2 0 0 0 0 0 0 0 0 0 1 1 1 1
## [2480] 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 1 1 1 1 1 1 1 1 1 1 3 1 1 1
## [2517] 1 1 1 1 1 1 1 1 1 1 1 3 1 1 1 1 1 1 1 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0
## [2554] 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 4 2 2 2 2 2 2 2 2 2 3 3 3
## [2591] 3 3 2 0 0 0 0 0 0 1 1 1 1 1 1 3 3 2 0 0 0 0 0 0 1 1 1 1 1 1 1 1 2 0 0
## [2628] 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0
## [2665] 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0
## [2702] 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 3 1
## [2739] 1 1 1 1 1 1 1 1 1 1 1 1 1 1 6 5 5 5 5 5 5 5 5 5 5 5 5 5 6 4 4 4 4 4 4
## [2776] 4 4 4 4 4 4 4 5 5 6 4 4 4 4 4 4 4 4 4 4 4 4 4 4 2 0 0 0 0 0 0 0 0 0 0
## [2813] 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 2 0 0 0 0 0 0 0 0 0 0 0 0 0 4
## [2850] 2 2 2 2 2 2 2 2 2 2 2 2 2 2 4 2 2 2 2 2 2 2 2 2 2 2 3 3 3 4 2 2 2 2 2
## [2887] 2 2 2 2 2 2 2 2 2 2 0 0 0 0 0 0 0 0 0 1 1 1 1 1 2 0 0 0 0 0 0 0 0 0 0
## [2924] 0 0 0 0 0
```

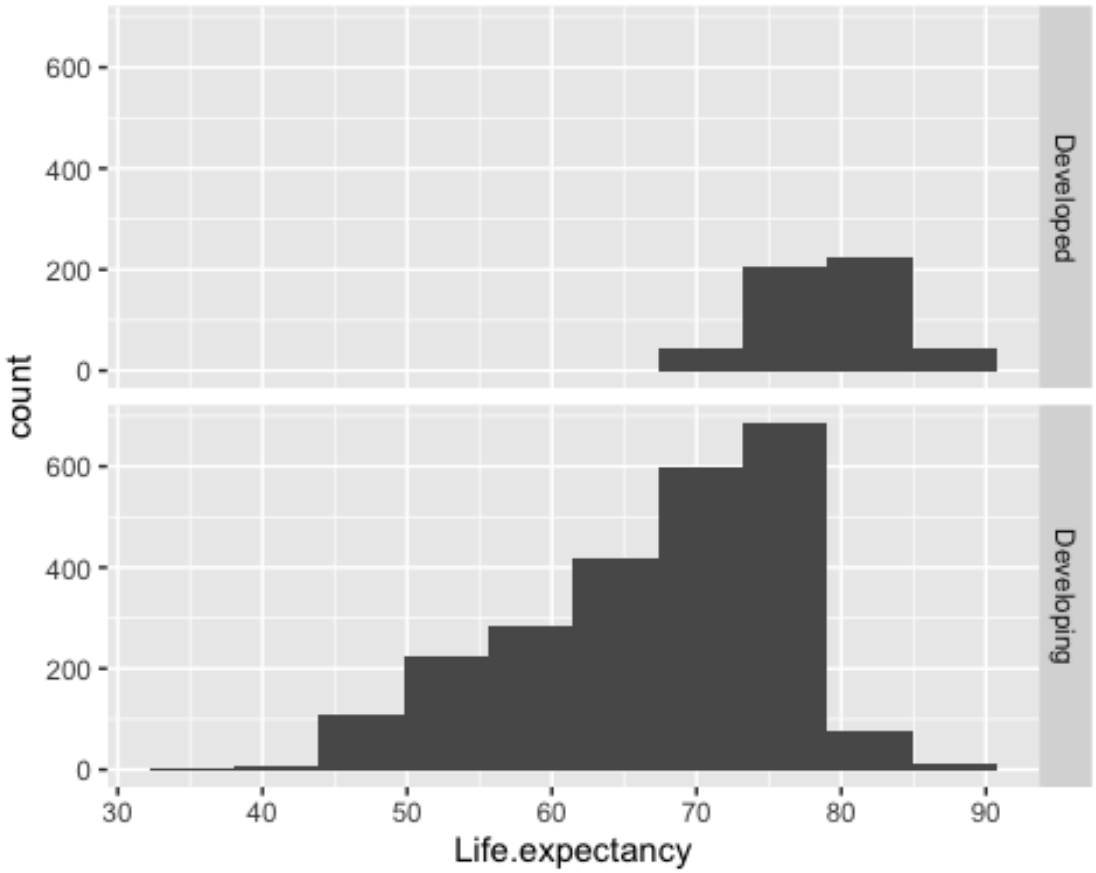
```
apply(is.na(data), 2, sum)
```

```
##                          Country                             Year
##                                0                                0
##                           Status                  Life.expectancy
##                                0                                0
##                  Adult.Mortality                     infant.deaths
##                                0                                0
##                          Alcohol           percentage.expenditure
##                              193                                0
##                     Hepatitis.B                          Measles
##                              553                                0
##                              BMI                under.five.deaths
##                               32                                0
##                            Polio                Total.expenditure
##                               19                              226
##                       Diphtheria                         HIV.AIDS
##                               19                                0
##                              GDP                       Population
##                              443                              644
##              thinness..1.19.years               thinness.5.9.years
##                               32                               32
## Income.composition.of.resources                         Schooling
##                              160                              160
##                        continent                  CountrytoMatch
##                                0                                0
```

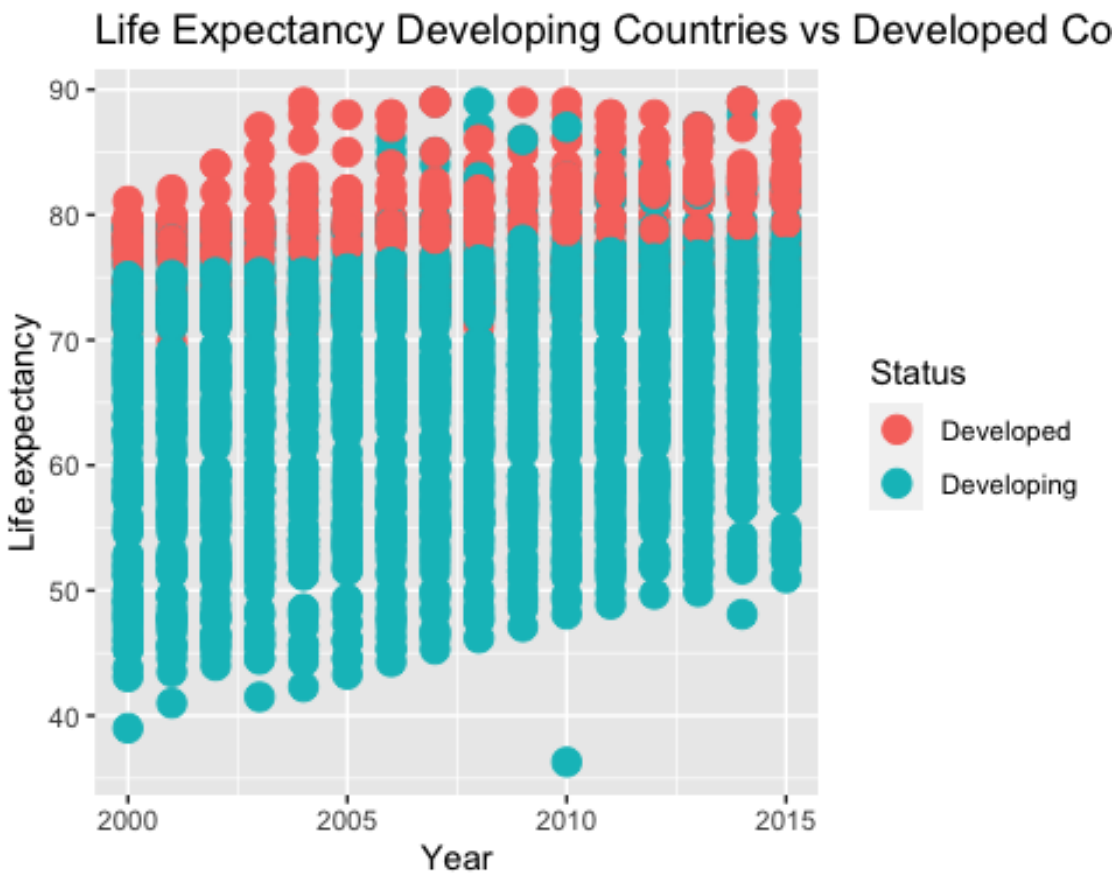
```
#life expectancy for all the countries
ggplot(data, aes(Life.expectancy)) + geom_histogram(bins = 10) + facet_grid(vars(continent))
```




```r
#life expectancy for developer vs developed
ggplot(data, aes(Life.expectancy)) + geom_histogram(bins = 10) + facet_grid(vars(Status))
```




```
#life expectancy year vs life expectancy
ggplot(data, aes(Year, Life.expectancy, color = Status)) + geom_point(size = 4) + ggtitle(("Life Expectancy D
eveloping Countries vs Developed Countries"))
```




```
#descriptive statistics removing the nas
data %>% drop_na(Life.expectancy) %>% group_by(Status) %>% summarize(Avg_lifexp = mean(Life.expectancy), Avg_
ChildMort = mean(infant.deaths), Avg_AdultMort = mean(Adult.Mortality))
```

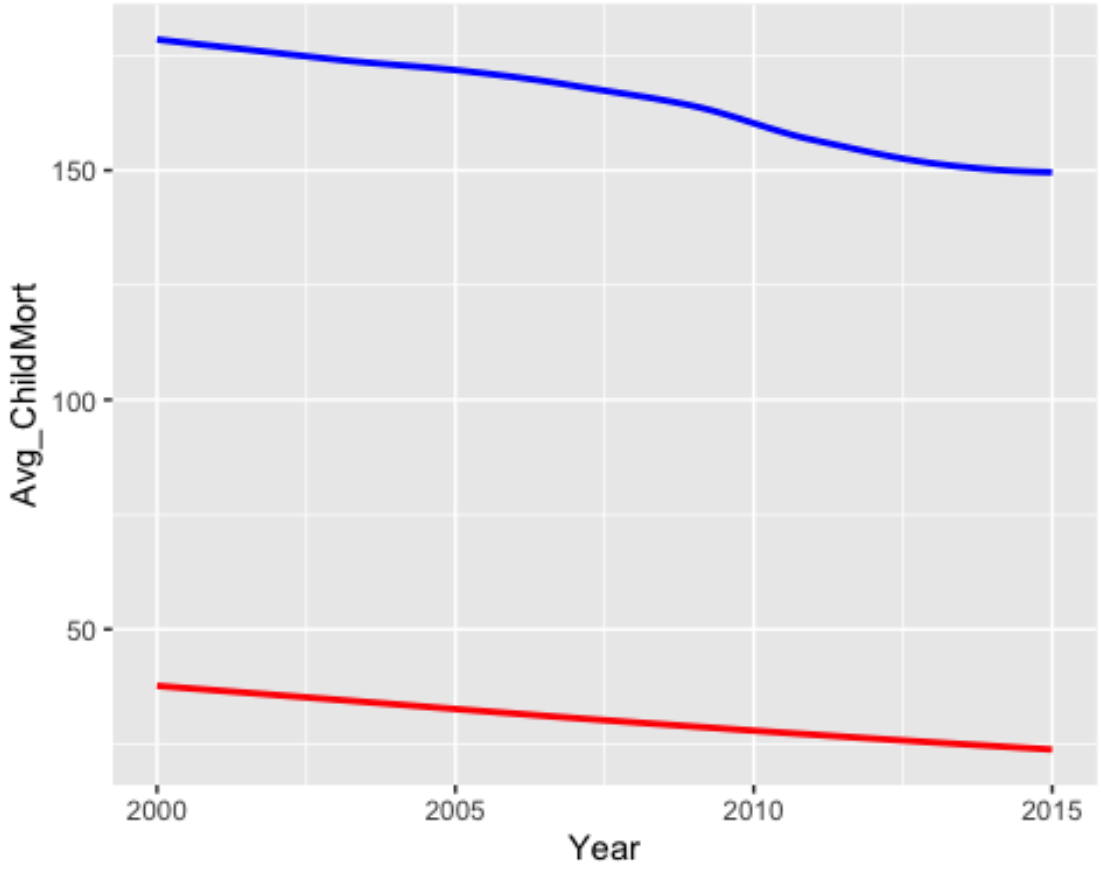
```
## # A tibble: 2 x 4
##   Status     Avg_lifexp Avg_ChildMort Avg_AdultMort
##   <chr>           <dbl>         <dbl>         <dbl>
## 1 Developed        79.2          1.49          79.7
## 2 Developing       67.1         36.5          183.
```

```
#descriptive statistics by continent
data %>% drop_na(Life.expectancy) %>% group_by(continent) %>% summarize(Avg_lifexp = mean(Life.expectancy), A
vg_ChildMort = mean(infant.deaths), Avg_AdultMort = mean(Adult.Mortality))
```

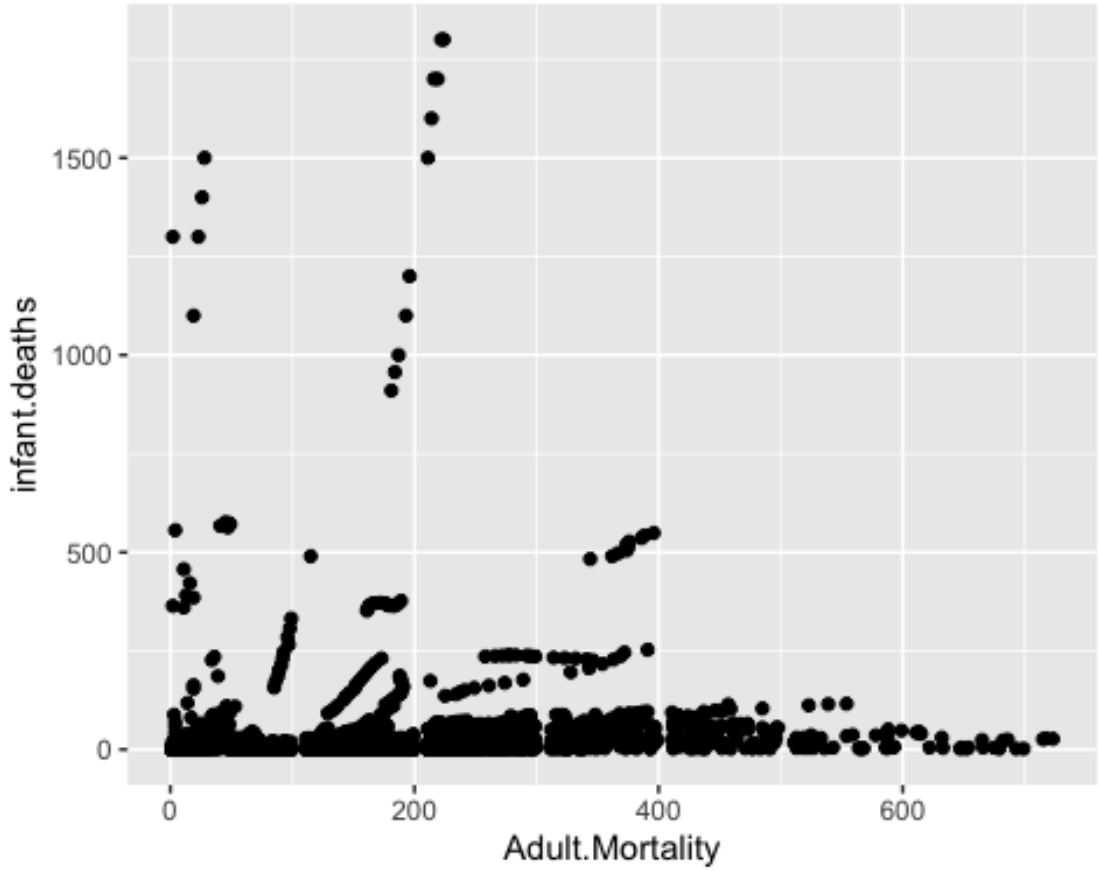
```
## # A tibble: 5 x 4
##   continent Avg_lifexp Avg_ChildMort Avg_AdultMort
##   <chr>          <dbl>         <dbl>         <dbl>
## 1 Africa          58.6         44.2          267.
## 2 Americas        73.5          7.78         131.
## 3 Asia            71.2         60.9          133.
## 4 Europe          77.4          1.18          98.0
## 5 Oceania         71.2          1.16         135.
```

```
#life expectancy of the developed and developing countries
data %>% drop_na(Life.expectancy) %>% group_by(Year) %>% summarize(Avg_lifexp = mean(Life.expectancy), Avg_Ch
ildMort = mean(infant.deaths), Avg_AdultMort = mean(Adult.Mortality)) %>% ggplot() + geom_smooth(aes(Year, Av
g_ChildMort), color = 'red', se = FALSE) + geom_smooth(aes(Year, Avg_AdultMort), color = 'blue', se = FALSE)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```




```
clean_data <- data %>% select(-continent, -Country, -Year, -Status)

## Adding missing grouping variables: `Country`

head(clean_data, 5)

## # A tibble: 5 x 21
## # Groups:   Country [1]
##   Country Life.expectancy Adult.Mortality infant.deaths Alcohol percentage.expe…
##   <chr>             <dbl>           <int>         <int>   <dbl>            <dbl>
## 1 Afghan…            65               263            62    0.01             71.3
## 2 Afghan…            59.9             271            64    0.01             73.5
## 3 Afghan…            59.9             268            66    0.01             73.2
## 4 Afghan…            59.5             272            69    0.01             78.2
## 5 Afghan…            59.2             275            71    0.01              7.10
## # … with 15 more variables: Hepatitis.B <int>, Measles <int>, BMI <dbl>,
## #   under.five.deaths <int>, Polio <int>, Total.expenditure <dbl>,
## #   Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>, Population <dbl>,
## #   thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>,
## #   CountrytoMatch <chr>

#relationship testing for adult mortality & infant deaths
ggplot(clean_data, aes(Adult.Mortality, infant.deaths )) + geom_point()
```



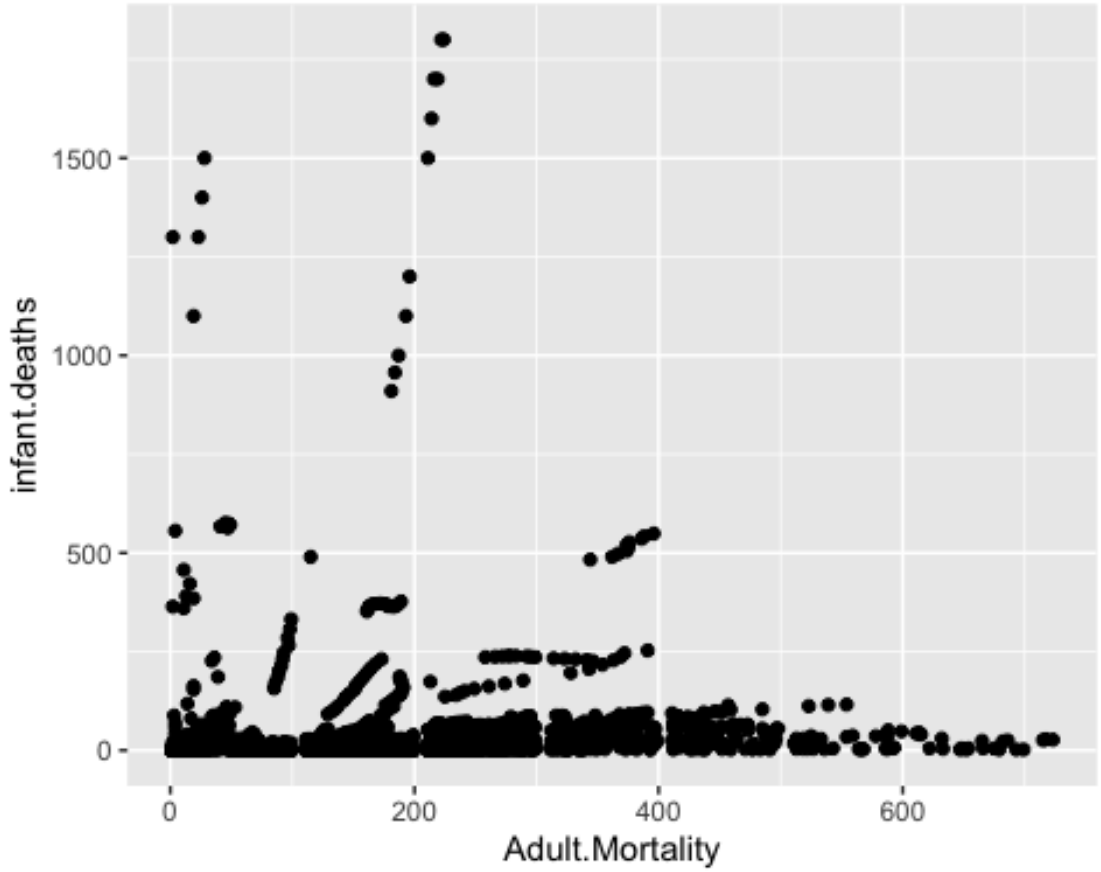

```
#correlation between Adult Mortality and Life Expectancy
clean_data %>% summarize(N = n(), cor(Adult.Mortality, as.integer(Life.expectancy), use = "pairwise.complete.
obs"))
```

```
## # A tibble: 183 x 3
##    Country             N `cor(Adult.Mortality, as.integer(Life.expectancy), use…
##    <chr>           <int>                                                   <dbl>
##  1 Afghanistan        16                                                0.000470
##  2 Albania            16                                                0.567
##  3 Algeria            16                                               -0.470
##  4 Angola             16                                                0.376
##  5 Antigua and Ba…    16                                               -0.498
##  6 Argentina          16                                               -0.0769
##  7 Armenia            16                                               -0.419
##  8 Australia          16                                               -0.228
##  9 Austria            16                                               -0.313
## 10 Azerbaijan         16                                               -0.115
## # … with 173 more rows
```

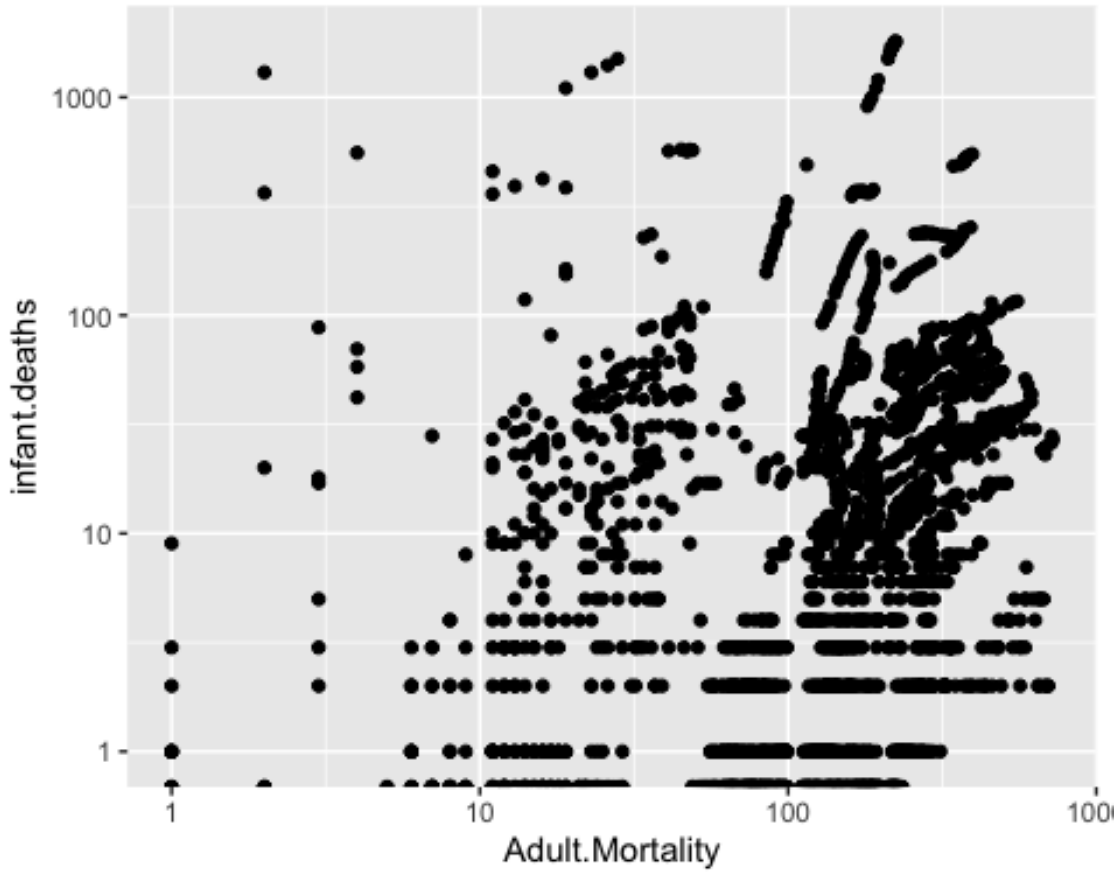
```
clean_data %>% summarize(N = n(), cor(Adult.Mortality, infant.deaths, use = "pairwise.complete.obs"))
```

```
## # A tibble: 183 x 3
##    Country             N `cor(Adult.Mortality, infant.deaths, use = "pairwise.…
##    <chr>           <int>                                                   <dbl>
##  1 Afghanistan        16                                               -0.0796
##  2 Albania            16                                               -0.407
##  3 Algeria            16                                               -0.111
##  4 Angola             16                                               -0.334
##  5 Antigua and Bar…   16                                               NA
##  6 Argentina          16                                                0.290
##  7 Armenia            16                                               NA
##  8 Australia          16                                               NA
##  9 Austria            16                                               NA
```

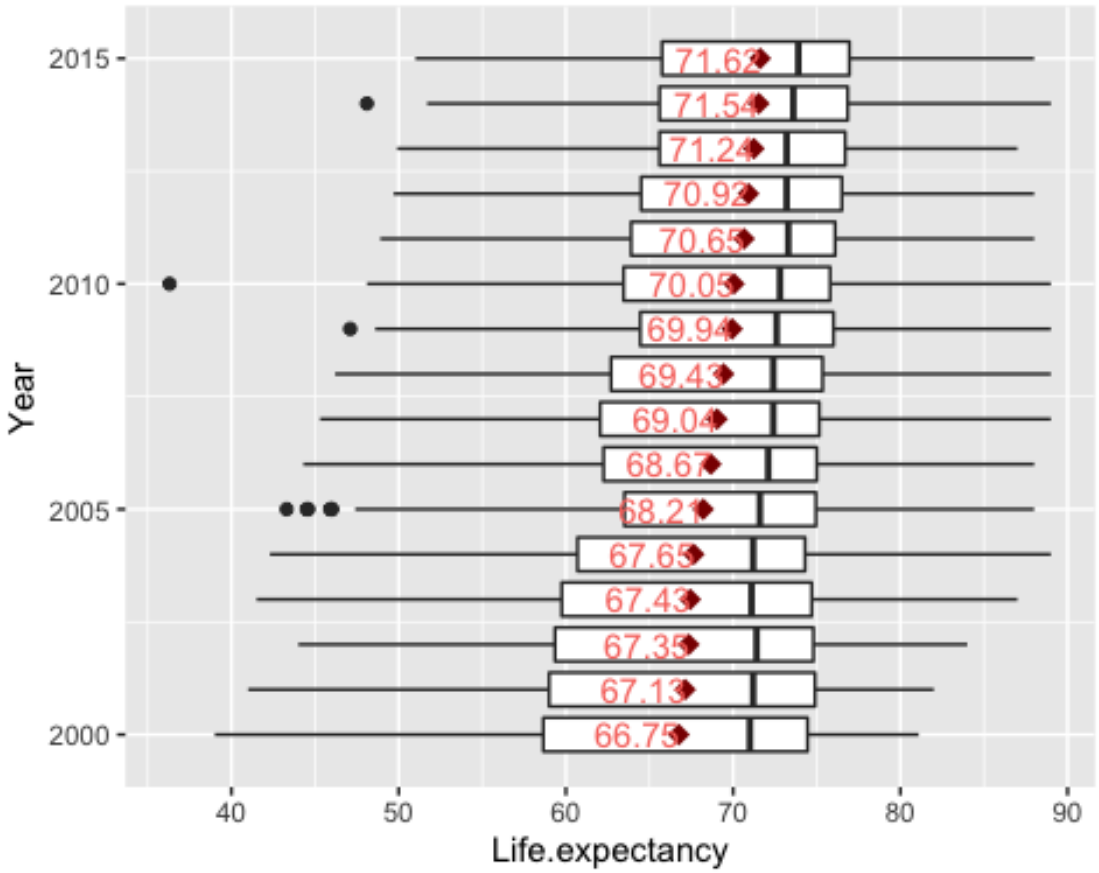
```
## 10 Azerbaijan          16                                                -0.0913
## # … with 173 more rows

clean_data %>% summarize(N = n(), cor(log(Adult.Mortality), log(infant.deaths), use = "pairwise.complete.obs"
))

## # A tibble: 183 x 3
##    Country             N `cor(log(Adult.Mortality), log(infant.deaths), use = "…
##    <chr>           <int>                                                  <dbl>
##  1 Afghanistan        16                                                -0.225
##  2 Albania            16                                               NaN
##  3 Algeria            16                                                -0.0444
##  4 Angola             16                                                -0.385
##  5 Antigua and Ba…    16                                               NaN
##  6 Argentina          16                                                 0.199
##  7 Armenia            16                                                NA
##  8 Australia          16                                                NA
##  9 Austria            16                                               NaN
## 10 Azerbaijan         16                                                -0.125
## # … with 173 more rows

#relationship testing for adult mortality & infant deaths
ggplot(clean_data, aes(Adult.Mortality, infant.deaths)) + geom_point()
```



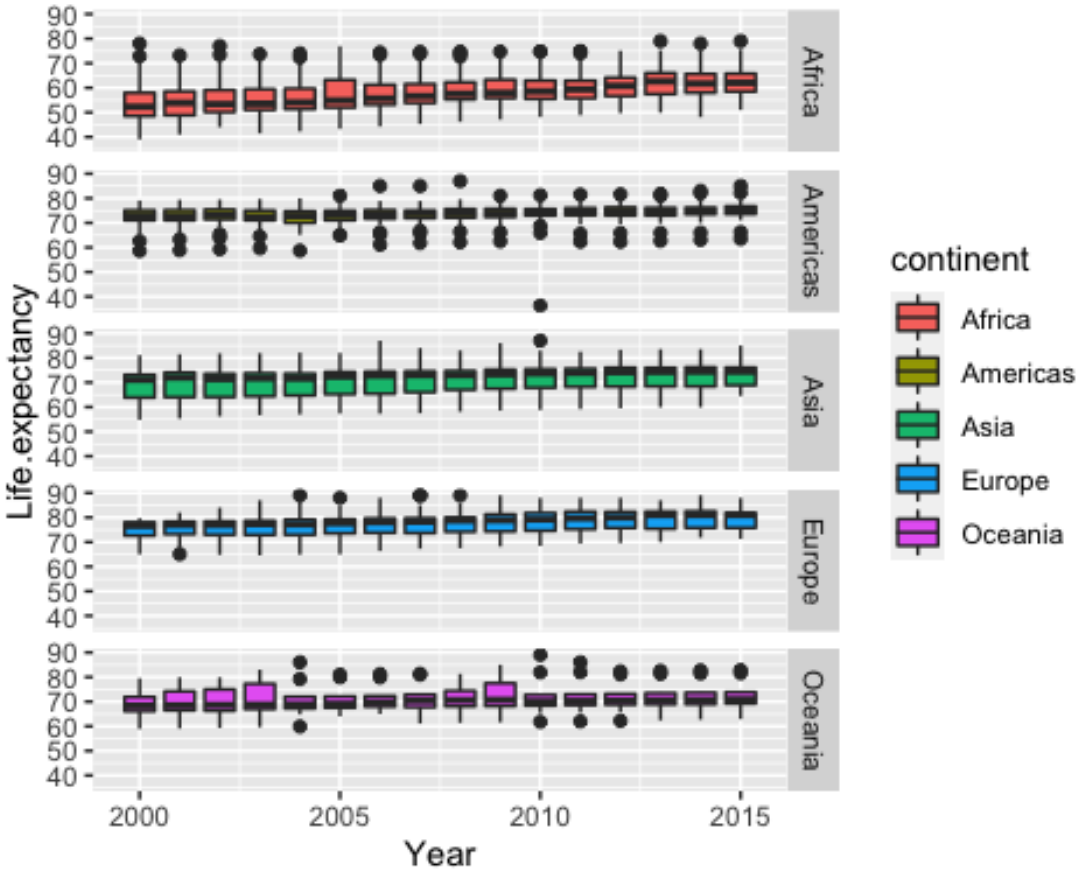

```
ggplot(clean_data, aes(Adult.Mortality, infant.deaths)) + geom_point() + scale_x_log10() + scale_y_log10()
```




```
# Boxplot of life expectancy vs. year shows that both mean and median of life expectancy is increasing every
year since average (mean) 66.75 in 2000 to average (mean) 71.62 in 2015
Life.expectancy_means <- aggregate(Life.expectancy ~ Year, lifeExpec, mean)

lifeExpec %>% ggplot(aes(x=Year, y=Life.expectancy, group=Year)) +
  geom_boxplot() +
  stat_summary(fun=mean, colour="darkred", geom="point",
               shape=18, size=3, show.legend=FALSE) +
  geom_text(data=Life.expectancy_means, aes(label = format(round(Life.expectancy, 2), nsmall = 2), y = Life.e
xpectancy - 2.5, col = "darkred")) +
  theme(legend.position = "none") +
  coord_flip()
```




```r
# Boxplot of life expectancy vs. continent also shows life expectancy increasing trend
lifeExpec %>% ggplot(aes(x=Year, y=Life.expectancy, group=Year)) +
  geom_boxplot(aes(fill=continent)) +
  facet_grid(continent ~ .)
```




```
# Wold map displays life expectancy in general (median value from 2000 - 2015) for each country.  Africa has
the lowest life expectancy, follows by Asia.

medianExpec <- aggregate(lifeExpec[, 4], list(lifeExpec$CountrytoMatch), median)
names(medianExpec)[names(medianExpec)=="Group.1"] <- "Country"

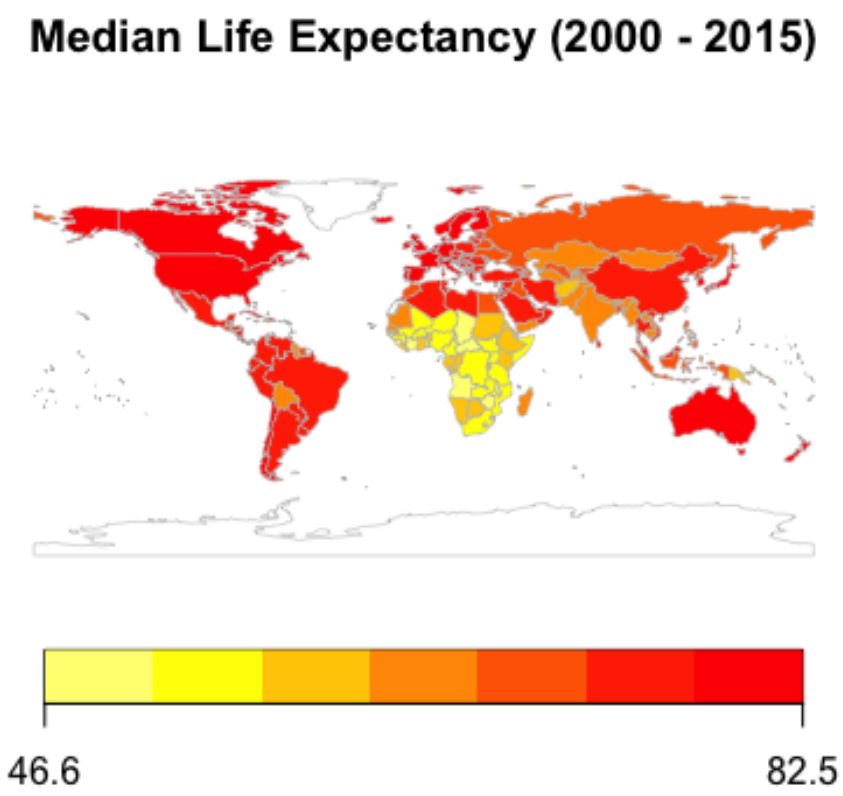
countryMap <- joinCountryData2Map(lifeExpec, joinCode = "NAME", nameJoinColumn = "Country")

## 2880 codes from your data successfully matched countries in the map
## 48 codes from your data failed to match with a country code in the map
## 63 codes from the map weren't represented in your data

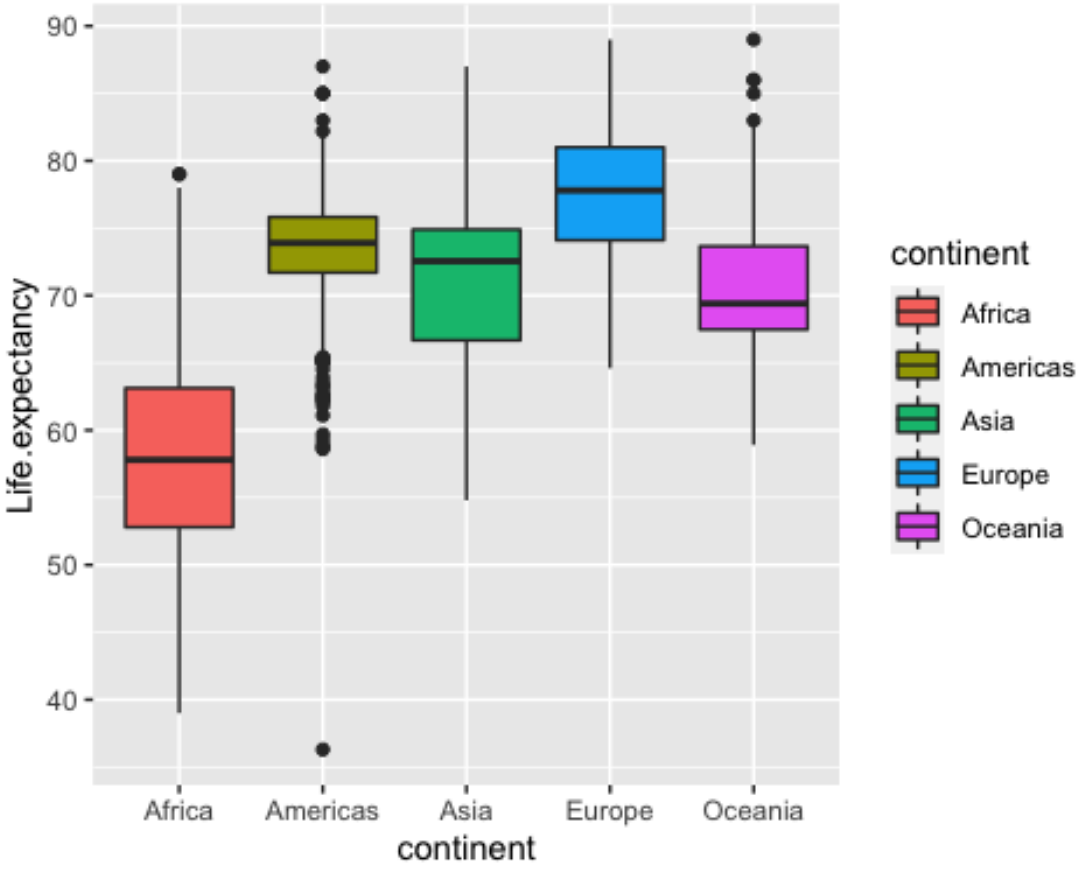
map <- joinCountryData2Map(
       medianExpec,
       joinCode       = "NAME",
       nameJoinColumn = "Country",
       verbose = TRUE
     )

## 183 codes from your data successfully matched countries in the map
## 0 codes from your data failed to match with a country code in the map
##      failedCodes failedCountries
## 60 codes from the map weren't represented in your data

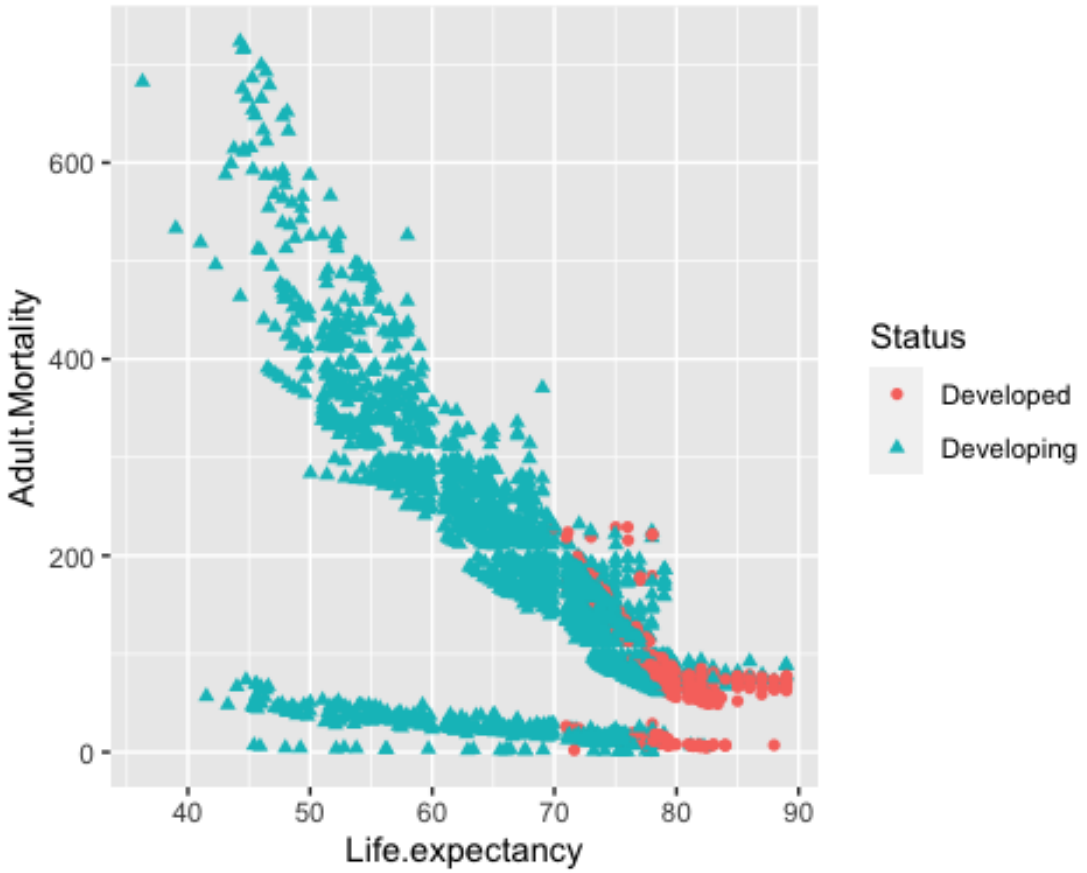
mapCountryData(map,
               mapTitle = "Median Life Expectancy (2000 - 2015)",
               nameColumnToPlot = "Life.expectancy",
               catMethod = "fixedWidth"
)
```



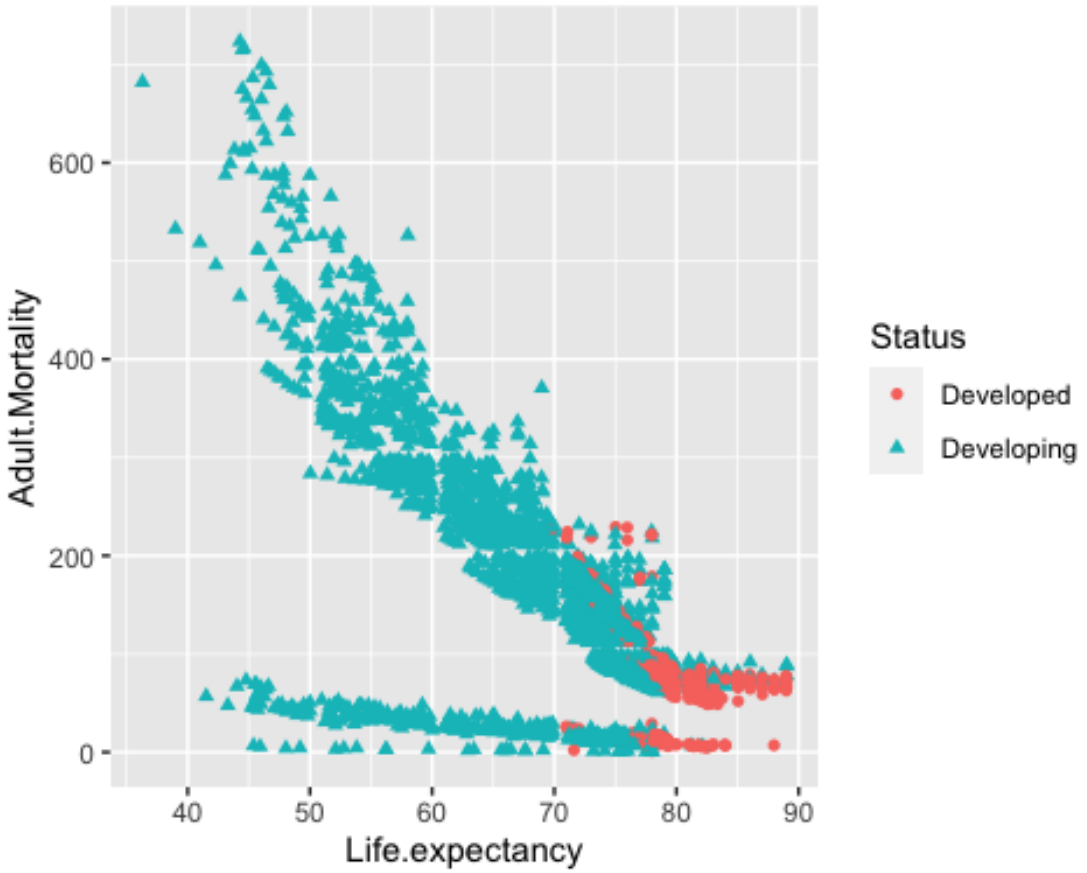

```
# Boxplot life expectancy vs. continent also shows the same trend
lifeExpec %>% ggplot(aes(x=continent, y=Life.expectancy)) +
  geom_boxplot(aes(fill=continent))
```




```
# Scatter plot life expectancy vs. adult martality color code by countrys' status.
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Adult.Mortality, shape=Status, color=Status)) +
  geom_jitter()
```

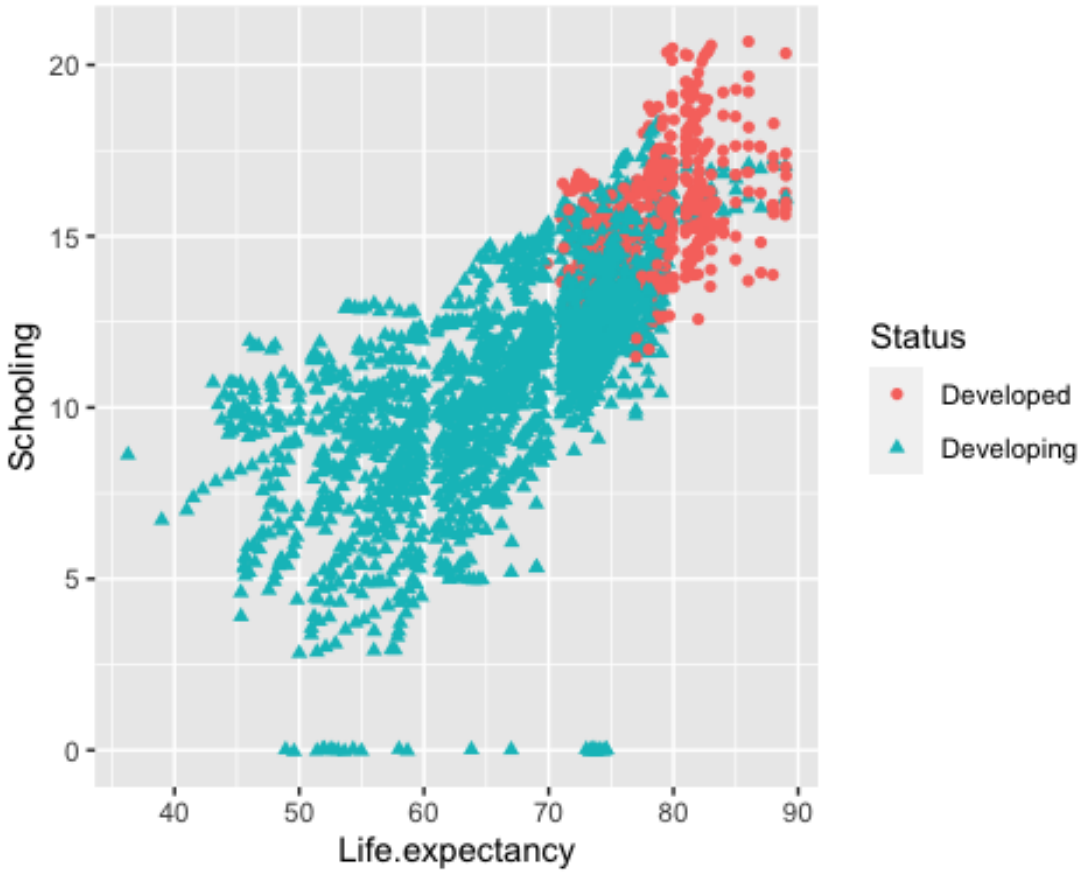



```
# Scatter plot life expectancy vs. adult mortality color code by countrys' status.
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Adult.Mortality, shape=Status, color=Status)) +
  geom_jitter()
```



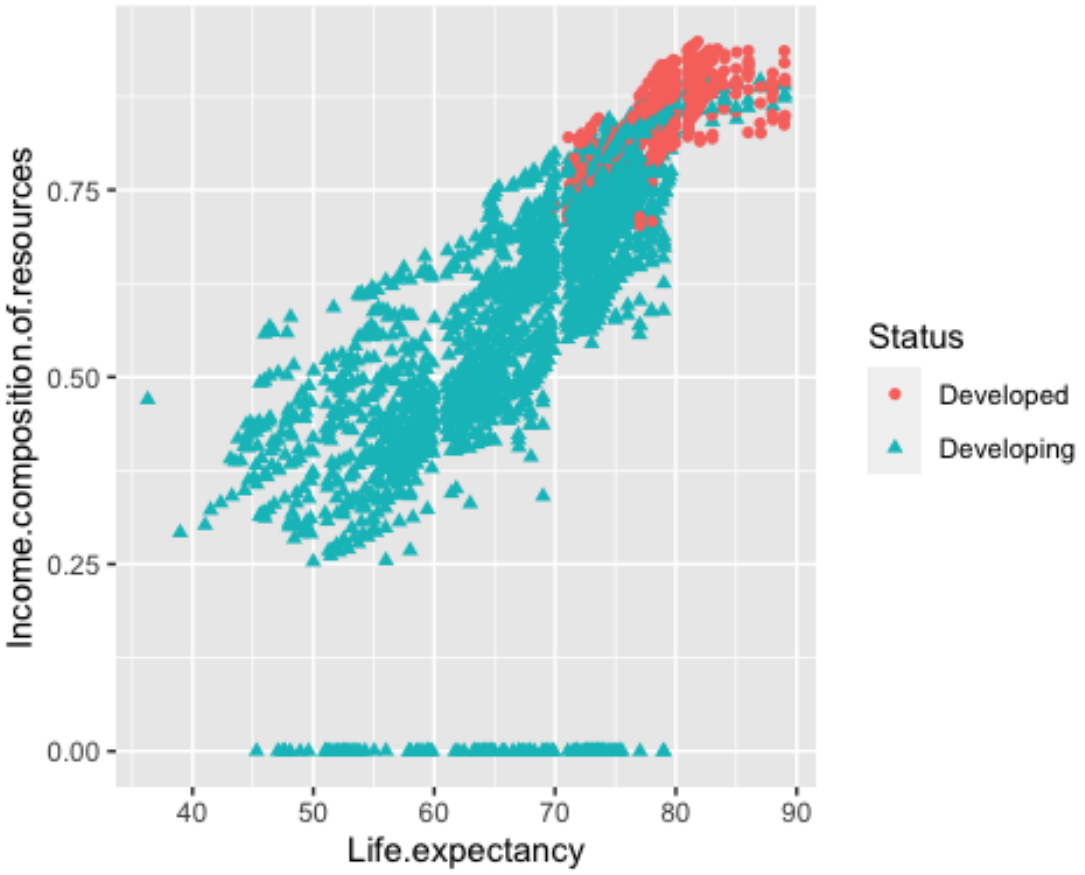

```
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Schooling, shape=Status, color=Status)) +
  geom_jitter()

## Warning: Removed 160 rows containing missing values (geom_point).
```

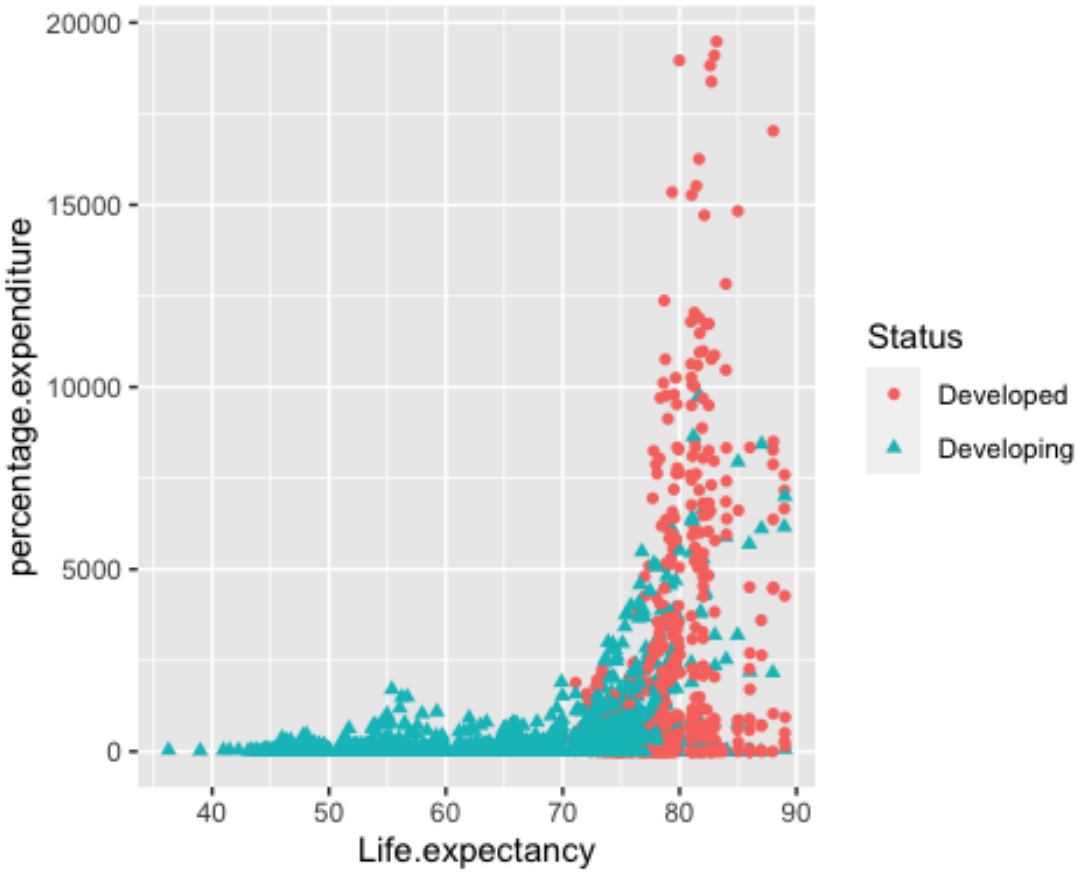



```
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Income.composition.of.resources, shape=Status, color=Status)) +
  geom_jitter()

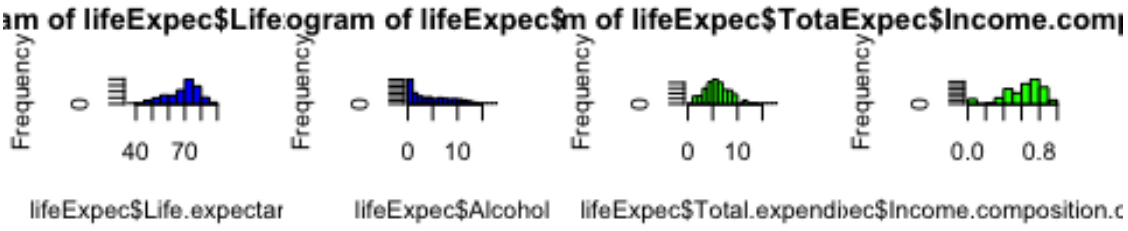
## Warning: Removed 160 rows containing missing values (geom_point).
```

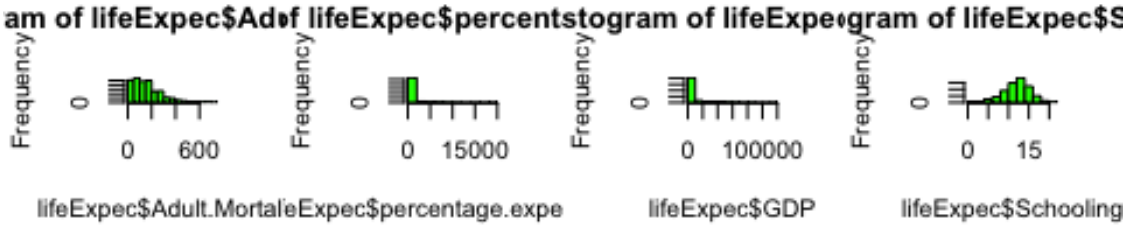


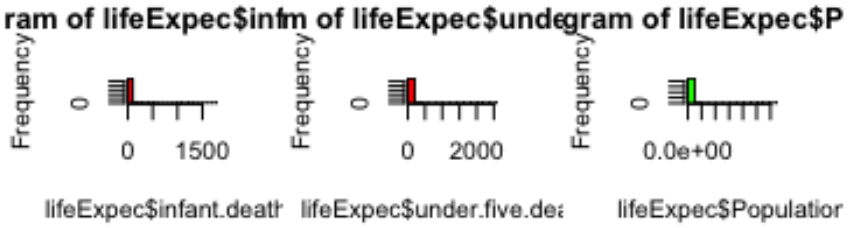

```
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=percentage.expenditure, shape=Status, color=Status)) +
  geom_jitter()
```



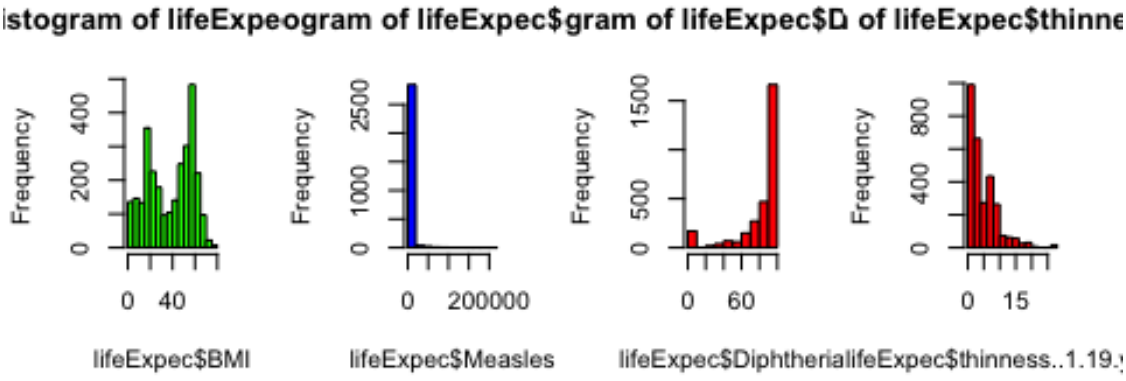

```
par("mfcol"=c(3, 4))
hist(lifeExpec$Life.expectancy, col="blue")
hist(lifeExpec$Adult.Mortality, col="green")
hist(lifeExpec$infant.deaths, col="red")
hist(lifeExpec$Alcohol, col="blue")
hist(lifeExpec$percentage.expenditure, col="green")
hist(lifeExpec$under.five.deaths, col="red")
hist(lifeExpec$Total.expenditure, col="green")
hist(lifeExpec$GDP, col="green")
hist(lifeExpec$Population, col="green")
hist(lifeExpec$Income.composition.of.resources, col="green")
hist(lifeExpec$Schooling, col="green")
par("mfcol"=c(1, 1))
```

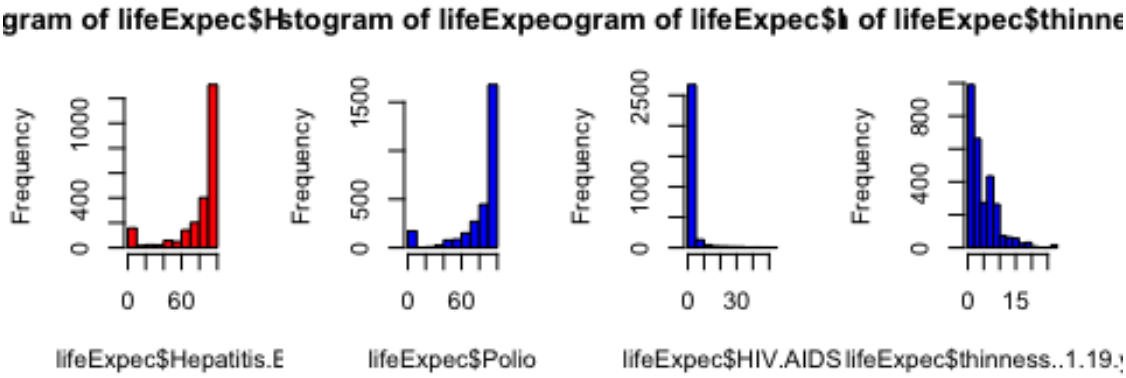







```
par("mfcol"=c(2, 4))
hist(lifeExpec$BMI, col="green")
hist(lifeExpec$Hepatitis.B, col="red")
hist(lifeExpec$Measles, col="blue")
hist(lifeExpec$Polio, col="blue")
hist(lifeExpec$Diphtheria, col="red")
hist(lifeExpec$HIV.AIDS, col="blue")
hist(lifeExpec$thinness..1.19.years, col="red")
hist(lifeExpec$thinness..1.19.years, col="blue")
```






```
par("mfcol"=c(1, 1))
```

Final Dataset

```
# Final dataset, lifeExpec_final, only includes Life.expectancy, Status, continent, BMI, HIV.AIDS, GDP, Incom
e.composition.of.resources, and Schooling
lifeExpec_final <- subset(lifeExpec, select = -c(Country, CountrytoMatch, Year, Adult.Mortality, Alcohol, per
centage.expenditure, infant.deaths, Hepatitis.B, Measles, under.five.deaths, Total.expenditure, Population, t
hinness..1.19.years, thinness.5.9.years, Polio, Diphtheria))


summary(lifeExpec_final)

##     Status          Life.expectancy      BMI           HIV.AIDS
##  Length:2928        Min.   :36.30   Min.   : 1.00   Min.   : 0.100
##  Class :character   1st Qu.:63.10   1st Qu.:19.30   1st Qu.: 0.100
##  Mode  :character   Median :72.10   Median :43.35   Median : 0.100
##                     Mean   :69.22   Mean   :38.24   Mean   : 1.748
##                     3rd Qu.:75.70   3rd Qu.:56.10   3rd Qu.: 0.800
##                     Max.   :89.00   Max.   :77.60   Max.   :50.600
##                                     NA's   :32
##       GDP            Income.composition.of.resources   Schooling
##  Min.   :     1.68   Min.   :0.0000                  Min.   : 0.0
##  1st Qu.:   463.85   1st Qu.:0.4930                  1st Qu.:10.1
##  Median :  1764.97   Median :0.6770                  Median :12.3
##  Mean   :  7494.21   Mean   :0.6274                  Mean   :12.0
##  3rd Qu.:  5932.90   3rd Qu.:0.7792                  3rd Qu.:14.3
##  Max.   :119172.74   Max.   :0.9480                  Max.   :20.7
##  NA's   :443         NA's   :160                     NA's   :160
##   continent
##  Length:2928
##  Class :character
##  Mode  :character
```

```
##
##
##
##

# Lowest BMI to survive is 12 so we replace everything <12 and NA with overall mean BMI then log transform
lifeExpec_final$BMI <- replace(lifeExpec_final$BMI, lifeExpec_final$BMI < 12, NA)

lifeExpec_final$BMI[is.na(lifeExpec_final$BMI)]<-mean(lifeExpec_final$BMI,na.rm=TRUE)
lifeExpec_final$BMI

##    [1] 19.10000 18.60000 18.10000 17.60000 17.20000 16.70000 16.20000 15.70000
##    [9] 15.20000 14.70000 14.20000 13.80000 13.40000 13.00000 12.60000 12.20000
##   [17] 58.00000 57.20000 56.50000 55.80000 55.10000 54.30000 53.50000 52.60000
##   [25] 51.70000 41.95655 49.90000 48.90000 47.90000 46.90000 46.00000 45.00000
##   [33] 59.50000 58.40000 57.20000 56.10000 55.00000 53.90000 52.80000 51.80000
##   [41] 41.95655 49.80000 48.90000 47.90000 47.00000 46.10000 45.30000 44.40000
##   [49] 23.30000 22.70000 22.10000 21.50000 21.00000 41.95655 19.80000 19.30000
##   [57] 18.80000 18.20000 17.70000 17.20000 16.80000 16.30000 15.80000 15.40000
##   [65] 47.70000 47.00000 46.40000 45.70000 45.10000 44.40000 43.80000 43.20000
##   [73] 42.60000 42.00000 41.40000 41.95655 41.95655 39.50000 38.90000 38.20000
##   [81] 62.80000 62.20000 61.60000 61.00000 41.95655 59.80000 59.20000 58.60000
##   [89] 58.00000 57.50000 56.90000 56.30000 55.70000 55.10000 54.60000 54.00000
##   [97] 54.90000 54.10000 53.30000 52.60000 51.90000 51.20000 41.95655 41.95655
##  [105] 49.70000 49.20000 48.80000 48.40000 48.10000 47.80000 47.40000 47.10000
##  [113] 66.60000 66.10000 65.50000 65.00000 64.40000 63.90000 63.40000 62.90000
##  [121] 62.50000 62.00000 61.50000 41.95655 41.95655 59.60000 59.00000 58.20000
##  [129] 57.60000 57.10000 56.60000 56.10000 55.70000 55.20000 54.70000 54.20000
##  [137] 53.70000 53.20000 52.70000 52.20000 51.70000 51.20000 41.95655 41.95655
##  [145] 52.50000 51.50000 41.95655 49.70000 48.80000 48.00000 47.30000 46.60000
##  [153] 45.90000 45.30000 44.70000 44.20000 43.60000 43.10000 42.60000 42.10000
##  [161] 64.50000 63.80000 63.20000 62.60000 62.00000 61.30000 41.95655 41.95655
##  [169] 59.40000 58.70000 58.10000 57.40000 56.70000 56.00000 55.20000 54.40000
##  [177] 63.60000 62.90000 62.20000 61.50000 41.95655 41.95655 59.30000 58.50000
##  [185] 57.60000 56.80000 56.10000 55.60000 55.20000 55.00000 54.80000 54.50000
##  [193] 18.30000 17.70000 17.00000 16.40000 15.80000 15.20000 14.60000 14.00000
##  [201] 13.50000 13.00000 12.50000 12.00000 41.95655 41.95655 41.95655 41.95655
##  [209] 54.50000 53.70000 53.00000 52.20000 51.40000 41.95655 49.90000 49.20000
##  [217] 48.40000 47.70000 46.90000 46.20000 45.40000 44.60000 43.80000 43.00000
##  [225] 62.30000 61.70000 61.10000 41.95655 59.90000 59.30000 58.70000 58.20000
##  [233] 57.70000 57.20000 56.70000 56.20000 55.80000 55.30000 54.90000 54.40000
##  [241] 63.70000 63.40000 63.00000 62.60000 62.30000 61.90000 61.60000 61.30000
##  [249] 41.95655 41.95655 41.95655 59.80000 59.40000 59.00000 58.50000 58.10000
##  [257] 41.95655 41.95655 49.30000 48.50000 47.80000 47.00000 46.30000 45.70000
##  [265] 45.00000 44.40000 43.80000 43.20000 42.60000 42.00000 41.40000 41.95655
##  [273] 25.70000 25.20000 24.60000 24.10000 23.50000 23.00000 22.50000 22.00000
##  [281] 21.50000 21.00000 41.95655 41.95655 19.70000 19.20000 18.80000 18.40000
##  [289] 24.50000 23.60000 22.70000 21.90000 21.10000 41.95655 19.50000 18.80000
##  [297] 18.00000 17.40000 16.70000 16.10000 15.50000 14.90000 14.40000 13.90000
##  [305] 52.60000 51.90000 51.20000 41.95655 49.90000 49.30000 48.60000 48.00000
##  [313] 47.30000 46.70000 46.00000 45.40000 44.70000 44.00000 43.30000 42.60000
##  [321] 55.80000 55.30000 54.70000 54.20000 53.70000 53.10000 52.60000 52.10000
##  [329] 51.50000 51.00000 41.95655 49.90000 49.40000 48.80000 48.20000 47.60000
##  [337] 37.90000 37.30000 36.80000 36.20000 35.70000 35.20000 34.70000 34.20000
##  [345] 33.70000 33.20000 32.70000 32.20000 31.60000 31.10000 41.95655 29.90000
##  [353] 56.10000 55.30000 54.50000 53.60000 52.80000 52.00000 51.10000 41.95655
##  [361] 49.40000 48.60000 47.80000 46.90000 46.10000 45.30000 44.50000 43.70000
##  [369] 41.20000 41.95655 39.20000 38.20000 37.20000 36.20000 35.20000 34.20000
##  [377] 33.20000 32.20000 31.20000 41.95655 29.10000 28.00000 27.00000 26.10000
##  [385] 65.70000 65.10000 64.50000 63.90000 63.30000 62.70000 62.10000 61.50000
##  [393] 41.95655 41.95655 59.70000 59.10000 58.60000 58.10000 57.50000 57.00000
##  [401] 19.40000 18.80000 18.20000 17.70000 17.10000 16.60000 16.10000 15.60000
##  [409] 15.10000 14.60000 14.20000 13.70000 13.30000 12.90000 12.50000 12.20000
##  [417] 18.70000 18.20000 17.60000 17.10000 16.60000 16.10000 15.70000 15.20000
##  [425] 14.80000 14.50000 14.10000 13.80000 13.50000 13.30000 13.00000 12.80000
##  [433] 28.00000 27.40000 26.80000 26.20000 25.60000 25.00000 24.40000 23.80000
```

```
##  [441] 23.20000 22.60000 22.10000 21.50000 41.95655 41.95655 19.90000 19.40000
##  [449] 31.30000 41.95655 29.70000 29.00000 28.20000 27.50000 26.80000 26.20000
##  [457] 25.50000 24.90000 24.30000 23.70000 23.20000 22.60000 22.10000 21.50000
##  [465] 19.60000 18.90000 18.20000 17.60000 17.00000 16.40000 15.90000 15.30000
##  [473] 14.80000 14.30000 13.90000 13.50000 13.10000 12.80000 12.40000 12.10000
##  [481] 29.00000 28.40000 27.80000 27.20000 26.60000 26.00000 25.40000 24.90000
##  [489] 24.40000 23.80000 23.30000 22.80000 22.30000 21.80000 21.30000 41.95655
##  [497] 67.00000 66.40000 65.80000 65.30000 64.70000 64.10000 63.60000 63.00000
##  [505] 62.50000 61.90000 61.30000 41.95655 41.95655 59.30000 58.50000 57.80000
##  [513] 22.70000 22.10000 21.60000 21.20000 41.95655 41.95655 19.80000 19.40000
##  [521] 19.00000 18.60000 18.20000 17.90000 17.50000 17.20000 16.80000 16.50000
##  [529] 19.10000 18.70000 18.20000 17.90000 17.50000 17.10000 16.70000 16.40000
##  [537] 16.10000 15.70000 15.40000 15.10000 14.80000 14.40000 14.10000 13.90000
##  [545] 63.80000 63.10000 62.50000 61.80000 61.20000 41.95655 59.90000 59.30000
##  [553] 58.70000 58.10000 57.40000 56.80000 56.10000 55.40000 54.70000 54.00000
##  [561] 32.90000 31.90000 41.95655 41.95655 29.00000 28.10000 27.30000 26.50000
##  [569] 25.70000 24.90000 24.10000 23.40000 22.60000 21.90000 21.20000 41.95655
##  [577] 57.90000 57.20000 56.40000 55.70000 55.00000 54.20000 53.50000 52.80000
##  [585] 52.00000 51.30000 41.95655 49.80000 49.00000 48.20000 47.50000 46.70000
##  [593] 24.20000 23.70000 23.20000 22.60000 22.10000 21.60000 21.10000 41.95655
##  [601] 41.95655 19.60000 19.20000 18.80000 18.40000 18.00000 17.60000 17.30000
##  [609] 27.40000 26.80000 26.20000 25.60000 25.00000 24.50000 23.90000 23.30000
##  [617] 22.80000 22.30000 21.70000 21.20000 41.95655 41.95655 19.80000 19.30000
##  [625] 41.95655 59.50000 58.50000 57.50000 56.50000 55.50000 54.40000 53.40000
##  [633] 52.40000 51.40000 41.95655 49.30000 48.30000 47.30000 46.40000 45.40000
##  [641] 63.70000 63.10000 62.50000 61.90000 61.30000 41.95655 41.95655 59.40000
##  [649] 58.70000 58.10000 57.50000 56.90000 56.30000 55.80000 55.20000 54.70000
##  [657] 61.40000 41.95655 59.90000 59.20000 58.40000 57.70000 56.90000 56.20000
##  [665] 55.40000 54.60000 53.80000 53.00000 52.10000 51.30000 41.95655 49.40000
##  [673] 41.95655 59.80000 59.20000 58.70000 58.30000 57.80000 57.30000 56.80000
##  [681] 56.30000 55.80000 55.30000 54.80000 54.30000 53.80000 53.30000 52.80000
##  [689] 66.10000 65.60000 65.10000 64.50000 64.00000 63.60000 63.10000 62.60000
##  [697] 62.20000 61.80000 61.30000 41.95655 41.95655 59.90000 59.40000 59.00000
##  [705] 32.90000 32.40000 31.80000 31.30000 41.95655 41.95655 29.70000 29.20000
##  [713] 28.70000 28.20000 27.70000 27.20000 26.70000 26.20000 25.70000 25.20000
##  [721] 21.60000 21.10000 41.95655 41.95655 19.60000 19.10000 18.60000 18.20000
##  [729] 17.80000 17.30000 16.90000 16.50000 16.10000 15.70000 15.30000 14.90000
##  [737] 58.80000 58.40000 58.10000 57.70000 57.40000 57.00000 56.60000 56.30000
##  [745] 55.90000 55.40000 55.00000 54.40000 53.90000 53.30000 52.80000 52.20000
##  [753] 35.00000 34.40000 33.80000 33.20000 32.70000 32.20000 31.70000 31.30000
##  [761] 41.95655 41.95655 41.95655 29.80000 29.40000 29.00000 28.60000 28.20000
##  [769] 58.90000 57.90000 56.80000 55.80000 54.70000 53.60000 52.60000 51.50000
##  [777] 41.95655 49.30000 48.20000 47.20000 46.10000 45.10000 44.10000 43.10000
##  [785] 54.20000 53.50000 52.80000 52.10000 51.40000 41.95655 41.95655 49.30000
##  [793] 48.60000 47.90000 47.20000 46.50000 45.80000 45.10000 44.30000 43.60000
##  [801] 61.10000 41.95655 59.40000 58.60000 57.80000 57.00000 56.20000 55.50000
##  [809] 54.80000 54.20000 53.50000 52.90000 52.30000 51.80000 51.20000 41.95655
##  [817] 56.10000 55.40000 54.70000 54.10000 53.40000 52.80000 52.10000 51.40000
##  [825] 41.95655 41.95655 49.40000 48.60000 47.80000 47.00000 46.20000 45.30000
##  [833] 24.50000 24.00000 23.50000 23.00000 22.60000 22.10000 21.70000 21.30000
##  [841] 41.95655 41.95655 41.95655 19.80000 19.50000 19.10000 18.70000 18.30000
##  [849] 18.60000 18.00000 17.50000 17.00000 16.50000 16.00000 15.50000 15.10000
##  [857] 14.70000 14.30000 13.90000 13.60000 13.30000 13.10000 12.80000 12.60000
##  [865] 59.90000 59.40000 59.00000 58.50000 58.00000 57.60000 57.10000 56.70000
##  [873] 56.30000 55.90000 55.50000 55.20000 54.90000 54.60000 54.30000 54.00000
##  [881] 17.60000 17.20000 16.80000 16.40000 16.00000 15.60000 15.30000 14.90000
##  [889] 14.50000 14.20000 13.80000 13.50000 13.20000 12.90000 12.60000 12.30000
##  [897] 62.70000 61.90000 61.10000 41.95655 59.50000 58.70000 58.00000 57.30000
##  [905] 56.60000 55.90000 55.10000 54.20000 53.20000 52.20000 51.20000 41.95655
##  [913] 62.10000 61.70000 61.40000 61.00000 41.95655 41.95655 59.80000 59.40000
##  [921] 59.00000 58.60000 58.10000 57.60000 57.10000 56.60000 56.10000 55.50000
##  [929] 62.50000 62.00000 61.60000 61.10000 41.95655 41.95655 59.60000 59.10000
##  [937] 58.60000 58.00000 57.50000 57.00000 56.40000 55.80000 55.20000 54.60000
##  [945] 36.30000 35.80000 35.20000 34.60000 34.10000 33.50000 33.00000 32.40000
##  [953] 31.90000 31.40000 41.95655 41.95655 29.80000 29.20000 28.70000 28.10000
##  [961] 27.30000 26.70000 26.00000 25.40000 24.80000 24.10000 23.50000 22.80000
```

```
##  [969] 22.20000 21.50000 41.95655 41.95655 19.70000 19.10000 18.50000 18.00000
##  [977] 56.20000 55.30000 54.40000 53.60000 52.80000 52.00000 51.30000 41.95655
##  [985] 49.90000 49.20000 48.60000 48.10000 47.50000 47.00000 46.50000 46.00000
##  [993] 62.30000 61.90000 61.40000 41.95655 41.95655 59.90000 59.50000 59.00000
## [1001] 58.50000 58.00000 57.60000 57.10000 56.60000 56.10000 55.60000 55.10000
## [1009] 28.60000 28.00000 27.30000 26.70000 26.10000 25.50000 24.90000 24.20000
## [1017] 23.60000 23.00000 22.40000 21.80000 21.20000 41.95655 41.95655 19.50000
## [1025] 66.50000 66.00000 65.40000 64.90000 64.30000 63.70000 63.10000 62.40000
## [1033] 61.80000 61.20000 41.95655 59.90000 59.20000 58.60000 58.00000 57.40000
## [1041] 48.40000 47.40000 46.50000 45.60000 44.70000 43.90000 43.10000 42.40000
## [1049] 41.80000 41.10000 41.95655 39.90000 39.40000 38.80000 38.20000 37.70000
## [1057] 41.95655 49.90000 49.30000 48.60000 47.90000 47.20000 46.50000 45.90000
## [1065] 45.20000 44.50000 43.80000 43.10000 42.40000 41.70000 41.10000 41.95655
## [1073] 23.30000 22.70000 22.20000 21.70000 21.20000 41.95655 41.95655 19.80000
## [1081] 19.40000 19.00000 18.50000 18.10000 17.70000 17.30000 16.90000 16.60000
## [1089] 26.30000 25.60000 25.00000 24.30000 23.70000 23.10000 22.50000 21.90000
## [1097] 21.30000 41.95655 41.95655 19.60000 19.00000 18.50000 17.90000 17.40000
## [1105] 46.70000 45.90000 45.00000 44.10000 43.20000 42.40000 41.60000 41.95655
## [1113] 41.95655 39.60000 39.00000 38.40000 37.80000 37.10000 36.40000 35.70000
## [1121] 49.90000 48.80000 47.70000 46.50000 45.30000 44.20000 43.00000 41.80000
## [1129] 41.95655 39.60000 38.50000 37.50000 36.50000 35.60000 34.80000 34.00000
## [1137] 51.00000 41.95655 49.30000 48.40000 47.60000 46.80000 45.90000 45.10000
## [1145] 44.30000 43.50000 42.80000 42.00000 41.20000 41.95655 39.60000 38.80000
## [1153] 64.80000 64.20000 63.60000 63.00000 62.40000 61.70000 61.10000 41.95655
## [1161] 59.90000 59.30000 58.80000 58.20000 57.60000 57.10000 56.60000 56.10000
## [1169] 61.00000 41.95655 41.95655 59.70000 59.30000 58.90000 58.50000 58.10000
## [1177] 57.80000 57.40000 56.90000 56.50000 55.90000 55.40000 54.80000 54.20000
## [1185] 18.70000 18.10000 17.50000 17.00000 16.40000 15.90000 15.40000 14.90000
## [1193] 14.40000 13.90000 13.50000 13.00000 12.60000 12.20000 41.95655 41.95655
## [1201] 27.40000 26.50000 25.60000 24.70000 23.80000 22.90000 22.10000 21.30000
## [1209] 41.95655 19.70000 19.00000 18.20000 17.50000 16.70000 16.00000 15.40000
## [1217] 59.70000 58.50000 57.20000 56.00000 54.80000 53.60000 52.50000 51.40000
## [1225] 41.95655 49.40000 48.50000 47.60000 46.90000 46.20000 45.50000 44.90000
## [1233] 59.10000 58.50000 57.80000 57.20000 56.50000 55.80000 55.20000 54.50000
## [1241] 53.80000 53.20000 52.50000 51.90000 51.30000 41.95655 41.95655 49.50000
## [1249] 62.80000 62.10000 61.30000 41.95655 59.70000 58.90000 58.20000 57.40000
## [1257] 56.60000 55.80000 55.10000 54.40000 53.60000 52.90000 52.20000 51.50000
## [1265] 64.90000 64.60000 64.20000 63.80000 63.40000 63.00000 62.60000 62.10000
## [1273] 61.60000 61.10000 41.95655 41.95655 59.60000 59.20000 58.70000 58.30000
## [1281] 63.60000 63.10000 62.60000 62.10000 61.50000 61.00000 41.95655 59.90000
## [1289] 59.40000 58.80000 58.20000 57.60000 57.00000 56.40000 55.70000 55.00000
## [1297] 54.20000 53.50000 52.70000 52.00000 51.20000 41.95655 49.70000 48.90000
## [1305] 48.10000 47.20000 46.30000 45.40000 44.50000 43.50000 42.50000 41.60000
## [1313] 29.00000 28.60000 28.20000 27.80000 27.40000 26.90000 26.40000 25.90000
## [1321] 25.40000 24.90000 24.40000 23.80000 23.40000 22.90000 22.50000 22.20000
## [1329] 65.60000 64.80000 64.00000 63.20000 62.40000 61.70000 41.95655 41.95655
## [1337] 59.30000 58.60000 57.80000 57.00000 56.30000 55.50000 54.80000 54.00000
## [1345] 53.10000 52.30000 51.40000 41.95655 49.90000 49.20000 48.50000 47.90000
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## [2921] 28.20000 27.90000 27.50000 27.10000 26.70000 26.30000 25.90000 25.50000

lifeExpec_final$BMI_log <- log(lifeExpec_final$BMI)


# Replace zero for Income.composition.of.resources with its mean
lifeExpec_final$Income.composition.of.resources <- replace(lifeExpec_final$Income.composition.of.resources,
                                                           lifeExpec_final$Income.composition.of.resources ==
0, NA)
summary(lifeExpec_final$Income.composition.of.resources)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##  0.2530  0.5230  0.6865  0.6583  0.7840  0.9480     290

lifeExpec_final$Income.composition.of.resources[is.na(lifeExpec_final$Income.composition.of.resources)] <-
  mean(lifeExpec_final$Income.composition.of.resources,na.rm=TRUE)
lifeExpec_final$Income.composition.of.resources

##    [1] 0.4790000 0.4760000 0.4700000 0.4630000 0.4540000 0.4480000 0.4340000
##    [8] 0.4330000 0.4150000 0.4050000 0.3960000 0.3810000 0.3730000 0.3410000
```

```
##   [15] 0.3400000 0.3380000 0.7620000 0.7610000 0.7590000 0.7520000 0.7380000
##   [22] 0.7250000 0.7210000 0.7130000 0.7030000 0.6960000 0.6850000 0.6810000
##   [29] 0.6740000 0.6700000 0.6620000 0.6560000 0.7430000 0.7410000 0.7370000
##   [36] 0.7320000 0.7240000 0.7140000 0.7050000 0.6970000 0.6900000 0.6860000
##   [43] 0.6800000 0.6730000 0.6630000 0.6530000 0.6440000 0.6360000 0.5310000
##   [50] 0.5270000 0.5230000 0.5080000 0.4950000 0.4880000 0.4800000 0.4680000
##   [57] 0.4540000 0.4390000 0.4260000 0.4150000 0.4060000 0.4010000 0.3910000
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## [1632] 0.2910000 0.8530000 0.8470000 0.8280000 0.8210000 0.8260000 0.8190000
## [1639] 0.8150000 0.8130000 0.8080000 0.8090000 0.8050000 0.7970000 0.7900000
## [1646] 0.7860000 0.7830000 0.7790000 0.5130000 0.5090000 0.5010000 0.4910000
## [1653] 0.4870000 0.4840000 0.4760000 0.4750000 0.4750000 0.4660000 0.4610000
## [1660] 0.4510000 0.4470000 0.4460000 0.4440000 0.4430000 0.7790000 0.7690000
## [1667] 0.7650000 0.7560000 0.7480000 0.7400000 0.7340000 0.7280000 0.7200000
## [1674] 0.7130000 0.7040000 0.6960000 0.6870000 0.6830000 0.6730000 0.6670000
## [1681] 0.7580000 0.7540000 0.7530000 0.7480000 0.7450000 0.7390000 0.7380000
## [1688] 0.7350000 0.7310000 0.7230000 0.7190000 0.7140000 0.7080000 0.7030000
## [1695] 0.7000000 0.6940000 0.6370000 0.6390000 0.6410000 0.6400000 0.6380000
## [1702] 0.6330000 0.6290000 0.6280000 0.6250000 0.6220000 0.6170000 0.6160000
## [1709] 0.6120000 0.6080000 0.6040000 0.6583378 0.7330000 0.7290000 0.7200000
## [1716] 0.7120000 0.7010000 0.6930000 0.6860000 0.6730000 0.6610000 0.6490000
## [1723] 0.6370000 0.6210000 0.6090000 0.5990000 0.5880000 0.5820000 0.8040000
## [1730] 0.8030000 0.7990000 0.7970000 0.7920000 0.7870000 0.7850000 0.7740000
## [1737] 0.7620000 0.7510000 0.7460000 0.7400000 0.6583378 0.6583378 0.6583378
## [1744] 0.6583378 0.6450000 0.6400000 0.6340000 0.6230000 0.6120000 0.6030000
## [1751] 0.5960000 0.5890000 0.5810000 0.5750000 0.5690000 0.5610000 0.5510000
## [1758] 0.5400000 0.5300000 0.5190000 0.4140000 0.4090000 0.4050000 0.4000000
## [1765] 0.3970000 0.3900000 0.3820000 0.3720000 0.3600000 0.3530000 0.3410000
## [1772] 0.3320000 0.3180000 0.3110000 0.2980000 0.2910000 0.5520000 0.5470000
## [1779] 0.5400000 0.5330000 0.5260000 0.5150000 0.5040000 0.4930000 0.4840000
## [1786] 0.4740000 0.4650000 0.4550000 0.4450000 0.4350000 0.4270000 0.4170000
## [1793] 0.6370000 0.6320000 0.6250000 0.6190000 0.6120000 0.6040000 0.5980000
## [1800] 0.5890000 0.5780000 0.5700000 0.5650000 0.5590000 0.5540000 0.5560000
## [1807] 0.5560000 0.5590000 0.5550000 0.5510000 0.5450000 0.5380000 0.5290000
## [1814] 0.5150000 0.5020000 0.4920000 0.4860000 0.4760000 0.4690000 0.4630000
## [1821] 0.4570000 0.4470000 0.4460000 0.4390000 0.9230000 0.9230000 0.9220000
## [1828] 0.9210000 0.9110000 0.9060000 0.9060000 0.9050000 0.8990000 0.8930000
## [1835] 0.8880000 0.8850000 0.8810000 0.8820000 0.8780000 0.8730000 0.9130000
## [1842] 0.9100000 0.9080000 0.9040000 0.9010000 0.8990000 0.8950000 0.8940000
## [1849] 0.8910000 0.8880000 0.8860000 0.8840000 0.8810000 0.8730000 0.8680000
## [1856] 0.8640000 0.6420000 0.6360000 0.6300000 0.6250000 0.6200000 0.6140000
```

```
## [1863] 0.6130000 0.6070000 0.6010000 0.5970000 0.5920000 0.5870000 0.5830000
## [1870] 0.5770000 0.5700000 0.5620000 0.3510000 0.3450000 0.3410000 0.3310000
## [1877] 0.3230000 0.3120000 0.3070000 0.2980000 0.2930000 0.2860000 0.2780000
## [1884] 0.2700000 0.2660000 0.2610000 0.2550000 0.2530000 0.5250000 0.5210000
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## [1898] 0.4660000 0.4630000 0.4450000 0.6583378 0.6583378 0.6583378 0.6583378
## [1905] 0.9480000 0.9450000 0.9420000 0.9410000 0.9390000 0.9360000 0.9360000
## [1912] 0.9360000 0.9340000 0.9310000 0.9290000 0.9240000 0.9180000 0.9160000
## [1919] 0.9170000 0.9110000 0.7950000 0.7960000 0.7960000 0.7970000 0.7970000
## [1926] 0.7970000 0.7820000 0.7650000 0.7530000 0.7480000 0.7420000 0.7340000
## [1933] 0.7250000 0.7160000 0.7050000 0.6583378 0.5480000 0.5420000 0.5380000
## [1940] 0.5290000 0.5250000 0.5210000 0.5140000 0.5130000 0.5050000 0.5010000
## [1947] 0.4870000 0.4740000 0.4650000 0.4570000 0.4500000 0.4450000 0.7850000
## [1954] 0.7800000 0.7730000 0.7650000 0.7580000 0.7560000 0.7550000 0.7500000
## [1961] 0.7430000 0.7440000 0.7400000 0.7330000 0.7280000 0.7250000 0.7210000
## [1968] 0.7160000 0.5150000 0.5110000 0.5060000 0.5010000 0.4940000 0.4850000
## [1975] 0.4770000 0.4690000 0.4610000 0.4540000 0.4460000 0.4390000 0.4330000
## [1982] 0.4280000 0.4220000 0.4180000 0.6920000 0.6880000 0.6790000 0.6790000
## [1989] 0.6750000 0.6640000 0.6630000 0.6540000 0.6490000 0.6480000 0.6460000
## [1996] 0.6390000 0.6420000 0.6320000 0.6240000 0.6250000 0.7370000 0.7350000
## [2003] 0.7310000 0.7250000 0.7210000 0.7080000 0.7060000 0.7000000 0.6960000
## [2010] 0.6930000 0.6920000 0.6850000 0.6860000 0.6860000 0.6770000 0.6740000
## [2017] 0.6790000 0.6760000 0.6710000 0.6660000 0.6690000 0.6620000 0.6610000
## [2024] 0.6550000 0.6480000 0.6460000 0.6420000 0.6360000 0.6310000 0.6250000
## [2031] 0.6220000 0.6180000 0.8520000 0.8500000 0.8380000 0.8340000 0.8290000
## [2038] 0.8220000 0.8180000 0.8130000 0.8080000 0.8030000 0.7970000 0.8000000
## [2045] 0.7960000 0.7900000 0.7840000 0.7770000 0.8410000 0.8370000 0.8270000
## [2052] 0.8240000 0.8180000 0.8120000 0.8090000 0.8040000 0.7970000 0.7930000
## [2059] 0.7900000 0.7920000 0.7890000 0.7880000 0.7820000 0.7770000 0.8550000
## [2066] 0.8540000 0.8430000 0.8370000 0.8270000 0.8250000 0.8280000 0.8250000
## [2073] 0.8300000 0.8350000 0.8300000 0.8260000 0.8150000 0.8070000 0.8090000
## [2080] 0.8080000 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2087] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2094] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2101] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2108] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.7980000 0.7970000
## [2115] 0.7940000 0.7970000 0.7980000 0.7970000 0.7950000 0.7800000 0.7660000
## [2122] 0.7550000 0.7450000 0.7330000 0.7220000 0.7140000 0.7080000 0.7030000
## [2129] 0.8050000 0.8030000 0.7990000 0.7920000 0.7850000 0.7730000 0.7760000
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## [2157] 0.3590000 0.3430000 0.3320000 0.3180000 0.7350000 0.7230000 0.7340000
## [2164] 0.7350000 0.7330000 0.7240000 0.7170000 0.7100000 0.7070000 0.6940000
## [2171] 0.6890000 0.6860000 0.6840000 0.6810000 0.6840000 0.6583378 0.7200000
## [2178] 0.7200000 0.7170000 0.7130000 0.7120000 0.7110000 0.7090000 0.7040000
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## [2192] 0.6583378 0.7020000 0.7010000 0.7000000 0.6980000 0.6930000 0.6900000
## [2199] 0.6910000 0.6880000 0.6820000 0.6770000 0.6710000 0.6650000 0.6590000
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## [2255] 0.3810000 0.3780000 0.7750000 0.7710000 0.7660000 0.7670000 0.7570000
## [2262] 0.7550000 0.7540000 0.7490000 0.7430000 0.7390000 0.7300000 0.7200000
## [2269] 0.7150000 0.7150000 0.7090000 0.7020000 0.7810000 0.7660000 0.7620000
## [2276] 0.7550000 0.7440000 0.7400000 0.7390000 0.7390000 0.7330000 0.7280000
## [2283] 0.7120000 0.7150000 0.7130000 0.7120000 0.7140000 0.6583378 0.4310000
## [2290] 0.4260000 0.4130000 0.4010000 0.3920000 0.3840000 0.3750000 0.3670000
## [2297] 0.3570000 0.3480000 0.3410000 0.3320000 0.3220000 0.3060000 0.3020000
## [2304] 0.2920000 0.9240000 0.9220000 0.9200000 0.9170000 0.9110000 0.8890000
## [2311] 0.8870000 0.8800000 0.8730000 0.8390000 0.8210000 0.8200000 0.8190000
## [2318] 0.8180000 0.8200000 0.8100000 0.8420000 0.8410000 0.8380000 0.8350000
```

```
## [2325] 0.8290000 0.8220000 0.8200000 0.8130000 0.8020000 0.7930000 0.7840000
## [2332] 0.7760000 0.7710000 0.7630000 0.7630000 0.7610000 0.8880000 0.8880000
## [2339] 0.8780000 0.8770000 0.8760000 0.8720000 0.8730000 0.8690000 0.8650000
## [2346] 0.8580000 0.8530000 0.8500000 0.8430000 0.8350000 0.8240000 0.8180000
## [2353] 0.5140000 0.5120000 0.5090000 0.5050000 0.4970000 0.4920000 0.4940000
## [2360] 0.4890000 0.4820000 0.4700000 0.4650000 0.4590000 0.4530000 0.4460000
## [2367] 0.4420000 0.4550000 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2374] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2381] 0.6583378 0.6583378 0.6583378 0.6583378 0.6650000 0.6600000 0.6520000
## [2388] 0.6440000 0.6380000 0.6300000 0.6220000 0.6160000 0.6120000 0.6090000
## [2395] 0.6090000 0.6110000 0.6130000 0.6200000 0.6290000 0.6350000 0.4210000
## [2402] 0.4210000 0.4170000 0.4190000 0.4290000 0.6583378 0.6583378 0.6583378
## [2409] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2416] 0.6583378 0.8820000 0.8770000 0.8740000 0.8710000 0.8670000 0.8600000
## [2423] 0.8580000 0.8540000 0.8490000 0.8440000 0.8370000 0.8330000 0.8300000
## [2430] 0.8280000 0.8250000 0.8200000 0.7640000 0.7600000 0.7570000 0.7520000
## [2437] 0.7460000 0.7390000 0.7350000 0.7310000 0.7250000 0.7180000 0.7120000
## [2444] 0.7050000 0.6970000 0.6990000 0.6860000 0.6770000 0.4880000 0.4850000
## [2451] 0.4780000 0.4680000 0.4630000 0.4610000 0.4560000 0.4440000 0.4400000
## [2458] 0.4300000 0.4230000 0.4150000 0.4090000 0.4030000 0.3990000 0.3940000
## [2465] 0.7230000 0.7220000 0.7190000 0.7080000 0.7040000 0.7000000 0.6960000
## [2472] 0.6910000 0.6840000 0.6780000 0.6720000 0.6583378 0.6583378 0.6583378
## [2479] 0.6583378 0.6583378 0.5410000 0.5410000 0.5390000 0.5340000 0.5260000
## [2486] 0.5230000 0.5190000 0.5140000 0.5080000 0.5020000 0.4950000 0.4920000
## [2493] 0.4930000 0.5020000 0.5060000 0.5160000 0.9090000 0.9060000 0.9040000
## [2500] 0.9030000 0.9010000 0.8950000 0.8980000 0.8970000 0.8950000 0.8920000
## [2507] 0.8900000 0.8880000 0.8820000 0.8800000 0.8770000 0.8730000 0.9380000
## [2514] 0.9360000 0.9340000 0.9320000 0.9320000 0.9200000 0.9160000 0.9140000
## [2521] 0.9110000 0.9040000 0.8990000 0.8950000 0.8890000 0.8900000 0.8880000
## [2528] 0.8790000 0.5530000 0.5750000 0.6350000 0.6450000 0.6460000 0.6500000
## [2535] 0.6480000 0.6510000 0.6440000 0.6360000 0.6240000 0.6100000 0.5990000
## [2542] 0.5960000 0.5890000 0.5880000 0.6250000 0.6220000 0.6170000 0.6130000
## [2549] 0.6080000 0.6030000 0.6010000 0.5920000 0.5860000 0.5790000 0.5720000
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## [2577] 0.7460000 0.7430000 0.7410000 0.7390000 0.7350000 0.7320000 0.7300000
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## [2612] 0.4640000 0.4570000 0.4490000 0.4420000 0.4410000 0.4430000 0.4360000
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## [2640] 0.6760000 0.7790000 0.7780000 0.7730000 0.7720000 0.7740000 0.7720000
## [2647] 0.7730000 0.7670000 0.7600000 0.7510000 0.7450000 0.7360000 0.7290000
## [2654] 0.7210000 0.7150000 0.7090000 0.7230000 0.7220000 0.7200000 0.7170000
## [2661] 0.7140000 0.7100000 0.7060000 0.7010000 0.6950000 0.6890000 0.6830000
## [2668] 0.6730000 0.6670000 0.6620000 0.6540000 0.6460000 0.7640000 0.7590000
## [2675] 0.7540000 0.7500000 0.7370000 0.7150000 0.7090000 0.7050000 0.6970000
## [2682] 0.6870000 0.6810000 0.6750000 0.6680000 0.6580000 0.6530000 0.6410000
## [2689] 0.6880000 0.6830000 0.6780000 0.6720000 0.6650000 0.6583378 0.6583378
## [2696] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2703] 0.6583378 0.6583378 0.4880000 0.4830000 0.4780000 0.4770000 0.4770000
## [2710] 0.4730000 0.4640000 0.4530000 0.4420000 0.4340000 0.4290000 0.4270000
## [2717] 0.4180000 0.4040000 0.3960000 0.3820000 0.7480000 0.7460000 0.7440000
## [2724] 0.7390000 0.7340000 0.7280000 0.7340000 0.7300000 0.7230000 0.7160000
## [2731] 0.7070000 0.7000000 0.6910000 0.6830000 0.6730000 0.6690000 0.8360000
## [2738] 0.8320000 0.8290000 0.8260000 0.8240000 0.8260000 0.8310000 0.8290000
## [2745] 0.8260000 0.8230000 0.8180000 0.8130000 0.8080000 0.8030000 0.7980000
## [2752] 0.7910000 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2759] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2766] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2773] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2780] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
```

```
## [2787] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2794] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378
## [2801] 0.7940000 0.7910000 0.7880000 0.7840000 0.7800000 0.7770000 0.7740000
## [2808] 0.7700000 0.7600000 0.7560000 0.7530000 0.7500000 0.7470000 0.7460000
## [2815] 0.7420000 0.7380000 0.6970000 0.6900000 0.6810000 0.6730000 0.6640000
## [2822] 0.6570000 0.6510000 0.6440000 0.6310000 0.6260000 0.6200000 0.6130000
## [2829] 0.6070000 0.6000000 0.5940000 0.6583378 0.5980000 0.5960000 0.5910000
## [2836] 0.5920000 0.5910000 0.5900000 0.5890000 0.5820000 0.5790000 0.5720000
## [2843] 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.7690000
## [2850] 0.7710000 0.7700000 0.7670000 0.7560000 0.7540000 0.7540000 0.7450000
## [2857] 0.7280000 0.7140000 0.7000000 0.6870000 0.6880000 0.6840000 0.6720000
## [2864] 0.6700000 0.6780000 0.6750000 0.6680000 0.6620000 0.6550000 0.6470000
## [2871] 0.6410000 0.6330000 0.6250000 0.6180000 0.6090000 0.6010000 0.5920000
## [2878] 0.5840000 0.5760000 0.5690000 0.4990000 0.5000000 0.4980000 0.4940000
## [2885] 0.4930000 0.4880000 0.4830000 0.4800000 0.4770000 0.4750000 0.4700000
## [2892] 0.4640000 0.4570000 0.4500000 0.4440000 0.4360000 0.5760000 0.5700000
## [2899] 0.5650000 0.5540000 0.5430000 0.5330000 0.5180000 0.5040000 0.4920000
## [2906] 0.4790000 0.4670000 0.4560000 0.4430000 0.4330000 0.4240000 0.4180000
## [2913] 0.5070000 0.4980000 0.4880000 0.4640000 0.4520000 0.4360000 0.4190000
## [2920] 0.4210000 0.4140000 0.4080000 0.4060000 0.4070000 0.4180000 0.4270000
## [2927] 0.4270000 0.4340000
```

```
# Replace zero for Schooling with its mean
lifeExpec_final$Schooling <- replace(lifeExpec_final$Schooling,
                                     lifeExpec_final$Schooling == 0, NA)
summary(lifeExpec_final$Schooling)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##    2.80   10.20   12.40   12.11   14.30   20.70     186
```

```
lifeExpec_final$Schooling[is.na(lifeExpec_final$Schooling)] <-
  mean(lifeExpec_final$Schooling,na.rm=TRUE)
lifeExpec_final$Schooling
```

```
##    [1] 10.10000 10.00000  9.90000  9.80000  9.50000  9.20000  8.90000  8.70000
##    [9]  8.40000  8.10000  7.90000  6.80000  6.50000  6.20000  5.90000  5.50000
##   [17] 14.20000 14.20000 14.20000 14.20000 13.30000 12.50000 12.20000 12.00000
##   [25] 11.60000 11.40000 10.80000 10.90000 10.70000 10.70000 10.60000 10.70000
##   [33] 14.40000 14.40000 14.40000 14.40000 14.00000 13.60000 13.10000 12.60000
##   [41] 12.30000 12.30000 12.00000 11.70000 11.50000 11.10000 10.90000 10.70000
##   [49] 11.40000 11.40000 11.40000 10.30000  9.40000  9.00000  8.50000  8.10000
##   [57]  7.70000  7.20000  6.80000  6.40000  5.90000  5.50000  5.10000  4.60000
##   [65] 13.90000 13.90000 13.90000 13.80000 14.10000 14.10000 14.20000 14.40000
##   [73] 14.50000 14.70000 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
##   [81] 17.30000 17.30000 17.30000 17.20000 17.10000 16.80000 16.50000 16.30000
##   [89] 16.30000 16.10000 16.30000 16.30000 16.40000 16.30000 15.60000 15.00000
##   [97] 12.70000 12.70000 12.70000 12.70000 12.70000 12.30000 11.90000 12.30000
##  [105] 11.70000 11.20000 10.90000 10.90000 10.80000 10.80000 11.10000 11.20000
##  [113] 20.40000 20.40000 20.30000 20.10000 19.80000 19.50000 19.10000 19.10000
##  [121] 19.00000 20.30000 20.30000 20.70000 20.60000 20.10000 20.50000 20.40000
##  [129] 15.90000 15.90000 15.70000 15.70000 15.70000 15.40000 15.30000 15.10000
##  [137] 15.20000 15.00000 14.90000 14.70000 14.70000 16.10000 15.50000 15.40000
##  [145] 12.70000 12.20000 11.90000 11.80000 11.70000 11.70000 11.60000 11.60000
##  [153] 11.60000 10.70000 11.20000 11.00000 10.80000 10.60000 10.40000 10.10000
##  [161] 12.60000 12.60000 12.60000 12.60000 12.60000 12.60000 12.60000 12.60000
##  [169] 12.50000 12.40000 12.40000 12.30000 12.20000 12.10000 12.10000 12.00000
##  [177] 14.50000 14.50000 14.50000 14.50000 14.40000 14.40000 14.40000 14.40000
##  [185] 14.40000 14.20000 14.00000 13.90000 13.70000 13.50000 13.30000 13.20000
##  [193] 10.20000 10.00000 10.00000  9.90000  9.40000  8.90000  8.40000  8.60000
##  [201]  8.60000  8.40000  8.20000  8.10000  7.90000  7.70000  7.50000  7.30000
##  [209] 15.30000 15.30000 15.30000 15.30000 15.50000 15.80000 15.50000 15.30000
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```

```
## [1849] 19.20000 19.10000 18.90000 18.40000 18.20000 17.50000 17.40000 17.20000
## [1857] 11.70000 11.60000 11.50000 11.50000 11.50000 11.40000 11.30000 11.10000
## [1865] 11.00000 11.00000 11.00000 11.00000 11.00000 10.70000 10.40000 10.10000
## [1873]  5.40000  5.30000  5.30000  5.10000  4.80000  4.50000  4.20000  4.00000
## [1881]  3.80000  3.70000  3.50000  3.10000  3.00000  2.90000  2.90000  2.80000
## [1889] 10.00000 10.00000  9.80000  9.70000  9.60000  9.50000  9.30000  9.20000
## [1897]  9.10000  9.00000  8.90000  8.50000  8.10000  7.70000  8.00000  7.60000
## [1905] 17.70000 17.70000 17.50000 17.60000 17.60000 17.40000 17.40000 17.60000
## [1913] 17.60000 17.50000 17.60000 17.50000 17.10000 17.10000 17.50000 17.10000
## [1921] 13.70000 13.70000 13.70000 13.70000 13.60000 13.50000 12.40000 11.90000
## [1929] 11.50000 11.60000 11.50000 11.50000 11.20000 11.00000 10.70000 10.40000
## [1937]  8.10000  7.80000  7.70000  7.60000  7.50000  7.50000  7.30000  7.30000
## [1945]  6.70000  6.50000  6.10000  5.60000  5.60000  5.50000  5.40000  5.30000
## [1953] 13.00000 13.00000 12.90000 12.80000 12.90000 12.80000 12.80000 12.80000
## [1961] 12.90000 12.90000 12.90000 12.80000 12.80000 12.60000 12.40000 12.10000
## [1969] 10.00000 10.00000 10.00000  9.90000  9.90000  9.60000  9.20000  8.90000
## [1977]  8.60000  8.20000  7.90000  7.60000  7.20000  6.90000  6.60000  6.20000
## [1985] 12.30000 12.30000 12.30000 12.30000 12.30000 12.40000 12.10000 11.90000
## [1993] 12.00000 12.10000 12.30000 12.10000 12.70000 12.20000 11.80000 11.60000
## [2001] 13.40000 13.40000 13.40000 13.40000 13.40000 13.30000 13.30000 13.20000
## [2009] 13.20000 13.00000 13.00000 12.80000 13.30000 13.90000 13.40000 13.50000
## [2017] 11.70000 11.70000 11.70000 11.60000 11.50000 11.40000 11.70000 11.50000
## [2025] 11.40000 11.50000 11.60000 11.60000 11.60000 11.40000 11.40000 11.40000
## [2033] 16.40000 16.40000 15.40000 15.30000 15.40000 15.10000 15.10000 15.00000
## [2041] 15.00000 15.00000 14.80000 15.50000 15.30000 15.00000 14.70000 14.60000
## [2049] 16.60000 16.80000 16.30000 16.30000 16.20000 16.00000 16.00000 15.80000
## [2057] 15.40000 15.40000 15.40000 15.90000 15.80000 15.90000 15.70000 15.50000
## [2065] 13.40000 13.40000 13.40000 13.40000 12.40000 12.00000 11.80000 11.70000
## [2073] 12.60000 13.70000 13.70000 13.50000 12.80000 12.20000 12.60000 13.00000
## [2081] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2089] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2097] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2105] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2113] 14.70000 14.70000 14.70000 15.30000 15.70000 15.80000 15.40000 14.70000
## [2121] 14.10000 13.70000 13.40000 12.90000 12.50000 12.00000 11.70000 11.50000
## [2129] 15.00000 14.90000 14.60000 14.30000 14.00000 13.70000 14.00000 13.90000
## [2137] 13.80000 13.80000 13.70000 13.60000 13.20000 12.80000 12.50000 12.10000
## [2145] 10.80000 10.80000 10.80000 10.50000 10.20000 10.00000 10.20000 10.40000
## [2153] 10.10000  9.30000  8.80000  8.20000  7.60000  7.20000  7.10000  6.60000
## [2161] 13.10000 13.10000 13.10000 13.00000 12.90000 12.80000 12.70000 12.60000
## [2169] 12.80000 12.40000 12.20000 12.30000 12.40000 12.50000 12.60000 12.80000
## [2177] 13.30000 13.30000 13.30000 13.30000 13.30000 13.30000 13.30000 13.30000
## [2185] 13.30000 13.30000 13.30000 13.20000 13.00000 12.90000 12.80000 12.70000
## [2193] 12.90000 12.90000 12.90000 12.90000 12.90000 12.90000 12.90000 12.90000
## [2201] 12.90000 12.70000 12.60000 12.40000 12.30000 12.10000 12.00000 12.10000
## [2209] 11.20000 11.10000 11.00000 10.80000 10.60000 10.60000 10.10000 10.40000
## [2217] 10.30000 10.20000 10.00000  9.80000  9.70000  9.60000  9.40000  9.30000
## [2225] 16.10000 15.80000 15.20000 14.50000 13.90000 13.30000 13.00000 12.80000
## [2233] 12.70000 12.50000 12.40000 12.30000 12.20000 12.10000 12.00000 11.80000
## [2241]  9.50000  9.10000  8.70000  8.30000  7.90000  7.70000  7.50000  7.10000
## [2249]  6.80000  6.60000  6.40000  6.20000  5.90000  5.70000  5.40000  5.20000
## [2257] 14.40000 14.30000 14.10000 14.00000 13.50000 13.60000 13.60000 13.50000
## [2265] 13.50000 13.40000 13.20000 13.10000 13.00000 13.20000 13.10000 13.00000
## [2273] 14.10000 13.20000 13.50000 13.50000 13.30000 13.20000 13.20000 13.20000
## [2281] 13.10000 13.10000 12.10000 12.30000 12.10000 12.10000 12.20000 12.30000
## [2289]  9.50000  9.50000  9.30000  9.10000  8.90000  8.70000  8.50000  8.30000
## [2297]  8.20000  8.00000  7.80000  7.60000  7.40000  7.20000  7.00000  6.70000
## [2305] 15.40000 15.40000 15.40000 15.40000 15.20000 14.50000 14.40000 14.20000
## [2313] 14.10000 13.90000 12.60000 12.70000 12.70000 12.60000 12.70000 12.50000
## [2321] 15.00000 15.10000 15.00000 15.00000 15.00000 15.00000 14.90000 14.80000
## [2329] 14.50000 14.30000 14.00000 13.80000 13.60000 13.30000 13.30000 13.00000
## [2337] 17.30000 17.60000 16.80000 16.80000 17.00000 16.90000 16.90000 16.90000
## [2345] 16.80000 16.70000 16.30000 16.60000 16.10000 15.60000 14.70000 14.60000
## [2353]  9.60000  9.60000  9.50000  9.40000  9.40000  9.30000  9.30000  9.20000
## [2361]  9.00000  8.40000  8.30000  8.10000  8.00000  7.30000  6.60000  7.20000
## [2369] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
```

```
## [2377] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2385] 13.00000 13.00000 12.80000 12.80000 12.80000 12.80000 12.80000 12.90000
## [2393] 12.90000 12.90000 12.90000 12.90000 12.90000 12.90000 13.00000 13.00000
## [2401]  4.90000  4.90000  4.90000  4.90000  4.90000 12.11342 12.11342 12.11342
## [2409] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2417] 17.70000 17.60000 17.50000 17.20000 16.90000 16.40000 16.30000 16.10000
## [2425] 16.00000 15.90000 15.80000 15.60000 15.60000 15.70000 15.70000 15.70000
## [2433] 14.00000 14.00000 13.80000 13.70000 13.60000 13.50000 13.40000 13.30000
## [2441] 13.20000 13.10000 12.90000 12.80000 12.70000 12.60000 12.50000 12.40000
## [2449]  7.20000  7.20000  7.00000  6.80000  7.00000  7.00000  6.80000  6.30000
## [2457]  6.40000  6.20000  6.10000  5.70000  5.60000  5.60000  5.60000  5.50000
## [2465] 12.70000 12.70000 12.70000 12.70000 12.50000 12.30000 12.10000 11.90000
## [2473] 11.70000 11.50000 11.30000 11.10000 10.90000 11.00000 11.00000 11.10000
## [2481] 11.40000 11.40000 11.40000 11.30000 11.20000 11.00000 10.80000 10.60000
## [2489] 10.50000  9.90000  9.70000  9.40000  9.10000  9.20000  9.30000  9.40000
## [2497] 15.90000 15.80000 15.80000 15.80000 16.00000 15.80000 15.80000 15.70000
## [2505] 15.80000 15.90000 16.00000 16.00000 15.90000 15.90000 15.90000 15.90000
## [2513] 16.00000 15.90000 15.80000 15.70000 15.60000 15.40000 15.30000 15.30000
## [2521] 15.30000 15.20000 15.20000 15.10000 15.00000 15.20000 15.20000 15.10000
## [2529]  9.00000  9.00000 13.00000 12.50000 12.00000 11.70000 11.80000 11.60000
## [2537] 11.50000 11.40000 11.00000 10.60000 10.30000 10.20000 10.10000 10.00000
## [2545] 11.30000 11.30000 11.20000 11.10000 11.10000 11.10000 11.10000 10.80000
## [2553] 10.90000 10.70000 10.60000 10.50000 10.10000  9.80000  9.70000  9.60000
## [2561] 13.60000 13.60000 13.60000 13.70000 13.30000 13.10000 13.00000 12.90000
## [2569] 12.30000 12.40000 12.00000 11.90000 11.80000 11.50000 11.20000 10.90000
## [2577] 12.90000 12.90000 12.90000 12.90000 12.90000 13.00000 13.00000 12.20000
## [2585] 12.20000 12.10000 11.90000 11.90000 11.90000 11.90000 11.80000 11.70000
## [2593] 12.50000 12.50000 12.50000 12.50000 12.50000 12.40000 12.10000 11.70000
## [2601] 11.30000 11.00000 10.60000 10.20000  9.80000  9.80000  9.80000 12.11342
## [2609] 12.00000 12.00000 12.00000 12.00000 11.50000 11.00000 10.60000 10.10000
## [2617] 10.60000 10.20000 10.10000 10.00000  9.90000  9.70000  9.40000  9.30000
## [2625] 14.30000 14.30000 14.30000 14.40000 14.40000 14.40000 14.50000 14.50000
## [2633] 14.50000 14.60000 14.60000 14.60000 13.70000 13.50000 13.20000 13.70000
## [2641] 12.70000 12.70000 12.70000 12.60000 12.60000 12.50000 12.50000 12.40000
## [2649] 12.40000 12.30000 12.30000 12.20000 12.00000 11.90000 11.80000 11.70000
## [2657] 14.60000 14.70000 14.70000 14.60000 14.50000 14.40000 14.40000 14.30000
## [2665] 14.30000 14.20000 13.90000 13.60000 13.50000 13.30000 13.10000 12.80000
## [2673] 14.50000 14.50000 14.40000 14.30000 13.80000 13.00000 12.50000 12.50000
## [2681] 12.30000 11.90000 11.90000 12.00000 11.90000 11.50000 11.10000 10.70000
## [2689] 10.80000 10.80000 10.70000 10.70000 10.60000 10.60000 10.50000 10.50000
## [2697] 10.40000 10.40000 10.30000 10.30000 10.30000 10.20000 10.20000 12.11342
## [2705] 10.00000 10.00000 10.00000 10.00000 10.70000 10.90000 10.80000 10.60000
## [2713] 10.30000 10.60000 10.90000 11.60000 11.50000 11.00000 10.80000  9.80000
## [2721] 15.30000 15.20000 15.20000 15.10000 14.90000 14.90000 14.90000 14.90000
## [2729] 14.80000 14.70000 14.50000 14.60000 14.30000 13.90000 13.20000 13.30000
## [2737] 13.30000 13.30000 13.30000 13.30000 13.30000 13.30000 13.20000 13.10000
## [2745] 12.90000 12.80000 12.60000 12.40000 12.30000 12.10000 12.00000 11.80000
## [2753] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2761] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2769] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2777] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2785] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2793] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342
## [2801] 15.50000 15.50000 15.50000 15.50000 15.50000 15.60000 15.50000 15.70000
## [2809] 15.30000 15.20000 15.50000 15.50000 15.00000 14.70000 14.20000 14.00000
## [2817] 12.10000 12.10000 12.00000 12.00000 12.00000 11.90000 11.80000 11.90000
## [2825] 11.80000 11.80000 11.70000 11.60000 11.30000 11.00000 10.70000 10.60000
## [2833] 10.80000 10.80000 10.80000 10.80000 10.80000 10.80000 10.70000 10.70000
## [2841] 10.70000 10.60000 10.60000 10.70000 10.40000 10.20000 10.10000  9.60000
## [2849] 14.30000 14.20000 14.20000 14.10000 14.10000 14.00000 14.00000 13.40000
## [2857] 12.90000 12.40000 11.80000 11.60000 11.60000 11.00000 10.40000 10.60000
## [2865] 12.60000 12.50000 12.30000 12.20000 12.00000 11.90000 11.70000 11.60000
## [2873] 11.40000 11.30000 11.10000 11.00000 10.90000 10.70000 10.60000 10.40000
## [2881]  9.00000  9.00000  9.00000  9.00000  8.60000  8.50000  8.40000  8.50000
## [2889]  8.60000  8.70000  8.60000  8.40000  8.20000  8.00000  7.90000  7.70000
## [2897] 12.50000 12.50000 12.50000 12.30000 12.00000 11.80000 11.60000 11.40000
```

```
## [2905] 11.10000 10.90000 10.70000 10.50000 10.20000 10.00000  9.80000  9.60000
## [2913] 10.30000 10.30000 10.40000  9.80000 10.10000 10.00000  9.90000  9.70000
## [2921]  9.60000  9.50000  9.30000  9.20000  9.50000 10.00000  9.80000  9.80000
```

```
# Replace GDP's NA with its mean then log transform
summary(lifeExpec_final$GDP)
```

```
##      Min.   1st Qu.    Median      Mean   3rd Qu.      Max.      NA's
##      1.68    463.85   1764.97   7494.21   5932.90 119172.74       443
```

```
lifeExpec_final$GDP[is.na(lifeExpec_final$GDP)]<-mean(lifeExpec_final$GDP,na.rm=TRUE)
lifeExpec_final$GDP
```

```
##    [1] 5.842592e+02 6.126965e+02 6.317450e+02 6.699590e+02 6.353723e+01
##    [6] 5.533289e+02 4.458933e+02 3.733611e+02 3.698358e+02 2.725638e+02
##   [11] 2.529413e+01 2.191414e+02 1.987285e+02 1.878459e+02 1.174970e+02
##   [16] 1.145600e+02 3.954228e+03 4.575764e+03 4.414723e+03 4.247614e+03
##   [21] 4.437179e+03 4.943588e+02 4.114137e+03 4.375396e+02 3.631368e+02
##   [26] 3.512930e+01 2.791429e+02 2.416588e+03 1.896816e+02 1.453643e+03
##   [31] 1.326973e+03 1.175789e+03 4.132763e+03 5.478517e+02 5.471867e+03
##   [36] 5.564826e+03 5.432252e+03 4.463395e+03 3.868831e+03 4.952549e+02
##   [41] 3.935183e+03 3.464618e+03 3.112238e+01 2.598982e+03 2.943356e+02
##   [46] 1.774337e+03 1.732858e+03 1.757178e+03 3.695794e+03 4.793122e+02
##   [51] 4.846169e+02 4.598250e+03 4.299129e+03 3.529535e+03 3.347845e+03
##   [56] 3.868579e+03 2.878837e+03 2.624151e+02 1.443992e+03 1.418684e+02
##   [61] 7.794684e+02 7.111817e+02 5.261687e+02 5.552969e+02 1.356695e+04
##   [66] 1.288830e+04 1.222486e+04 1.256544e+04 1.192935e+04 1.212688e+04
##   [71] 1.312467e+03 1.473319e+03 1.425229e+04 1.272439e+04 1.137194e+04
##   [76] 1.352837e+03 9.739826e+03 9.386716e+03 9.358154e+03 9.875162e+03
##   [81] 1.346712e+04 1.224526e+04 1.297664e+04 1.296977e+04 1.272698e+04
##   [86] 1.276265e+03 8.161370e+03 8.953359e+03 7.193618e+03 5.878761e+03
##   [91] 5.768838e+02 4.251574e+03 3.334376e+02 2.579193e+03 7.176947e+02
##   [96] 7.669274e+03 3.696548e+02 3.994712e+03 3.843591e+03 3.684848e+03
##  [101] 3.526978e+03 3.218382e+03 2.993833e+03 4.126997e+01 3.138887e+03
##  [106] 2.158299e+03 1.643758e+03 1.191962e+03 9.316616e+01 7.832617e+02
##  [111] 6.944351e+02 6.227427e+02 5.655439e+04 6.221469e+04 6.779234e+04
##  [116] 6.767763e+04 6.224513e+04 5.187485e+04 4.274300e+04 4.966469e+04
##  [121] 4.991983e+03 3.611828e+04 3.416715e+03 3.472380e+03 2.346539e+04
##  [126] 2.818176e+02 1.951784e+04 2.169921e+03 4.366595e+04 5.132264e+04
##  [131] 5.547153e+02 4.833357e+04 5.112674e+04 4.665763e+04 4.765419e+04
##  [136] 5.138638e+04 4.658665e+04 4.439936e+02 3.824243e+04 3.669343e+04
##  [141] 3.212936e+03 2.635138e+04 2.448974e+04 2.451727e+04 5.531382e+01
##  [146] 7.891300e+03 7.875757e+03 7.496336e+03 7.189691e+03 5.842858e+03
##  [151] 4.952948e+02 5.574638e+03 3.851438e+03 2.473858e+03 1.578424e+03
##  [156] 1.452163e+02 8.836440e+02 7.637386e+02 7.368384e+01 6.559743e+02
##  [161] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
##  [166] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
##  [171] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
##  [176] 7.494211e+03 2.268888e+04 2.498338e+04 2.511833e+02 2.364937e+04
##  [181] 2.281124e+03 2.722139e+03 1.935667e+04 2.367565e+03 2.977115e+03
##  [186] 1.937995e+03 1.795918e+04 1.584648e+04 1.422199e+04 1.312335e+03
##  [191] 1.286821e+04 1.363635e+04 1.211581e+02 1.845654e+02 9.518895e+02
##  [196] 8.563429e+02 8.357893e+02 7.576718e+02 6.811254e+02 6.157775e+02
##  [201] 5.416515e+02 4.945147e+02 4.841555e+02 4.675792e+01 4.327389e+02
##  [206] 4.613575e+00 4.259812e+01 4.563371e+01 1.555784e+04 1.535967e+04
##  [211] 1.547278e+04 1.538487e+04 1.553416e+04 1.595912e+03 1.652332e+04
##  [216] 1.657323e+03 1.646249e+04 1.564656e+04 1.422387e+04 1.286886e+04
##  [221] 1.228545e+03 1.167539e+04 1.151387e+04 1.156811e+04 5.949117e+03
##  [226] 8.318429e+03 7.978825e+03 6.942439e+02 6.519718e+03 6.338877e+01
##  [231] 5.176173e+03 6.376183e+03 4.735485e+03 3.848216e+03 3.126718e+03
##  [236] 2.378339e+03 1.819526e+03 1.479383e+03 1.244373e+03 1.276288e+03
##  [241] 4.356875e+03 4.743940e+04 4.651386e+03 4.474572e+03 4.772774e+03
##  [246] 4.438237e+03 4.488561e+03 4.842459e+04 4.443831e+03 3.885236e+04
##  [251] 3.696728e+04 3.558971e+04 3.743957e+03 2.552333e+03 2.312157e+04
##  [256] 2.327459e+03 4.849997e+03 4.852224e+03 4.688538e+03 4.673638e+03
##  [261] 4.516247e+03 4.344152e+03 4.258789e+03 4.472280e+02 4.324876e+03
##  [266] 4.187378e+03 3.933332e+03 3.831538e+03 3.679995e+03 3.556562e+03
```

```
##  [271] 3.419276e+03 3.364424e+03 7.839479e+02 9.436866e+02 9.152675e+02
##  [276] 8.379551e+02 8.259428e+02 7.576960e+02 7.934524e+02 8.215135e+01
##  [281] 7.653542e+01 6.258392e+02 6.179998e+01 5.834935e+02 5.192923e+02
##  [286] 4.186986e+02 3.787365e+02 3.741924e+02 2.613645e+03 2.522797e+03
##  [291] 2.358829e+02 2.422816e+03 2.458460e+03 2.178921e+03 1.772345e+02
##  [296] 1.795181e+03 1.741143e+03 1.335457e+03 1.247614e+03 1.974579e+02
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## [2061] 1.577273e+04 1.288229e+04 1.172915e+04 1.152397e+03 6.634652e+04
## [2066] 8.685271e+04 8.834880e+03 8.856482e+04 8.594875e+04 7.362278e+02
## [2071] 6.147824e+04 8.296737e+04 6.756126e+02 6.256559e+03 5.148850e+04
## [2076] 4.181835e+04 3.417698e+04 2.999655e+03 2.843636e+03 2.998629e+04
## [2081] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2086] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2091] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2096] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2101] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2106] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2111] 7.494211e+03 7.494211e+03 8.958789e+03 1.227733e+01 9.585267e+03
## [2116] 8.558398e+03 9.227783e+01 8.297484e+03 8.221833e+02 1.136474e+03
## [2121] 8.214185e+03 5.828746e+03 4.676315e+03 3.552925e+03 2.774956e+03
## [2126] 2.124874e+03 1.839729e+03 1.668163e+03 9.329298e+03 1.412596e+04
## [2131] 1.554368e+04 1.515446e+04 1.421269e+04 1.674988e+03 8.562896e+03
## [2136] 1.163526e+04 9.112539e+02 6.921944e+02 5.323474e+03 4.123723e+02
## [2141] 2.975133e+03 2.375594e+03 2.136239e+01 1.771587e+03 7.134840e+01
## [2146] 7.656995e+01 6.888769e+02 6.787970e+02 6.173176e+02 5.634915e+02
## [2151] 5.391538e+02 5.668726e+00 4.485334e+01 3.423656e+02 2.879319e+02
## [2156] 2.369114e+02 2.126619e+02 1.965978e+02 2.156965e+01 2.161727e+02
## [2161] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2166] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2171] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2176] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2181] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2186] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2191] 7.494211e+03 7.494211e+03 4.149363e+03 4.178973e+03 4.219651e+03
## [2196] 4.234554e+03 3.942983e+03 3.453487e+03 3.351128e+02 3.598222e+02
## [2201] 3.225431e+02 2.879639e+02 2.571262e+03 2.351338e+03 1.972942e+02
## [2206] 1.631417e+03 1.555475e+03 1.546892e+02 1.624640e+03 1.821879e+03
## [2211] 1.619533e+03 1.389500e+02 1.343262e+02 1.129755e+03 1.995715e+02
## [2216] 1.126462e+03 8.949280e+02 8.438945e+02 8.186157e+01 6.933457e+02
## [2221] 6.493422e+02 5.558185e+02 5.121638e+01 7.494211e+03 2.732862e+03
## [2226] 2.457543e+04 2.493439e+04 2.533946e+03 2.377747e+03 1.925959e+04
## [2231] 1.694293e+03 2.378323e+02 1.647217e+04 1.533467e+04 1.373983e+04
## [2236] 1.113887e+04 9.567458e+03 8.655312e+03 8.643494e+03 9.126954e+03
## [2241] 9.872561e+01 1.524439e+02 1.489124e+02 1.364518e+02 1.825321e+01
## [2246] 1.163138e+01 1.256646e+01 1.133678e+01 9.539785e+01 8.983830e+01
```

```
## [2251] 7.738699e+02 7.335818e+02 6.427663e+02 5.132623e+02 4.812874e+02
## [2256] 4.734534e+02 5.237255e+03 6.217322e+01 6.353826e+03 5.659382e+03
## [2261] 6.423292e+03 5.411877e+03 5.821354e+03 6.717739e+02 5.458122e+03
## [2266] 4.129759e+03 3.528132e+03 3.331229e+03 2.832497e+03 2.149994e+03
## [2271] 1.634876e+03 8.713653e+01 1.539464e+03 1.557779e+03 1.568735e+04
## [2276] 1.284517e+04 1.218995e+04 1.846845e+02 9.769566e+02 1.112286e+04
## [2281] 1.215483e+04 1.214400e+03 1.192517e+03 1.176659e+03 8.524961e+03
## [2286] 8.331262e+03 7.663138e+03 7.578852e+03 5.875382e+02 7.843948e+01
## [2291] 7.181870e+01 5.618984e+02 4.455250e+02 4.512842e+01 3.945932e+02
## [2296] 4.637592e+01 3.588275e+02 3.223135e+02 2.876892e+02 2.631458e+02
## [2301] 2.637618e+02 2.499395e+02 2.277795e+02 1.393148e+02 5.362974e+04
## [2306] 5.633672e+04 5.629189e+03 5.443116e+04 5.316668e+04 4.656968e+04
## [2311] 3.857756e+04 3.972148e+04 3.922358e+04 3.357986e+04 2.986985e+04
## [2316] 2.745271e+03 2.357363e+04 2.216833e+03 2.157778e+04 2.379268e+04
## [2321] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2326] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2331] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2336] 7.494211e+03 2.729864e+03 2.426729e+02 2.315318e+03 2.248647e+04
## [2341] 2.498525e+04 2.343747e+04 2.463380e+04 2.751813e+03 2.384132e+04
## [2346] 1.972613e+04 1.816919e+04 1.726915e+03 1.488472e+03 1.181500e+04
## [2351] 1.479296e+03 1.227737e+03 1.922414e+03 2.965262e+01 1.885159e+02
## [2356] 1.858690e+03 1.642838e+03 1.272448e+03 1.158283e+03 1.257917e+02
## [2361] 1.469311e+02 9.486593e+02 8.887486e+01 8.184426e+02 7.447657e+02
## [2366] 7.849563e+02 9.448168e+02 1.545186e+02 4.269854e+02 4.178914e+02
## [2371] 4.754324e+01 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2376] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2381] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 5.769773e+03
## [2386] 6.479626e+03 6.876954e+03 7.548164e+03 8.499542e+02 7.362761e+03
## [2391] 5.888628e+03 5.786600e+03 6.125400e+03 5.631735e+03 5.414634e+03
## [2396] 4.863517e+03 3.775683e+03 2.518398e+03 2.681781e+03 3.372253e+02
## [2401] 7.587258e+02 1.151862e+03 1.186113e+03 9.584558e+02 1.769713e+02
## [2406] 1.562239e+03 1.264790e+03 1.678712e+03 7.494211e+03 7.494211e+03
## [2411] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2416] 7.494211e+03 2.568385e+04 2.964722e+02 2.921934e+03 2.856229e+04
## [2421] 3.183422e+04 3.736228e+03 3.233347e+04 3.557874e+04 3.279414e+03
## [2426] 2.848269e+04 2.651717e+03 2.491865e+04 2.149577e+04 1.719535e+03
## [2431] 1.532361e+04 1.467677e+04 3.844891e+03 3.825499e+02 3.612894e+02
## [2436] 3.355214e+02 3.229926e+02 2.819511e+03 2.166816e+02 2.544892e+02
## [2441] 1.644816e+03 1.448761e+03 1.259876e+03 1.746692e+02 9.894548e+02
## [2446] 8.731472e+02 8.376998e+02 8.754122e+02 2.513885e+03 2.176898e+03
## [2451] 1.955668e+03 1.892894e+03 1.666858e+03 1.476479e+03 1.226884e+03
## [2456] 1.291529e+03 1.115695e+03 8.938794e+02 6.797540e+02 5.655695e+02
## [2461] 4.777385e+02 4.121518e+02 3.775254e+02 3.613584e+02 8.818983e+03
## [2466] 9.564464e+03 9.484569e+03 9.272413e+03 8.318977e+03 8.333133e+02
## [2471] 7.443852e+03 6.858163e+03 5.761395e+03 5.279200e+02 3.595885e+03
## [2476] 3.648773e+01 2.631399e+02 2.232513e+03 1.598775e+03 1.888618e+03
## [2481] 3.136925e+03 3.464352e+03 3.598760e+03 3.851515e+03 3.934273e+03
## [2486] 3.692393e+02 3.325171e+02 2.842438e+03 3.474880e+02 2.937367e+03
## [2491] 2.873862e+03 2.529634e+03 2.299449e+01 1.324996e+03 1.437635e+03
## [2496] 1.637457e+03 5.585258e+03 5.918199e+03 6.283245e+03 5.713478e+04
## [2501] 5.959329e+04 5.276256e+03 4.627592e+03 5.574684e+04 5.332438e+04
## [2506] 4.625647e+04 4.385353e+03 4.244222e+04 3.696143e+04 2.957174e+04
## [2511] 2.696924e+04 2.928355e+04 8.989842e+03 8.581459e+04 8.465889e+04
## [2516] 8.316439e+04 8.799844e+04 7.427672e+04 6.967247e+04 7.211957e+04
## [2521] 6.322347e+04 5.734893e+04 5.479755e+04 5.325598e+04 4.796565e+03
## [2526] 4.133672e+04 3.853864e+04 3.781323e+04 7.494211e+03 7.494211e+03
## [2531] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2536] 7.494211e+03 2.583529e+02 1.762246e+03 1.577457e+03 1.488527e+02
## [2541] 1.253391e+03 1.263135e+03 1.258422e+03 1.177629e+03 9.186772e+02
## [2546] 1.144592e+02 1.421441e+01 9.547253e+02 8.345413e+02 7.383475e+02
## [2551] 6.663459e+02 7.691413e+01 5.235956e+01 4.428727e+01 3.373592e+02
## [2556] 3.928183e+01 2.363144e+02 1.893879e+02 1.781597e+01 1.384366e+02
## [2561] 5.814863e+03 5.941847e+03 6.171262e+03 5.859916e+03 5.491160e+03
## [2566] 5.753218e+02 4.212549e+03 4.378687e+03 3.972265e+03 3.368953e+03
## [2571] 2.893651e+03 2.659839e+03 2.358936e+03 2.965462e+02 1.893145e+03
## [2576] 2.756483e+01 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
```

```
## [2581] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2586] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2591] 7.494211e+03 7.494211e+03 1.161769e+03 1.153516e+03 1.177657e+02
## [2596] 1.117777e+03 1.145618e+02 8.498627e+02 7.573114e+02 6.437191e+02
## [2601] 5.248959e+02 4.415323e+02 4.783319e+02 4.675438e+02 4.714566e+02
## [2606] 4.861552e+01 5.642499e+01 4.222863e+02 5.511383e+02 6.213185e+01
## [2611] 5.794348e+02 5.636894e+02 5.623394e+02 4.879239e+02 4.996469e+02
## [2616] 5.133919e+02 4.276474e+01 3.773363e+02 3.721722e+02 3.499937e+02
## [2621] 3.143714e+01 2.883212e+01 2.663947e+01 2.639329e+01 4.937754e+02
## [2626] 4.192350e+03 4.266557e+03 4.515425e+02 4.451887e+02 3.547600e+03
## [2631] 3.784656e+01 3.392647e+03 2.932316e+03 2.892523e+03 2.594750e+03
## [2636] 2.284379e+03 2.297147e+02 1.842444e+03 1.837977e+03 2.632724e+02
## [2641] 1.732183e+04 1.932524e+04 1.967833e+03 1.915253e+04 1.953977e+03
## [2646] 1.668395e+04 1.458880e+03 2.118812e+04 1.653184e+03 1.495963e+03
## [2651] 1.232313e+04 1.295191e+02 8.845187e+02 7.496266e+02 6.935721e+03
## [2656] 6.439473e+02 3.828916e+03 4.271682e+03 4.199473e+03 4.137554e+03
## [2661] 4.256913e+03 4.141518e+02 4.129977e+03 4.319326e+02 3.778184e+03
## [2666] 3.371712e+03 3.194562e+03 3.112835e+03 2.761969e+03 2.346594e+03
## [2671] 2.254933e+03 2.213915e+03 1.979526e+03 1.212723e+04 1.254294e+04
## [2676] 1.172384e+03 1.134113e+04 1.672569e+03 9.364999e+02 1.856898e+02
## [2681] 9.794925e+02 8.348692e+02 7.384355e+03 6.472953e+01 4.718513e+03
## [2686] 3.665700e+02 3.119637e+03 4.316554e+03 6.432669e+03 7.962366e+03
## [2691] 7.344253e+02 6.675263e+03 5.649978e+03 4.439230e+03 4.364592e+02
## [2696] 3.944677e+02 2.637143e+01 2.136668e+03 1.745147e+02 1.453917e+03
## [2701] 1.283886e+03 9.679175e+02 7.744763e+02 6.431752e+02 6.938964e+02
## [2706] 7.191727e+02 6.624923e+02 6.477474e+02 5.843962e+02 5.949973e+02
## [2711] 6.471773e+02 4.496928e+02 4.185863e+01 3.364594e+02 3.157882e+02
## [2716] 2.882369e+02 2.379996e+02 2.424232e+01 2.349848e+02 2.576337e+02
## [2721] 2.124663e+03 3.146583e+02 4.297155e+02 3.855421e+03 3.569757e+03
## [2726] 2.965142e+03 2.545483e+03 3.891378e+03 3.686900e+02 2.331883e+02
## [2731] 1.828718e+03 1.367352e+03 1.485225e+02 8.794755e+02 7.873824e+01
## [2736] 6.357896e+02 3.911747e+03 4.444974e+04 4.335643e+03 4.211224e+04
## [2741] 4.462313e+03 3.549148e+03 3.372575e+03 4.575896e+04 4.267261e+04
## [2746] 4.237222e+04 3.943982e+04 3.616118e+04 3.323523e+03 3.131136e+04
## [2751] 3.161529e+03 3.371269e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2756] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2761] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2766] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2771] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2776] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2781] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2786] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2791] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2796] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2801] 1.552484e+04 1.673790e+04 1.688126e+04 1.592682e+03 1.416650e+04
## [2806] 1.193821e+04 9.415174e+03 9.623122e+02 7.969746e+01 5.877877e+03
## [2811] 5.229511e+02 4.117389e+03 3.622523e+03 4.887689e+02 6.281377e+03
## [2816] 6.871898e+03 2.137577e+03 2.544841e+01 1.975512e+02 1.744683e+02
## [2821] 1.564967e+03 1.377821e+03 1.213265e+03 1.822862e+02 8.347694e+01
## [2826] 6.542838e+02 5.467769e+02 4.651199e+02 3.961300e+02 3.833495e+02
## [2831] 4.567349e+02 5.582211e+02 2.858341e+02 3.148365e+03 3.167344e+03
## [2836] 3.158587e+03 3.275917e+03 2.965824e+03 2.643441e+03 2.697961e+03
## [2841] 2.393367e+03 2.479782e+02 1.886433e+03 1.787947e+03 1.585272e+02
## [2846] 1.353935e+03 1.362617e+03 1.469849e+03 7.494211e+03 7.494211e+03
## [2851] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2856] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2861] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2866] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2871] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2876] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2881] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2886] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2891] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03
## [2896] 7.494211e+03 1.313890e+03 1.738882e+03 1.857934e+02 1.734936e+03
## [2901] 1.644620e+03 1.463214e+03 1.139112e+03 1.369682e+03 1.145880e+02
## [2906] 1.315420e+01 6.913178e+02 5.327722e+01 4.291583e+02 3.771352e+02
```

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## [2911] 3.782736e+02 3.419556e+02 1.186938e+02 1.274746e+02 1.112274e+02
## [2916] 9.556485e+02 8.399279e+02 7.136356e+02 6.582412e+01 3.256786e+02
## [2921] 3.969982e+02 4.147962e+02 4.447658e+02 4.543667e+02 4.533512e+02
## [2926] 5.734834e+01 5.485873e+02 5.473589e+02

lifeExpec_final$GDP_log <- log(lifeExpec_final$GDP)


# Replace HIV.AIDS's NA with its mean then log transform
summary(lifeExpec_final$HIV.AIDS)

##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##   0.100   0.100   0.100   1.748   0.800  50.600

lifeExpec_final$HIV.AIDS[is.na(lifeExpec_final$HIV.AIDS)]<-mean(lifeExpec_final$HIV.AIDS,na.rm=TRUE)
lifeExpec_final$HIV.AIDS

##    [1]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   [15]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   [29]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   [43]  0.1  0.1  0.1  0.1  0.1  0.1  1.9  2.0  2.3  2.6  2.5  2.5  2.5  2.6
##   [57]  2.6  2.5  2.6  2.5  2.4  2.3  2.1  2.0  0.2  0.2  0.2  0.2  0.1  0.1
##   [71]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   [85]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##   [99]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [113]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [127]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [141]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [155]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.1  0.2  0.1  0.1
##  [169]  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [183]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [197]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [211]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.4  0.8  0.7  0.9
##  [225]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [239]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [253]  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.1  0.5  0.2  0.3  0.1  0.6  0.6
##  [267]  0.8  0.8  1.5  0.1  0.4  0.3  1.0  1.1  1.2  1.3  1.4  1.4  1.6  1.8
##  [281]  2.0  2.0  2.1  2.1  2.1  2.1  2.1  2.0  0.5  0.5  0.6  0.6  0.5  0.5
##  [295]  0.4  0.4  0.3  0.3  0.3  0.3  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [309]  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.1  0.1  0.1  0.1  0.1
##  [323]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [337]  2.2  2.3  2.8  4.4  5.5  6.2  9.0 12.7 13.4 14.4 20.6 28.4 31.9 34.6
##  [351] 37.2 38.8  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [365]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [379]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [393]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.6  0.6  0.7  0.8  0.9  1.0
##  [407]  1.1  1.5  1.7  2.0  2.3  2.5  2.9  3.2  3.6  4.0  0.7  0.7  1.0  1.2
##  [421]  1.5  1.9  2.4  2.9  3.4  3.8  4.3  4.8  5.1  5.2  5.3  5.2  1.9  2.0
##  [435]  2.4  2.9  3.3  3.3  3.7  4.1  5.3  5.8  6.1  6.5  6.7  6.9  7.0  7.1
##  [449]  0.2  0.2  0.2  0.3  0.3  0.4  0.4  0.4  0.6  0.6  0.8  0.8  0.9  0.8
##  [463]  0.8  0.8  0.2  0.2  0.2  0.3  0.3  0.5  0.6  0.7  0.9  1.1  1.4  1.7
##  [477]  1.9  2.1  2.2  2.1  3.5  3.7  4.0  4.6  4.9  5.5  6.3  6.7  7.0  7.2
##  [491]  7.4  7.5  7.7  7.8  7.9  7.7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [505]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  4.4  4.5  5.1  5.1  5.8  6.6
##  [519]  7.3  8.3  9.0 10.0 11.2 12.0 12.8 13.4 13.9 14.3  2.8  2.9  3.1  3.6
##  [533]  3.9  4.1  4.4  4.7  4.9  5.1  5.2  5.2  5.1  5.0  4.8  4.6  0.1  0.1
##  [547]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [561]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [575]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [589]  0.1  0.1  0.1  0.1  0.8  0.8  0.8  0.8  0.2  0.1  0.1  0.1  0.1  0.1
##  [603]  0.1  0.1  0.1  0.1  0.1  0.1  2.8  3.0  3.0  3.3  3.5  3.8  4.0  4.3
##  [617]  5.0  5.5  5.9  6.3  6.8  7.2  7.6  7.8  0.1  0.1  0.1  0.1  0.1  0.1
##  [631]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [645]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [659]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [673]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
```

```
##  [687]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [701]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [715]  0.1  0.1  0.1  0.1  0.1  0.1  1.1  1.1  1.2  1.5  1.6  1.6  1.7  1.8
##  [729]  1.9  2.0  2.0  2.1  2.2  2.4  2.4  2.5  0.1  0.1  0.1  0.1  0.1  0.1
##  [743]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  2.1  2.1  2.1  1.9
##  [757]  2.7  3.1  3.2  3.3  3.5  3.7  3.9  4.0  4.2  4.3  4.3  4.1  0.3  0.3
##  [771]  0.3  0.4  0.7  0.9  1.2  1.4  1.6  1.8  2.0  2.1  2.3  2.4  2.5  2.5
##  [785]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.3  0.3  0.3  0.3  0.3
##  [799]  0.3  0.3  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [813]  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.3  0.3  0.3  0.3  0.3  0.3  0.2
##  [827]  0.2  0.3  0.3  0.4  0.4  0.4  4.2  4.4  5.7  8.2  7.7  7.2  7.3  6.3
##  [841]  5.9  5.3  4.9  4.4  3.6  2.9  2.3  1.9  0.4  0.4  0.5  0.6  0.7  0.9
##  [855]  1.0  1.1  1.3  1.4  1.6  1.8  1.9  1.9  2.0  1.9  0.1  0.1  0.1  0.1
##  [869]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.6  0.6
##  [883]  0.9  1.2  1.4  1.7  2.0  2.4  2.8  3.3  3.7  4.1  4.4  4.6  4.9  5.0
##  [897]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [911]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [925]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [939]  0.1  0.1  0.1  0.1  0.1  0.1  2.7  2.8  3.7  4.9  6.0  7.0  8.0  8.9
##  [953] 10.0 10.7 10.9 11.1 11.0 10.7 10.1  9.5  1.7  1.7  1.6  1.4  1.8  2.1
##  [967]  2.7  3.0  3.1  3.0  3.0  2.9  2.7  2.5  2.3  2.0  0.1  0.1  0.1  0.1
##  [981]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
##  [995]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1009]  0.7  0.8  0.9  0.9  1.3  1.9  2.1  2.2  2.6  2.9  3.1  3.2  3.4  3.5
## [1023]  3.5  3.6  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1037]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1051]  0.1  0.1  0.1  0.1  0.1  0.1  0.4  0.4  0.4  0.4  0.4  0.4  0.4  0.4
## [1065]  0.4  0.4  0.4  0.4  0.4  0.3  0.3  0.2  0.5  0.5  1.0  1.9  2.0  2.2
## [1079]  2.3  2.3  2.4  2.6  2.7  2.8  2.9  3.0  3.0  3.0  3.2  3.4  4.5  5.3
## [1093]  5.7  5.9  6.0  6.0  5.7  5.6  5.4  5.0  4.6  4.1  3.6  3.1  0.3  0.3
## [1107]  0.3  0.3  0.4  0.4  0.3  0.8  1.9  1.1  1.8  1.9  2.1  2.3  1.7  1.1
## [1121]  0.5  0.5  0.5  0.8  1.5  1.9  2.0  2.4  2.7  3.3  3.9  4.3  4.6  4.8
## [1135]  5.0  5.1  0.3  0.3  0.4  0.4  0.4  0.4  0.5  0.6  0.7  0.8  0.9  1.2
## [1149]  1.4  1.5  1.6  1.7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1163]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1177]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.2  0.2  0.2
## [1191]  0.2  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3
## [1205]  0.3  0.3  0.3  0.2  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1219]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1233]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1247]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1261]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1275]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1289]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.5  0.5  0.6  0.5  0.6  0.5
## [1303]  0.6  0.4  0.9  1.5  1.9  2.3  2.3  2.3  2.2  2.2  0.1  0.1  0.1  0.1
## [1317]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1331]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1345]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1359]  0.1  0.1  2.8  2.9  3.0  3.0  3.4  4.3  5.0  6.4  9.1 10.3 11.6 13.2
## [1373] 14.5 15.7 16.9 18.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1387]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1401]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.1
## [1415]  0.1  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.3  0.3
## [1429]  0.3  0.3  0.2  0.2  0.2  0.2  0.2  0.2  0.1  0.1  0.1  0.1  0.1  0.1
## [1443]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1457]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1471]  0.1  0.1  9.3  9.4  9.6  9.0 10.5 13.4 18.2 27.3 30.0 34.1 34.8 34.6
## [1485] 33.8 32.5 31.2 29.8  0.9  0.9  1.1  1.2  1.5  1.8  2.1  2.4  2.8  3.0
## [1499]  3.1  3.2  3.2  3.1  3.1  3.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1513]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1527]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1541]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.3  0.3
## [1555]  0.4  0.4  0.4  0.5  0.5  0.5  0.6  0.6  0.6  0.6  0.7  0.7  0.7  0.6
## [1569]  4.8  5.1  6.3  8.3 11.2 13.7 14.9 16.9 19.3 21.1 22.4 23.4 24.2 24.7
## [1583] 25.1 25.5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1597]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
```

```
## [1611]  0.1  0.1  0.1  0.1  0.1  0.1  1.5  1.6  1.6  1.5  1.5  1.5  1.6  1.6
## [1625]  1.7  1.8  1.9  2.0  2.2  2.3  2.4  2.5  0.1  0.1  0.1  0.1  0.1  0.1
## [1639]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.9  0.9  1.1  1.2
## [1653]  1.2  1.2  1.2  1.3  1.3  1.3  1.3  1.3  1.3  1.2  1.2  1.1  0.1  0.1
## [1667]  0.1  0.1  0.1  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1681]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1695]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1709]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1723]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1737]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1751]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  3.9  4.1  5.1  6.9
## [1765]  9.6 10.8 11.3 12.6 14.1 16.3 16.2 15.9 15.3 14.5 13.4 12.2  0.3  0.3
## [1779]  0.4  0.5  0.5  0.5  0.6  0.6  0.6  0.6  0.5  0.5  0.5  0.4  0.4  0.4
## [1793]  2.1  2.2  2.5  3.7  4.7  6.2  8.7 11.7 15.2 19.2 22.1 24.0 24.7 24.6
## [1807] 23.9 22.8  0.1  0.1  0.1  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.2
## [1821]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1835]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1849]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1863]  0.2  0.2  0.2  0.3  0.3  0.3  0.3  0.4  0.4  0.4  0.4  0.5  0.6  0.7
## [1877]  0.7  0.9  1.1  1.3  1.4  1.5  1.6  1.6  1.6  1.6  1.6  1.5  3.7  3.9
## [1891]  3.9  4.4  4.7  4.8  4.9  5.0  5.2  5.3  5.4  5.4  5.4  5.3  5.1  4.9
## [1905]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1919]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1933]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1947]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [1961]  0.2  0.1  0.1  0.2  0.1  0.2  0.1  0.2  0.6  0.7  0.8  1.0  1.0  1.1
## [1975]  1.1  1.3  1.4  1.5  1.5  1.5  1.4  1.4  1.3  1.1  0.2  0.2  0.2  0.1
## [1989]  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.1  0.1  0.1  0.1  0.1  0.1
## [2003]  0.1  0.1  0.2  0.2  0.3  0.3  0.3  0.4  0.4  0.4  0.4  0.4  0.5  0.5
## [2017]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2031]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2045]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2059]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2073]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2087]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2101]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2115]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2129]  0.1  0.1  0.2  0.3  0.3  0.2  0.3  0.3  0.3  0.3  0.3  0.3  0.4  0.3
## [2143]  0.3  0.2  0.4  0.4  0.5  0.7  1.3  2.3  2.8  3.7  5.0  6.2  7.1  7.7
## [2157]  8.1  8.0  8.1  8.5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2171]  0.2  0.2  0.2  0.1  0.3  0.4  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.3
## [2185]  0.3  0.3  0.2  0.4  0.4  0.4  0.7  0.7  0.1  0.1  0.1  0.1  0.1  0.1
## [2199]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.5
## [2213]  0.5  0.5  0.9  0.9  1.2  1.2  1.6  1.6  1.6  1.4  1.5  1.5  0.1  0.1
## [2227]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2241]  0.3  0.3  0.3  0.4  0.4  0.4  0.5  0.6  0.7  0.7  0.7  0.7  0.7  0.7
## [2255]  0.6  0.5  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2269]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2283]  0.1  0.1  0.1  0.1  0.1  0.1  0.5  0.6  0.8  0.9  1.3  1.6  1.7  1.9
## [2297]  2.2  2.2  2.2  2.1  1.9  1.7  1.5  1.2  0.1  0.1  0.1  0.1  0.1  0.1
## [2311]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2325]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2339]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2353]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2367]  0.1  0.1  0.7  0.8  0.8  0.8  0.8  0.8  0.8  0.9  0.9  0.9  0.9  0.9
## [2381]  0.9  0.9  0.8  0.8  3.6  3.7  4.5  7.6  8.5 11.0 19.0 23.5 26.4 28.1
## [2395] 29.5 29.7 28.9 26.6 24.0 21.3  3.4  3.5  3.6  3.8  3.9  4.0  4.2  4.2
## [2409]  4.2  4.1  3.9  3.8  3.5  3.3  3.0  2.7  0.1  0.1  0.1  0.1  0.1  0.1
## [2423]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2437]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.3  0.3
## [2451]  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.2  0.2  0.2  0.2  0.2  0.2  0.1
## [2465]  0.4  0.4  0.4  0.9  0.1  0.5  0.6  1.2  0.8  0.6  0.6  0.9  1.0  1.6
## [2479]  1.8  0.4  7.1  7.3  9.8 12.2 15.7 21.6 33.7 40.2 40.7 43.7 49.1 50.3
## [2493] 50.6 49.9 48.8 46.4  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2507]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2521]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
```

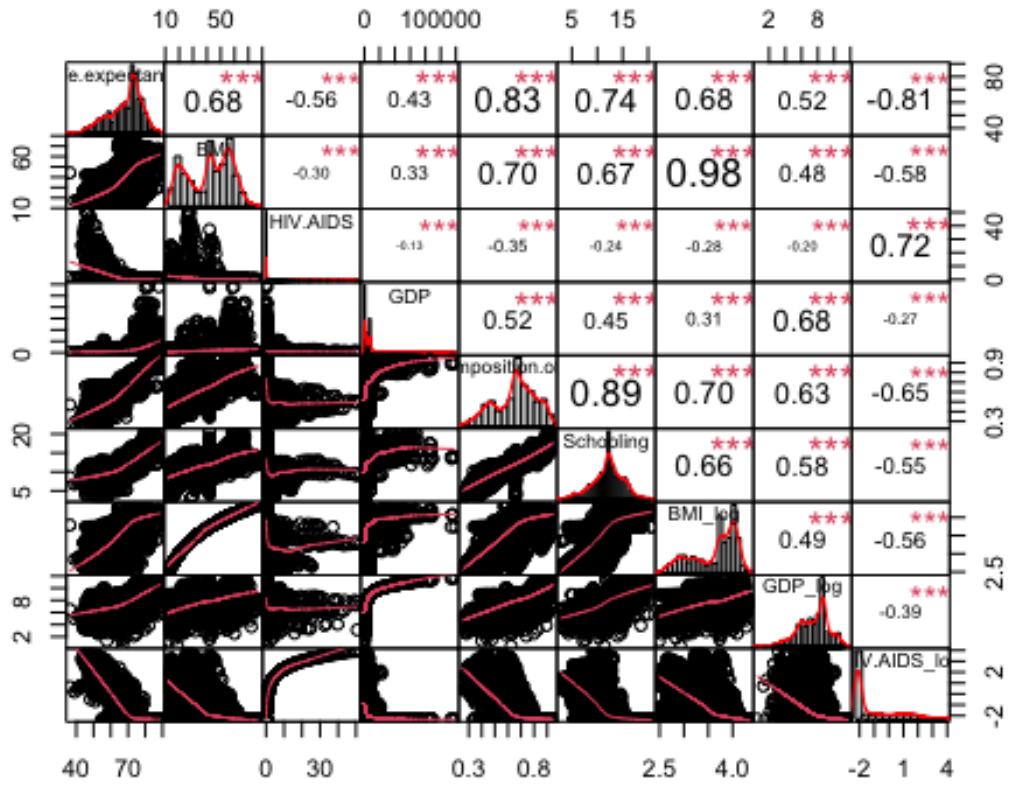
```
## [2535]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.2  0.2
## [2549]  0.2  0.2  0.2  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.3  0.1  0.1
## [2563]  0.1  0.1  0.2  0.2  0.3  0.3  0.4  0.5  0.5  0.5  0.6  0.7  0.8  0.8
## [2577]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2591]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2605]  0.1  0.1  0.1  0.1  1.0  1.0  1.5  1.7  2.6  3.8  4.3  4.8  5.1  5.0
## [2619]  5.0  5.1  5.2  5.3  5.3  5.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2633]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.3  0.3  0.3  0.4  0.4  0.4
## [2647]  0.2  0.3  0.7  0.6  0.5  1.0  0.5  2.0  1.2  0.9  0.1  0.1  0.1  0.1
## [2661]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2675]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2689]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2703]  0.1  0.1  3.1  3.2  4.0  4.6  6.8  8.0  8.1  8.2  8.4  8.6  8.7  8.9
## [2717]  9.4 10.0 10.8 11.6  0.2  0.2  0.2  0.2  0.2  0.2  0.3  0.4  0.7  0.8
## [2731]  0.9  1.0  0.9  0.9  0.8  0.7  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2745]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2759]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  1.4  1.4  2.1  2.4
## [2773]  3.1  4.6  6.4  7.4  8.5  9.4 10.0 10.8 11.5 12.1 12.5 12.8  0.1  0.1
## [2787]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2801]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2815]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.2  0.2  0.3  0.3  0.4  0.3  0.3
## [2829]  0.3  0.2  0.2  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2843]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2857]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1
## [2871]  0.1  0.2  0.2  0.2  0.2  0.2  0.2  0.2  0.1  0.1  0.1  0.1  0.1  0.1
## [2885]  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  0.1  4.1  4.3
## [2899]  4.8  5.6  6.3  6.8  9.1 11.9 13.6 15.9 17.0 17.6 18.2 18.4 18.6 18.7
## [2913]  6.2  6.3  6.8  8.8 13.3 15.7 18.1 20.5 23.7 26.8 30.3 33.6 36.7 39.8
## [2927] 42.1 43.5

lifeExpec_final$HIV.AIDS_log <- log(lifeExpec_final$HIV.AIDS)
```

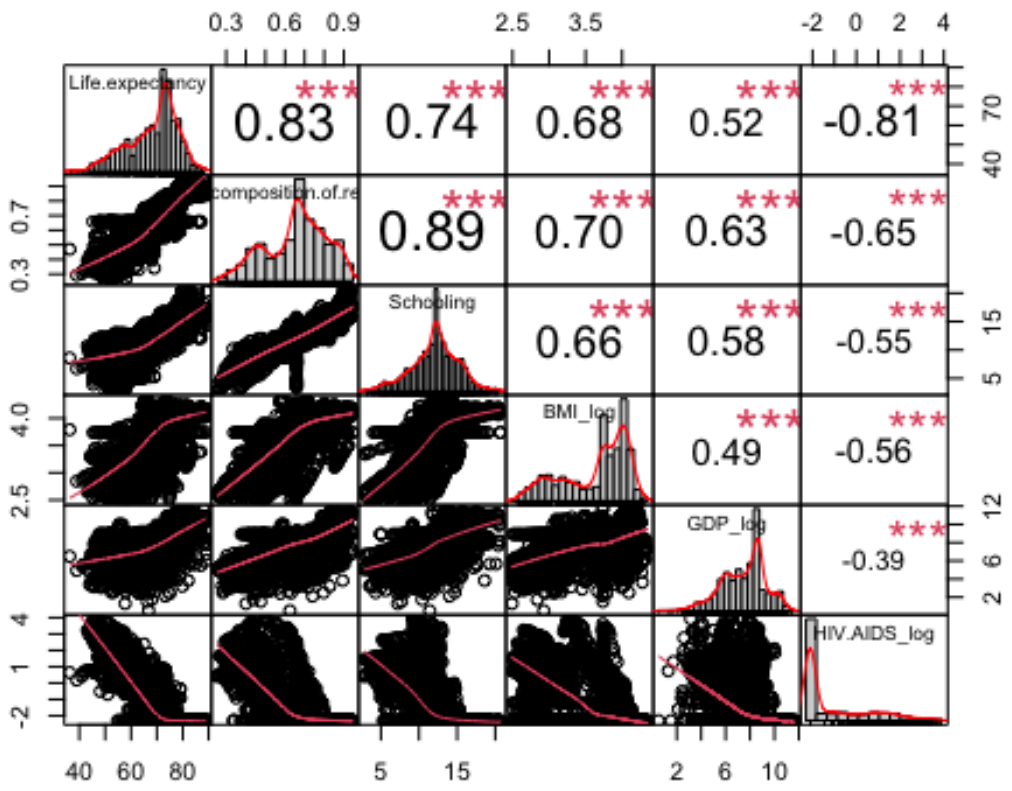
Correlation plot for final dataset and VIF value

```
# Plot correlation chart for final dataset numerical variables

## Original variables before transformation included
lifeExpec_final_numCol_Orig <- subset(lifeExpec_final, select = -c(Status, continent))
chart.Correlation(lifeExpec_final_numCol_Orig, histogram=TRUE, pch=19)
```




```r
## Remove unlog BMI, GDP, and HIV.AIDS
lifeExpec_final_numCol <- subset(lifeExpec_final, select = -c(Status, continent, BMI, GDP, HIV.AIDS))
chart.Correlation(lifeExpec_final_numCol, histogram=TRUE, pch=19)
```




```
lifeExpec_final <- subset(lifeExpec_final, select = -c(BMI, GDP, HIV.AIDS))
summary(lifeExpec_final)
```

```
##     Status          Life.expectancy Income.composition.of.resources
##  Length:2928        Min.   :36.30   Min.   :0.2530
##  Class :character   1st Qu.:63.10   1st Qu.:0.5540
##  Mode  :character   Median :72.10   Median :0.6620
##                     Mean   :69.22   Mean   :0.6583
##                     3rd Qu.:75.70   3rd Qu.:0.7730
##                     Max.   :89.00   Max.   :0.9480
##    Schooling      continent           BMI_log         GDP_log
##  Min.   : 2.80   Length:2928        Min.   :2.485   Min.   : 0.5196
##  1st Qu.:10.38   Class :character   1st Qu.:3.246   1st Qu.: 6.3609
##  Median :12.11   Mode  :character   Median :3.761   Median : 8.0432
##  Mean   :12.11                      Mean   :3.638   Mean   : 7.6878
##  3rd Qu.:14.10                      3rd Qu.:4.027   3rd Qu.: 8.9219
##  Max.   :20.70                      Max.   :4.352   Max.   :11.6883
##   HIV.AIDS_log
##  Min.   :-2.3026
##  1st Qu.:-2.3026
##  Median :-2.3026
##  Mean   :-1.2183
##  3rd Qu.:-0.2231
##  Max.   : 3.9240
```

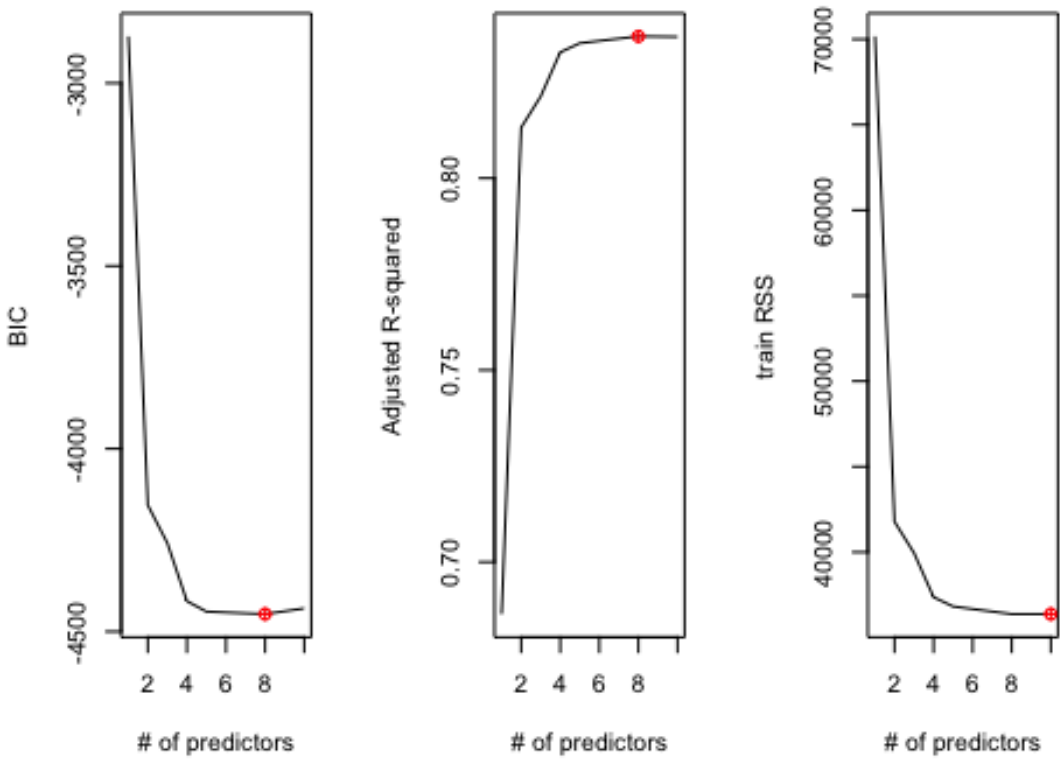
```
# VIF for selected variables
## Refer to GVIF^(1/(2*Df)), Income_comp shows the highest VIF = 2.77, follows by Schooling at 2.33.
## Other variables shows VIF between 1.26 - 1.69
full.model <- lm(Life.expectancy~., data = lifeExpec_final)
vif(full.model)
```

```
##                                     GVIF Df GVIF^(1/(2*Df))
## Status                          2.105181  1        1.450924
## Income.composition.of.resources 7.655455  1        2.766849
```

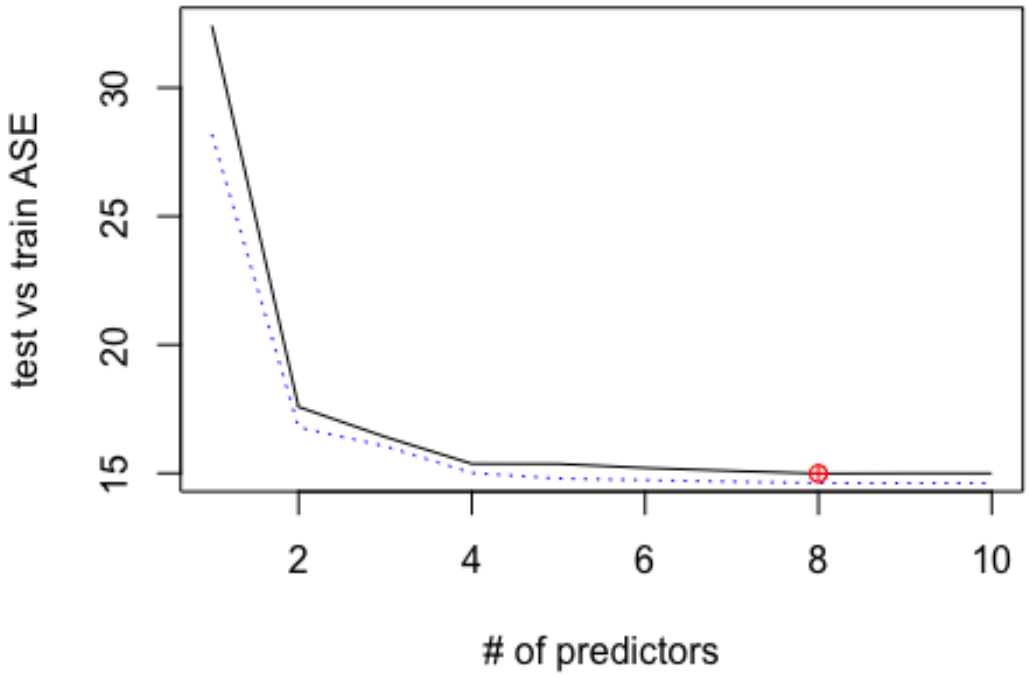
```
## Schooling                       5.431457  1        2.330549
## continent                       6.174644  4        1.255528
## BMI_log                         2.630606  1        1.621914
## GDP_log                         1.710327  1        1.307795
## HIV.AIDS_log                    2.859684  1        1.691060

set.seed(7)
splitPerc = .85
trainIndices = sample(1:dim(lifeExpec_final)[1],round(splitPerc * dim(lifeExpec_final)[1]))
train = lifeExpec_final[trainIndices,]
test = lifeExpec_final[-trainIndices,]
```

Build Simple Multiple Linear Regression Models

```
#model1 <- lm(Life.expectancy ~ Status + continent + Income.composition.of.resources + Schooling + BMI_log +
GDP_log + HIV.AIDS_log, data = train)

model.fwd = regsubsets(Life.expectancy~.,data=train, method="forward", nvmax=10)

summary(model.fwd)$adjr2

##  [1] 0.6864399 0.8131832 0.8213125 0.8328051 0.8351690 0.8357808 0.8363717
##  [8] 0.8369654 0.8369035 0.8368390

summary(model.fwd)$rss

##  [1] 70167.07 41788.21 39953.73 37368.98 36825.81 36674.34 36527.67 36380.46
##  [9] 36379.60 36379.30

summary(model.fwd)$bic

##  [1] -2872.014 -4154.156 -4258.073 -4416.720 -4445.344 -4447.784 -4449.938
##  [8] -4452.170 -4444.409 -4436.610

par(mfrow=c(1,3))
bics<-summary(model.fwd)$bic
plot(1:10,bics,type="l",ylab="BIC",xlab="# of predictors")
index<-which(bics==min(bics))
points(index,bics[index],col="red",pch=10)

adjr2<-summary(model.fwd)$adjr2
plot(1:10,adjr2,type="l",ylab="Adjusted R-squared",xlab="# of predictors")
index<-which(adjr2==max(adjr2))
points(index,adjr2[index],col="red",pch=10)

rss<-summary(model.fwd)$rss
plot(1:10,rss,type="l",ylab="train RSS",xlab="# of predictors")
index<-which(rss==min(rss))
points(index,rss[index],col="red",pch=10)
```



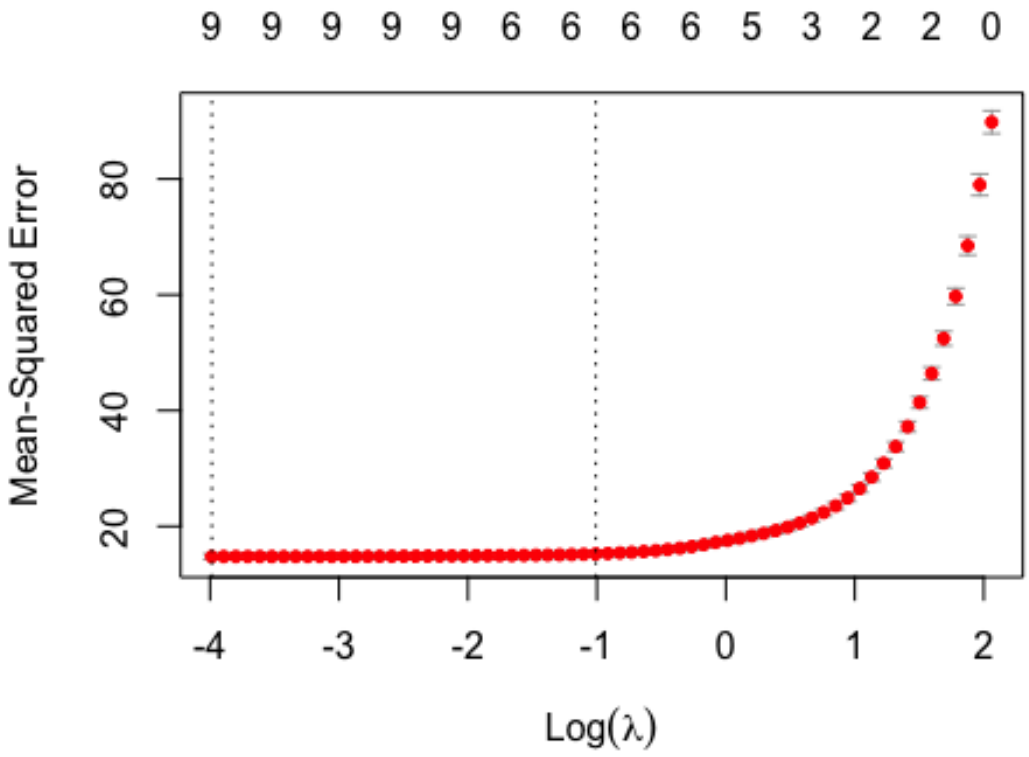

```
predict.regsubsets =function (object , newdata ,id ,...){
  form=as.formula (object$call [[2]])
  mat=model.matrix(form ,newdata)
  coefi=coef(object ,id=id)
  xvars=names(coefi)
  mat[,xvars]%*%coefi
}

testASE<-c()
#note my index is to 20 since that what I set it in regsubsets
for (i in 1:10){
  predictions <-predict.regsubsets(object=model.fwd,newdata=test,id=i)
  testASE[i]<-mean((test$Life.expectancy-predictions)^2)
}

par(mfrow=c(1,1))
plot(1:10,testASE,type="l",xlab="# of predictors",ylab="test vs train ASE")
index<-which(testASE==min(testASE))
points(index,testASE[index],col="red",pch=10)
rss<-summary(model.fwd)$rss
lines(1:10,rss/2489,lty=3,col="blue")  #Dividing by 100 since ASE=RSS/sample size
```




```
coef(model.fwd,8)

##                      (Intercept)                StatusDeveloping
##                       46.6054768                      -3.0958074
## Income.composition.of.resources                       Schooling
##                       19.5325569                       0.2155874
##                continentAmericas                   continentAsia
##                        3.4329479                       1.1371771
##                  continentEurope                         BMI_log
##                        1.0149562                       1.5071876
##                     HIV.AIDS_log
##                       -2.5741339

forward.final <-lm(Life.expectancy~Status+Income.composition.of.resources+Schooling+continent+BMI_log+HIV.AID
S_log, data= lifeExpec_final)

summary(forward.final)

##
## Call:
## lm(formula = Life.expectancy ~ Status + Income.composition.of.resources +
##     Schooling + continent + BMI_log + HIV.AIDS_log, data = lifeExpec_final)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -25.6374  -2.2019   0.2547   2.1975  15.8103
##
## Coefficients:
##                                 Estimate Std. Error t value Pr(>|t|)
## (Intercept)                     46.67572    0.78491  59.466  < 2e-16 ***
## StatusDeveloping                -3.08664    0.26959 -11.449  < 2e-16 ***
## Income.composition.of.resources 19.14419    1.23391  15.515  < 2e-16 ***
## Schooling                        0.24018    0.05418   4.433 9.62e-06 ***
## continentAmericas                3.49645    0.27905  12.530  < 2e-16 ***
```

```
## continentAsia                    1.14281    0.27201   4.201 2.73e-05 ***
## continentEurope                  0.97855    0.34180   2.863  0.00423 **
## continentOceania                -0.18630    0.39872  -0.467  0.64036
## BMI_log                          1.44535    0.24047   6.011 2.08e-09 ***
## HIV.AIDS_log                    -2.62897    0.07424 -35.412  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.836 on 2918 degrees of freedom
## Multiple R-squared:  0.8383, Adjusted R-squared:  0.8378
## F-statistic:  1681 on 9 and 2918 DF,  p-value: < 2.2e-16
```

```
x=model.matrix(Life.expectancy~.,train)[,-1]
y=train$Life.expectancy

xtest<-model.matrix(Life.expectancy~.,test)[,-1]
ytest<-test$Life.expectancy


grid=10^seq(10,-2, length =100)
lasso.mod=glmnet(x,y,alpha=1, lambda =grid)

cv.out=cv.glmnet(x,y,alpha=1) #alpha=1 performs LASSO
plot(cv.out)
```




```
bestlambda<-cv.out$lambda.min  #Optimal penalty parameter.  You can make this call visually.
lasso.pred=predict (lasso.mod ,s=bestlambda ,newx=xtest)

testMSE_LASSO<-mean((ytest-lasso.pred)^2)
testMSE_LASSO
```

```
## [1] 15.02061
```

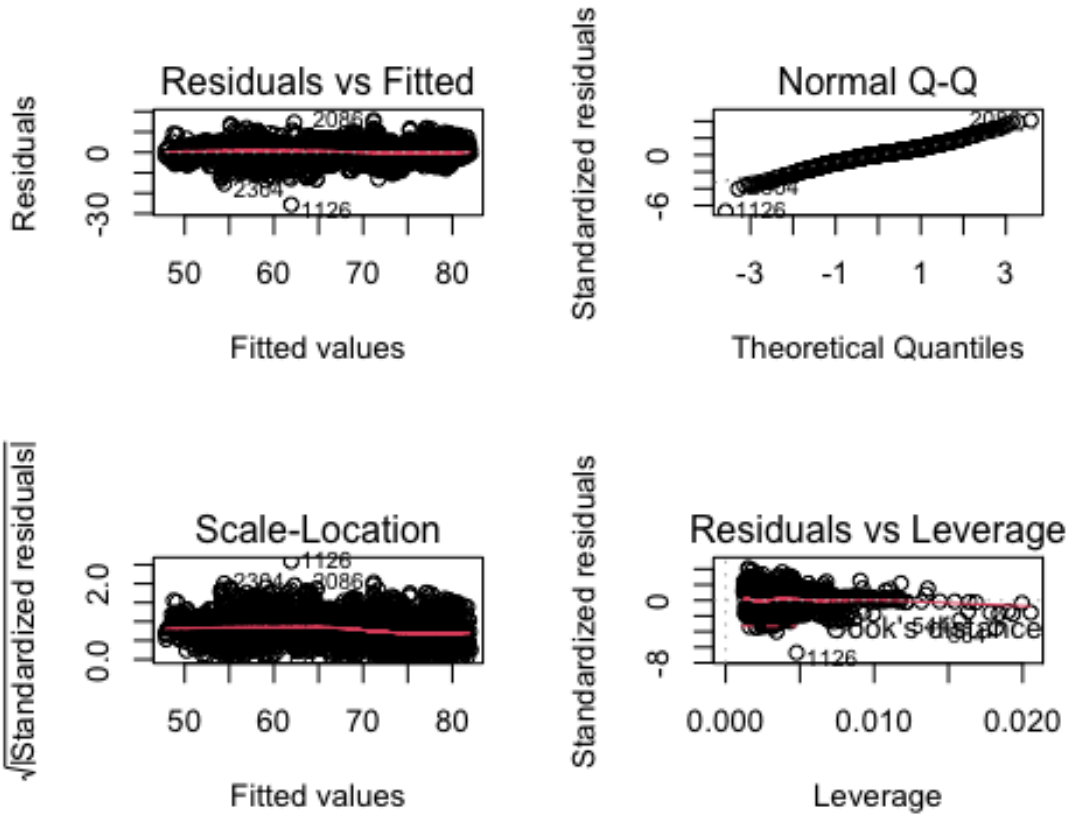
```r
coef(lasso.mod,s=bestlambda)
```

```
## 11 x 1 sparse Matrix of class "dgCMatrix"
##                                        1
## (Intercept)                    46.64029783
## StatusDeveloping               -3.05610765
## Income.composition.of.resources 19.77090480
## Schooling                       0.20978999
## continentAmericas               3.24710386
## continentAsia                   0.94585317
## continentEurope                 0.83162798
## continentOceania               -0.09025952
## BMI_log                         1.49178345
## GDP_log                         .
## HIV.AIDS_log                   -2.59772732
```

```r
lasso.final <- lm(Life.expectancy~Status+Income.composition.of.resources+Schooling+continent+BMI_log+HIV.AIDS
_log, data= lifeExpec_final)

summary(lasso.final)
```

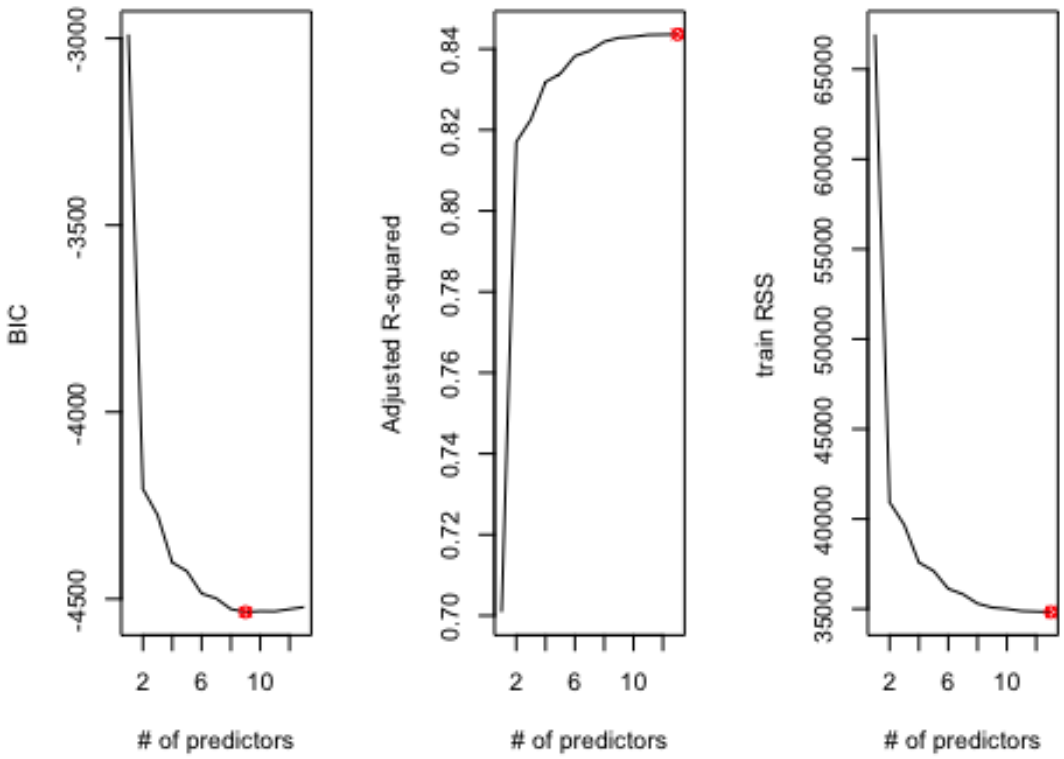
```
##
## Call:
## lm(formula = Life.expectancy ~ Status + Income.composition.of.resources +
##     Schooling + continent + BMI_log + HIV.AIDS_log, data = lifeExpec_final)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -25.6374  -2.2019   0.2547   2.1975  15.8103
##
## Coefficients:
##                                Estimate Std. Error t value Pr(>|t|)
## (Intercept)                    46.67572    0.78491  59.466  < 2e-16 ***
## StatusDeveloping               -3.08664    0.26959 -11.449  < 2e-16 ***
## Income.composition.of.resources 19.14419    1.23391  15.515  < 2e-16 ***
## Schooling                       0.24018    0.05418   4.433 9.62e-06 ***
## continentAmericas               3.49645    0.27905  12.530  < 2e-16 ***
## continentAsia                   1.14281    0.27201   4.201 2.73e-05 ***
## continentEurope                 0.97855    0.34180   2.863  0.00423 **
## continentOceania               -0.18630    0.39872  -0.467  0.64036
## BMI_log                         1.44535    0.24047   6.011 2.08e-09 ***
## HIV.AIDS_log                   -2.62897    0.07424 -35.412  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.836 on 2918 degrees of freedom
## Multiple R-squared:  0.8383, Adjusted R-squared:  0.8378
## F-statistic:  1681 on 9 and 2918 DF,  p-value: < 2.2e-16
```

```r
par(mfrow=c(2,2))
plot(lasso.final)
```

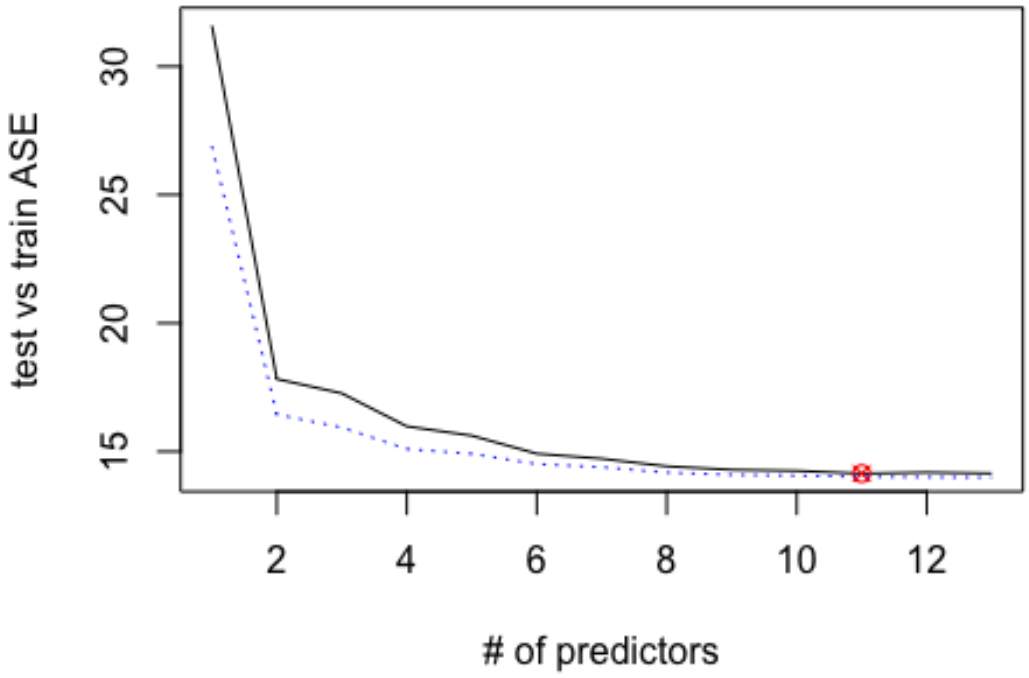



```
lifeExpec_final[1126,]

## # A tibble: 1 x 8
##   Status  Life.expectancy Income.compositio… Schooling continent BMI_log GDP_log
##   <chr>             <dbl>              <dbl>     <dbl> <chr>       <dbl>   <dbl>
## 1 Develo…            36.3               0.47       8.6 Americas     3.79    6.50
## # … with 1 more variable: HIV.AIDS_log <dbl>

lifeExpec_final[544,]

## # A tibble: 1 x 8
##   Status  Life.expectancy Income.compositio… Schooling continent BMI_log GDP_log
##   <chr>             <dbl>              <dbl>     <dbl> <chr>       <dbl>   <dbl>
## 1 Develo…            47.6              0.658       4.7 Africa       2.63    5.11
## # … with 1 more variable: HIV.AIDS_log <dbl>

lifeExpec_final[864,]

## # A tibble: 1 x 8
##   Status  Life.expectancy Income.compositio… Schooling continent BMI_log GDP_log
##   <chr>             <dbl>              <dbl>     <dbl> <chr>       <dbl>   <dbl>
## 1 Develo…            45.3              0.658       3.9 Africa       2.53    3.34
## # … with 1 more variable: HIV.AIDS_log <dbl>

lifeExpec[1126,]

## # A tibble: 1 x 24
## # Groups:   Country [1]
##   Country  Year Status     Life.expectancy Adult.Mortality infant.deaths Alcohol
##   <chr>   <int> <chr>                <dbl>           <int>         <int>   <dbl>
## 1 Haiti    2010 Developing            36.3             682            23    5.76
## # … with 17 more variables: percentage.expenditure <dbl>, Hepatitis.B <int>,
## #   Measles <int>, BMI <dbl>, under.five.deaths <int>, Polio <int>,
## #   Total.expenditure <dbl>, Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>,
```

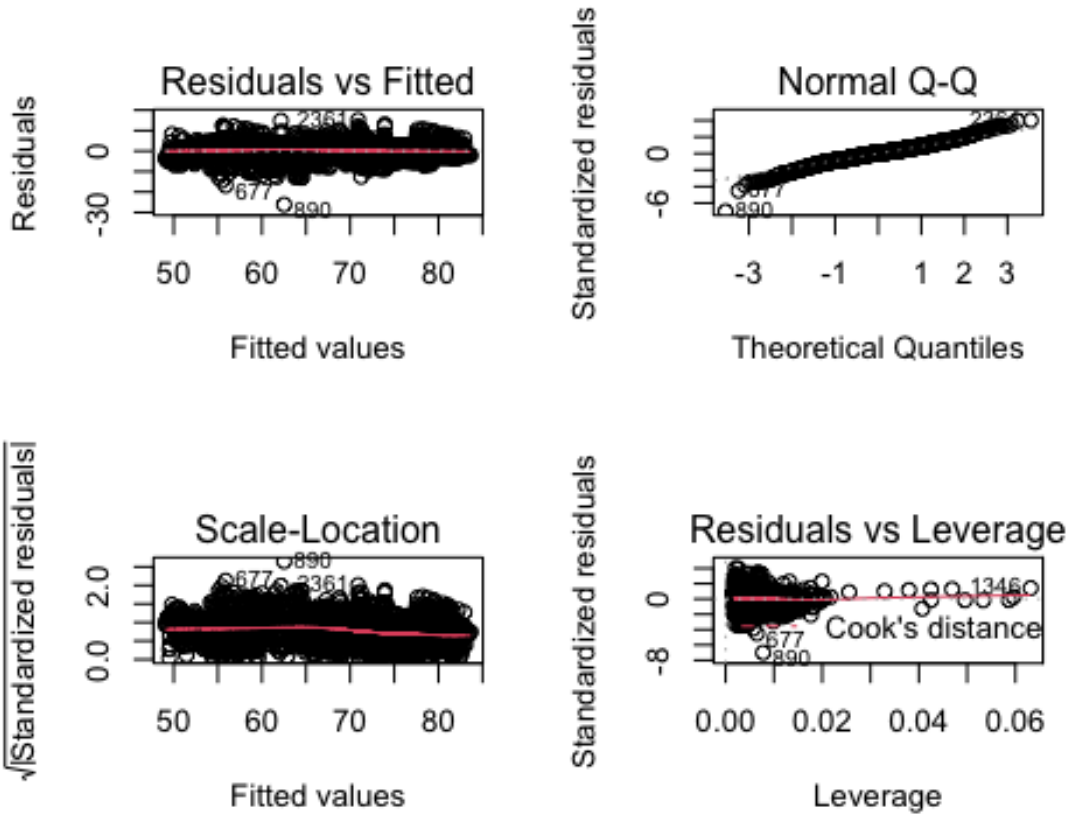
```
## #   Population <dbl>, thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>, continent <chr>,
## #   CountrytoMatch <chr>

lifeExpec[544,]

## # A tibble: 1 x 24
## # Groups:   Country [1]
##   Country  Year Status     Life.expectancy Adult.Mortality infant.deaths Alcohol
##   <chr>   <int> <chr>                <dbl>           <int>         <int>   <dbl>
## 1 Chad     2000 Developing            47.6              44            41    0.25
## # … with 17 more variables: percentage.expenditure <dbl>, Hepatitis.B <int>,
## #   Measles <int>, BMI <dbl>, under.five.deaths <int>, Polio <int>,
## #   Total.expenditure <dbl>, Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>,
## #   Population <dbl>, thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>, continent <chr>,
## #   CountrytoMatch <chr>

lifeExpec[864,]

## # A tibble: 1 x 24
## # Groups:   Country [1]
##   Country  Year Status     Life.expectancy Adult.Mortality infant.deaths Alcohol
##   <chr>   <int> <chr>                <dbl>           <int>         <int>   <dbl>
## 1 Eritrea  2000 Developing            45.3              593             7    0.83
## # … with 17 more variables: percentage.expenditure <dbl>, Hepatitis.B <int>,
## #   Measles <int>, BMI <dbl>, under.five.deaths <int>, Polio <int>,
## #   Total.expenditure <dbl>, Diphtheria <int>, HIV.AIDS <dbl>, GDP <dbl>,
## #   Population <dbl>, thinness..1.19.years <dbl>, thinness.5.9.years <dbl>,
## #   Income.composition.of.resources <dbl>, Schooling <dbl>, continent <chr>,
## #   CountrytoMatch <chr>

#complex model with interaction terms
fwdcpmodel1 <- regsubsets(Life.expectancy ~ Status + continent + Income.composition.of.resources + Schooling
+ BMI_log + GDP_log + HIV.AIDS_log + Income.composition.of.resources*Schooling + Income.composition.of.resour
ces*BMI_log + Income.composition.of.resources*GDP_log + Schooling*BMI_log+Schooling*GDP_log + BMI_log*GDP_log
, data = train, method = 'backward', nvmax=13)

#base check of model summary with VIF
#par(mfrow=c(2,2))
#plot(fwdcpmodel1)
#summary(fwdcpmodel1)

#plot of BIC, ADJR^2, and RSS
bicsb <- summary(fwdcpmodel1)$bic
adjr2b <- summary(fwdcpmodel1)$adjr2
rssb <- summary(fwdcpmodel1)$rss

par(mfrow=c(1,3))
plot(1:13,bicsb,type="l",ylab="BIC",xlab="# of predictors")
index<-which(bicsb==min(bicsb))
points(index,bicsb[index],col="red",pch=13)

plot(1:13,adjr2b,type="l",ylab="Adjusted R-squared",xlab="# of predictors")
index<-which(adjr2b==max(adjr2b))
points(index,adjr2b[index],col="red",pch=13)

plot(1:13,rssb,type="l",ylab="train RSS",xlab="# of predictors")
index<-which(rssb==min(rssb))
points(index,rssb[index],col="red",pch=13)
```




```r
#Cross validation function
predict.regsubsets =function (object , newdata ,id ,...){
  form=as.formula (object$call [[2]])
  mat=model.matrix(form ,newdata)
  coefi=coef(object ,id=id)
  xvars=names(coefi)
  mat[,xvars]%*%coefi
}

#test versus train
testASEb<-c()
for (i in 1:13){
  predictions <-predict.regsubsets(object=fwdcpmodel1,newdata=test,id=i)
  testASEb[i]<-mean((test$Life.expectancy-predictions)^2)
}

#test versus train graph
par(mfrow=c(1,1))
plot(1:13,testASEb,type="l",xlab="# of predictors",ylab="test vs train ASE")
index<-which(testASEb==min(testASEb))
points(index,testASEb[index],col="red",pch=13)
lines(1:13,rssb/2489,lty=3,col="blue")
```

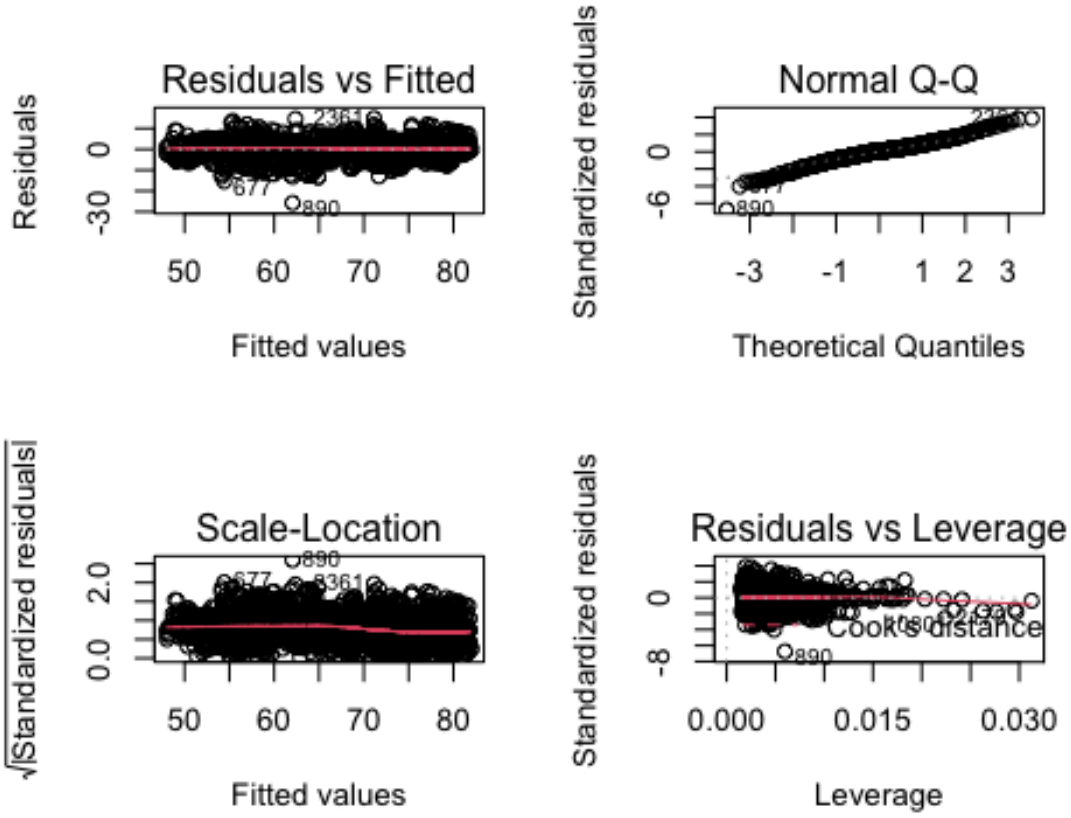



```
#8 seems to be optimum number of variables
coef(fwdcpmodel1,8)

##                                (Intercept)
##                                 56.5759918
##                           StatusDeveloping
##                                 -2.4211025
##                           continentAmericas
##                                  2.9347051
##             Income.composition.of.resources
##                                -45.9258346
##                                  Schooling
##                                  2.3990868
##                               HIV.AIDS_log
##                                 -2.7567059
## Income.composition.of.resources:Schooling
##                                  0.9680913
##   Income.composition.of.resources:BMI_log
##                                 16.9911794
##                           Schooling:BMI_log
##                                 -0.8376356

#vif check before final model
vifcheckmodel <- lm(Life.expectancy ~ Status + continent +  Income.composition.of.resources + Schooling + HIV
.AIDS_log + Income.composition.of.resources*Schooling + Income.composition.of.resources*BMI_log + Schooling*B
MI_log, data = train)

#base check of model summary with VIF
par(mfrow=c(2,2))
plot(vifcheckmodel)
```




```
summary(vifcheckmodel)

##
## Call:
## lm(formula = Life.expectancy ~ Status + continent + Income.composition.of.resources +
##     Schooling + HIV.AIDS_log + Income.composition.of.resources *
##     Schooling + Income.composition.of.resources * BMI_log + Schooling *
##     BMI_log, data = train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -26.2137  -2.2354   0.1633   2.1307  15.0978
##
## Coefficients:
##                                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)                              45.36392    2.83125  16.023  < 2e-16
## StatusDeveloping                         -2.22758    0.30496  -7.305 3.73e-13
## continentAmericas                         3.61332    0.30051  12.024  < 2e-16
## continentAsia                             1.02960    0.29643   3.473 0.000523
## continentEurope                           1.07408    0.37057   2.898 0.003783
## continentOceania                          0.36429    0.43999   0.828 0.407774
## Income.composition.of.resources         -34.23500    7.17998  -4.768 1.97e-06
## Schooling                                 2.20670    0.34944   6.315 3.19e-10
## HIV.AIDS_log                             -2.59254    0.07974 -32.513  < 2e-16
## BMI_log                                   4.65385    1.07333   4.336 1.51e-05
## Income.composition.of.resources:Schooling  1.68300    0.22415   7.508 8.31e-14
## Income.composition.of.resources:BMI_log   10.94063    2.19690   4.980 6.80e-07
## Schooling:BMI_log                         -0.90157    0.10873  -8.292  < 2e-16
##
## (Intercept)                              ***
## StatusDeveloping                         ***
## continentAmericas                        ***
## continentAsia                            ***
## continentEurope                          **
```

```
## continentOceania
## Income.composition.of.resources           ***
## Schooling                                 ***
## HIV.AIDS_log                              ***
## BMI_log                                   ***
## Income.composition.of.resources:Schooling ***
## Income.composition.of.resources:BMI_log   ***
## Schooling:BMI_log                         ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.753 on 2476 degrees of freedom
## Multiple R-squared:  0.8442, Adjusted R-squared:  0.8435
## F-statistic:  1118 on 12 and 2476 DF,  p-value: < 2.2e-16

vif(vifcheckmodel)

##                                             GVIF Df GVIF^(1/(2*Df))
## Status                                  2.383054  1        1.543714
## continent                               7.458016  4        1.285517
## Income.composition.of.resources       218.625856  1       14.786002
## Schooling                             202.708328  1       14.237567
## HIV.AIDS_log                            2.896186  1        1.701818
## BMI_log                                46.716817  1        6.834970
## Income.composition.of.resources:Schooling 121.312511  1       11.014196
## Income.composition.of.resources:BMI_log   528.450555  1       22.988052
## Schooling:BMI_log                       478.920429  1       21.884251

vifcheckmodelb <- lm(Life.expectancy ~ Status + continent +  Income.composition.of.resources + HIV.AIDS_log +
Schooling*BMI_log, data = train)

#base check of model summary with VIF
par(mfrow=c(2,2))
plot(vifcheckmodelb)
```



```r
summary(vifcheckmodelb)
```

```
##
## Call:
## lm(formula = Life.expectancy ~ Status + continent + Income.composition.of.resources +
##     HIV.AIDS_log + Schooling * BMI_log, data = train)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -25.760  -2.192   0.244   2.211  14.853
##
## Coefficients:
##                                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)                      45.57293    2.27797  20.006  < 2e-16 ***
## StatusDeveloping                 -3.11821    0.29531 -10.559  < 2e-16 ***
## continentAmericas                 3.41218    0.30467  11.200  < 2e-16 ***
## continentAsia                     1.10111    0.29902   3.682 0.000236 ***
## continentEurope                   1.01153    0.37530   2.695 0.007081 **
## continentOceania                 -0.03569    0.44514  -0.080 0.936110
## Income.composition.of.resources 19.56617    1.35754  14.413  < 2e-16 ***
## HIV.AIDS_log                     -2.57986    0.08131 -31.728  < 2e-16 ***
## Schooling                         0.31672    0.21628   1.464 0.143219
## BMI_log                           1.81334    0.67093   2.703 0.006924 **
## Schooling:BMI_log                -0.02889    0.05992  -0.482 0.629753
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.831 on 2478 degrees of freedom
## Multiple R-squared:  0.8375, Adjusted R-squared:  0.8369
## F-statistic:  1277 on 10 and 2478 DF,  p-value: < 2.2e-16
```

```r
vif(vifcheckmodelb)
```

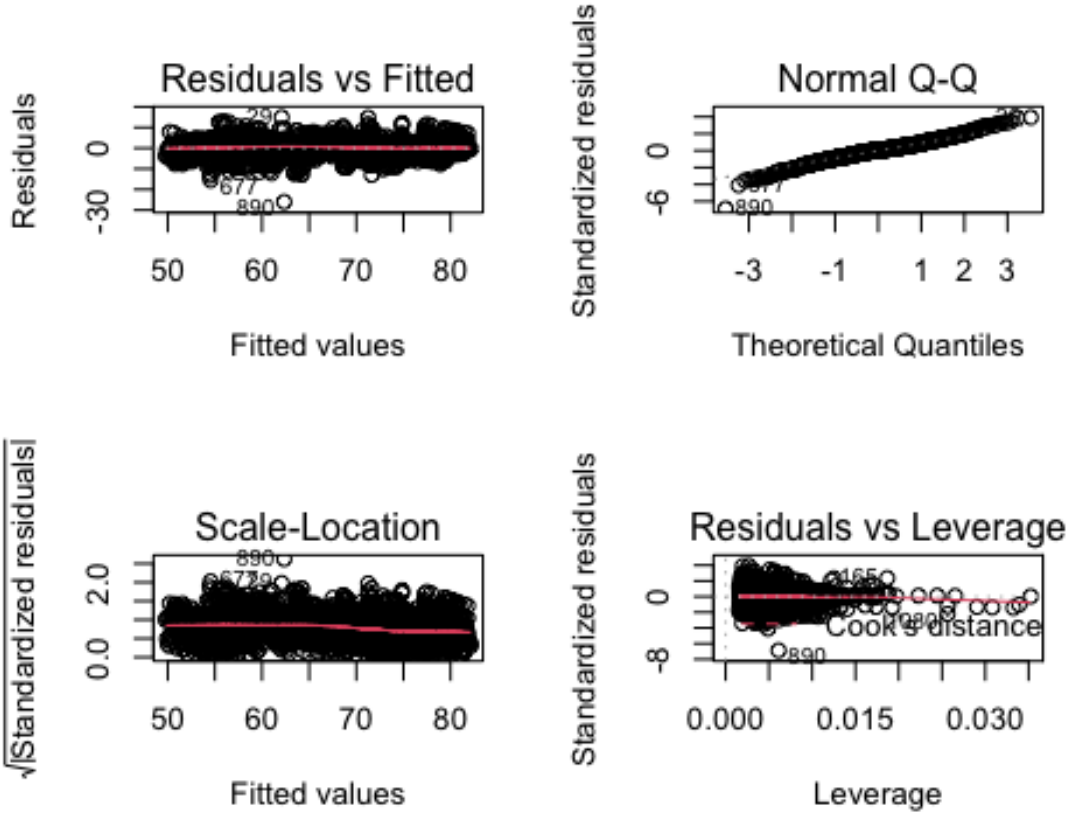
```
##                                      GVIF Df GVIF^(1/(2*Df))
## Status                           2.144139  1        1.464288
## continent                        6.820763  4        1.271245
## Income.composition.of.resources  7.498905  1        2.738413
## HIV.AIDS_log                     2.889566  1        1.699872
## Schooling                       74.506796  1        8.631732
## BMI_log                         17.514491  1        4.185032
## Schooling:BMI_log              139.552841  1       11.813249
```

```r
#Final model with VIF handled.
finalcpmodelb <- lm(Life.expectancy ~ Status + continent +  Income.composition.of.resources*HIV.AIDS_log + Sc
hooling*BMI_log, data = train)

#checkign final residual plots.
par(mfrow=c(2,2))
summary(finalcpmodelb)
```

```
##
## Call:
## lm(formula = Life.expectancy ~ Status + continent + Income.composition.of.resources *
##     HIV.AIDS_log + Schooling * BMI_log, data = train)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -26.0481  -2.2967   0.1816   2.2121  14.9192
##
## Coefficients:
##                                           Estimate Std. Error t value
## (Intercept)                               40.35037    2.39793  16.827
## StatusDeveloping                          -2.73127    0.29888  -9.138
## continentAmericas                          3.57671    0.30323  11.795
## continentAsia                              1.03473    0.29674   3.487
## continentEurope                            1.07395    0.37234   2.884
## continentOceania                           0.26041    0.44383   0.587
```

```
## Income.composition.of.resources              17.93391    1.36961  13.094
## HIV.AIDS_log                                 -0.90329    0.27030  -3.342
## Schooling                                     0.88285    0.23152   3.813
## BMI_log                                       3.54723    0.71692   4.948
## Income.composition.of.resources:HIV.AIDS_log -3.03832    0.46754  -6.499
## Schooling:BMI_log                            -0.20908    0.06558  -3.188
##                                              Pr(>|t|)
## (Intercept)                                   < 2e-16 ***
## StatusDeveloping                              < 2e-16 ***
## continentAmericas                             < 2e-16 ***
## continentAsia                                0.000497 ***
## continentEurope                              0.003957 **
## continentOceania                             0.557442
## Income.composition.of.resources               < 2e-16 ***
## HIV.AIDS_log                                 0.000845 ***
## Schooling                                    0.000140 ***
## BMI_log                                      8.01e-07 ***
## Income.composition.of.resources:HIV.AIDS_log 9.77e-11 ***
## Schooling:BMI_log                            0.001449 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.8 on 2477 degrees of freedom
## Multiple R-squared:  0.8402, Adjusted R-squared:  0.8395
## F-statistic:  1184 on 11 and 2477 DF,  p-value: < 2.2e-16
```

```
plot(finalcpmodelb)
```




```
# the KNN regression model for project 1 using final dataset

head(lifeExpec_final)

## # A tibble: 6 x 8
##   Status  Life.expectancy Income.compositio… Schooling continent BMI_log GDP_log
```

```
##   <chr>             <dbl>              <dbl>     <dbl> <chr>       <dbl>   <dbl>
## 1 Develo…            65                0.479      10.1 Asia         2.95    6.37
## 2 Develo…            59.9              0.476      10   Asia         2.92    6.42
## 3 Develo…            59.9              0.47        9.9 Asia         2.90    6.45
## 4 Develo…            59.5              0.463       9.8 Asia         2.87    6.51
## 5 Develo…            59.2              0.454       9.5 Asia         2.84    4.15
## 6 Develo…            58.8              0.448       9.2 Asia         2.82    6.32
## # … with 1 more variable: HIV.AIDS_log <dbl>

lifeExpec_final$Life.expectancy <- as.numeric(lifeExpec_final$Life.expectancy)
lifeExpec_final$Income.composition.of.resources <- as.numeric(lifeExpec_final_numCol$Income.composition.of.re
sources)
lifeExpec_final$Schooling <- as.numeric(lifeExpec_final$Schooling)
lifeExpec_final$BMI_log <- as.numeric(lifeExpec_final$BMI_log)
lifeExpec_final$GDP_log <- as.numeric(lifeExpec_final$GDP_log)
lifeExpec_final$HIV.AIDS_log <- as.numeric(lifeExpec_final$HIV.AIDS_log)
lifeExpec_final$Status <- as.numeric(as.factor(lifeExpec_final$Status))
lifeExpec_final$continent <- as.numeric(as.factor(lifeExpec_final$continent))

head(lifeExpec_final, 5)

## # A tibble: 5 x 8
##   Status Life.expectancy Income.composition… Schooling continent BMI_log GDP_log
##    <dbl>           <dbl>               <dbl>     <dbl>     <dbl>   <dbl>   <dbl>
## 1      2            65                 0.479      10.1         3    2.95    6.37
## 2      2            59.9               0.476      10           3    2.92    6.42
## 3      2            59.9               0.47        9.9         3    2.90    6.45
## 4      2            59.5               0.463       9.8         3    2.87    6.51
## 5      2            59.2               0.454       9.5         3    2.84    4.15
## # … with 1 more variable: HIV.AIDS_log <dbl>

#Test and train sets
set.seed(7)
splitPerc = .85
trainIndices = sample(1:dim(lifeExpec_final)[1],round(splitPerc * dim(lifeExpec_final)[1]))
train = lifeExpec_final[trainIndices,]
test = lifeExpec_final[-trainIndices,]

#estimation-validation split
lifeEst_trn_idx  <- sample(nrow(train), size = 0.8 * nrow(train))
lifeEst_est <- train[lifeEst_trn_idx,]
lifeEst_val <- train[-lifeEst_trn_idx,]

#verify data
head(train, 10)

## # A tibble: 10 x 8
##    Status Life.expectancy Income.compositio… Schooling continent BMI_log GDP_log
##     <dbl>           <dbl>               <dbl>     <dbl>     <dbl>   <dbl>   <dbl>
##  1      2            61.1               0.419       9.8         1    3.26    6.12
##  2      2            61.5               0.458       9.7         3    2.60    3.88
##  3      1            81                 0.658      12.1         4    4.19    8.92
##  4      2            56.5               0.556      11.7         1    3.22    7.51
##  5      2            73.6               0.739      13.4         4    4.00    8.33
##  6      2            74.2               0.715      13           3    4.13    7.42
##  7      2            67.6               0.624      12.6         3    3.68    8.92
##  8      2            65.4               0.498       9           3    3.68    8.92
##  9      2            58.6               0.394       9.8         1    3.15    5.45
## 10      2            65.4               0.531      10.4         1    3.23    7.03
## # … with 1 more variable: HIV.AIDS_log <dbl>

#building KNN reg model
lifeEst_knn_01 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 1)
lifeEst_knn_05 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 5)
lifeEst_knn_10 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 10)
lifeEst_knn_25 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 25)
```

```r
head(lifeEst_knn_10$learn$X)
```

```
##   Status Income.composition.of.resources Schooling continent  BMI_log  GDP_log
## 1      2                           0.479      10.1         3 2.949688 6.370345
## 2      2                           0.476      10.0         3 2.923162 6.417870
## 3      2                           0.470       9.9         3 2.895912 6.448486
## 4      2                           0.463       9.8         3 2.867899 6.507217
## 5      2                           0.454       9.5         3 2.844909 4.151626
## 6      2                           0.448       9.2         3 2.815409 6.315953
##   HIV.AIDS_log
## 1    -2.302585
## 2    -2.302585
## 3    -2.302585
## 4    -2.302585
## 5    -2.302585
## 6    -2.302585
```

```r
dist(head(lifeEst_knn_10$learn$X))
```

```
##           1         2         3         4         5
## 2 0.1138916
## 3 0.2215376 0.1082399
## 4 0.3401167 0.2262870 0.1195116
## 5 2.3009381 2.3221688 2.3320424 2.3747455
## 6 0.9121132 0.8141141 0.7173073 0.6321092 2.1852267
```

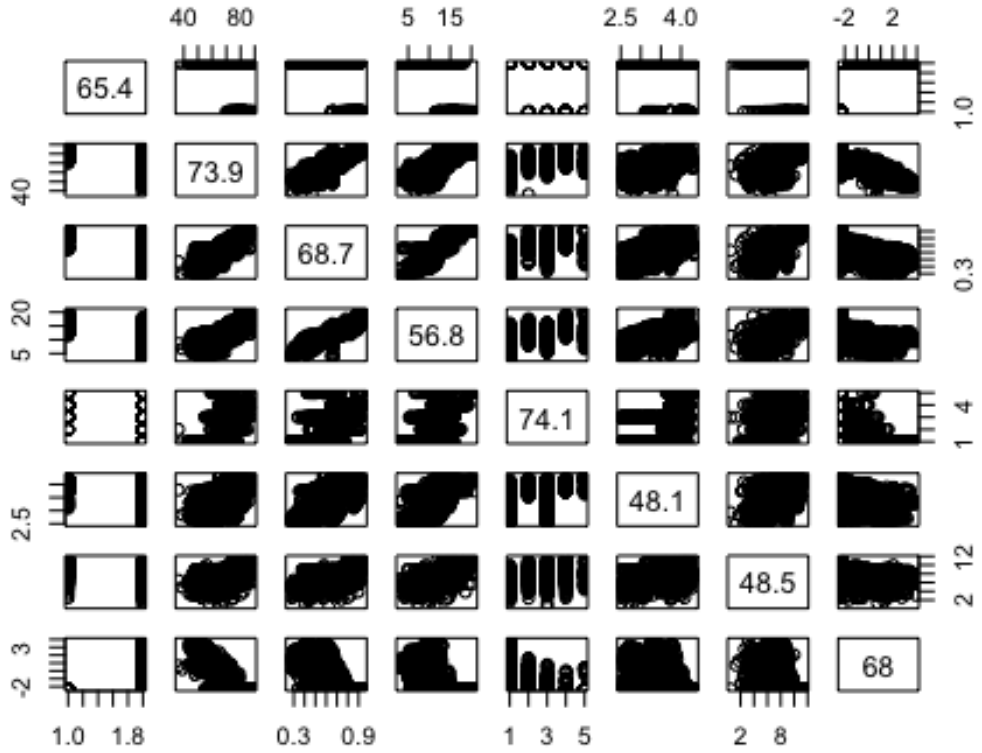
```r
#calculating the distance between the 3rd observation and 4th observation
sqrt(sum((lifeEst_knn_10$learn$X[3,] - lifeEst_knn_10$learn$X[4,])^4))
```

```
## [1] 0.01060735
```

```r
#test the predict function
predict(lifeEst_knn_10, lifeEst_val[1:50,])
```

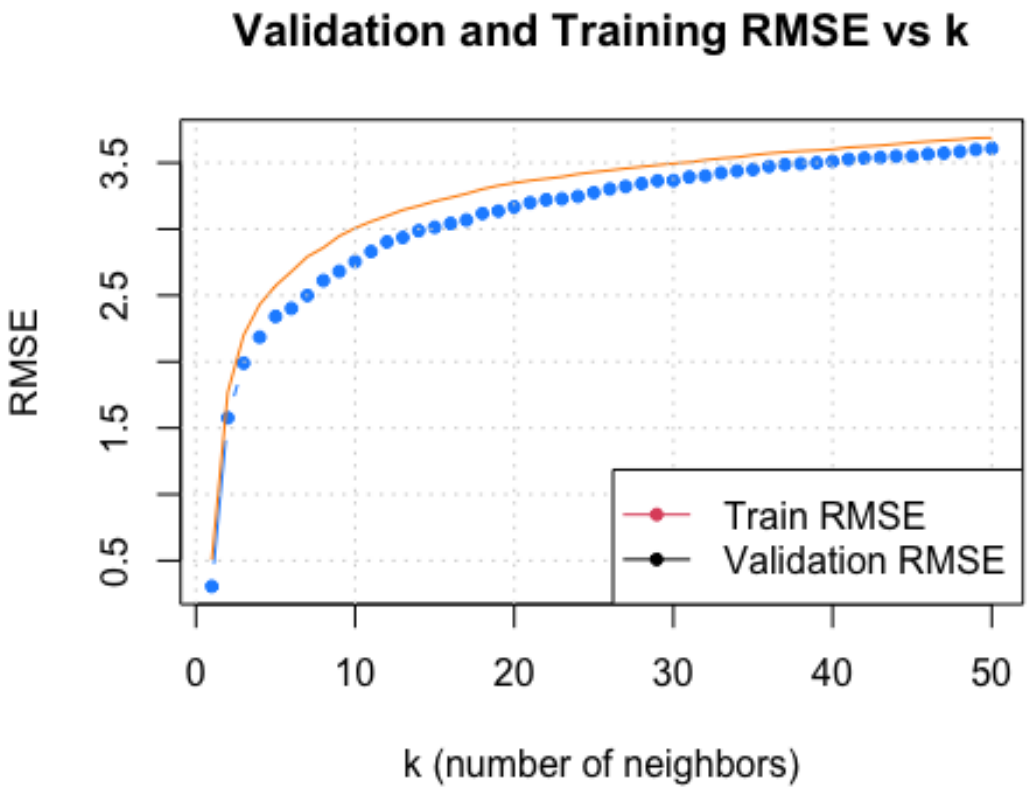
```
##  [1] 66.37 67.91 71.83 56.69 74.89 51.48 47.92 69.52 81.59 74.01 78.41 52.42
## [13] 75.20 77.55 80.88 77.43 59.62 50.79 77.47 82.37 72.49 71.93 57.05 74.23
## [25] 70.35 74.32 75.98 80.20 73.82 72.04 64.81 52.99 68.56 71.42 81.86 74.86
## [37] 72.49 80.30 82.50 67.43 75.00 73.41 52.28 76.26 80.13 76.39 58.01 56.48
## [49] 76.05 56.28
```

```r
#calculating the RMSE for the models
knn_mod_list = list(
lifeEst_knn_01 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 1),
lifeEst_knn_05 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 5),
lifeEst_knn_10 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 10),
lifeEst_knn_25 <- knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = 25)
)

plot(lifeEst_est,predict(lifeEst_knn_01,lifeEst_val))
```

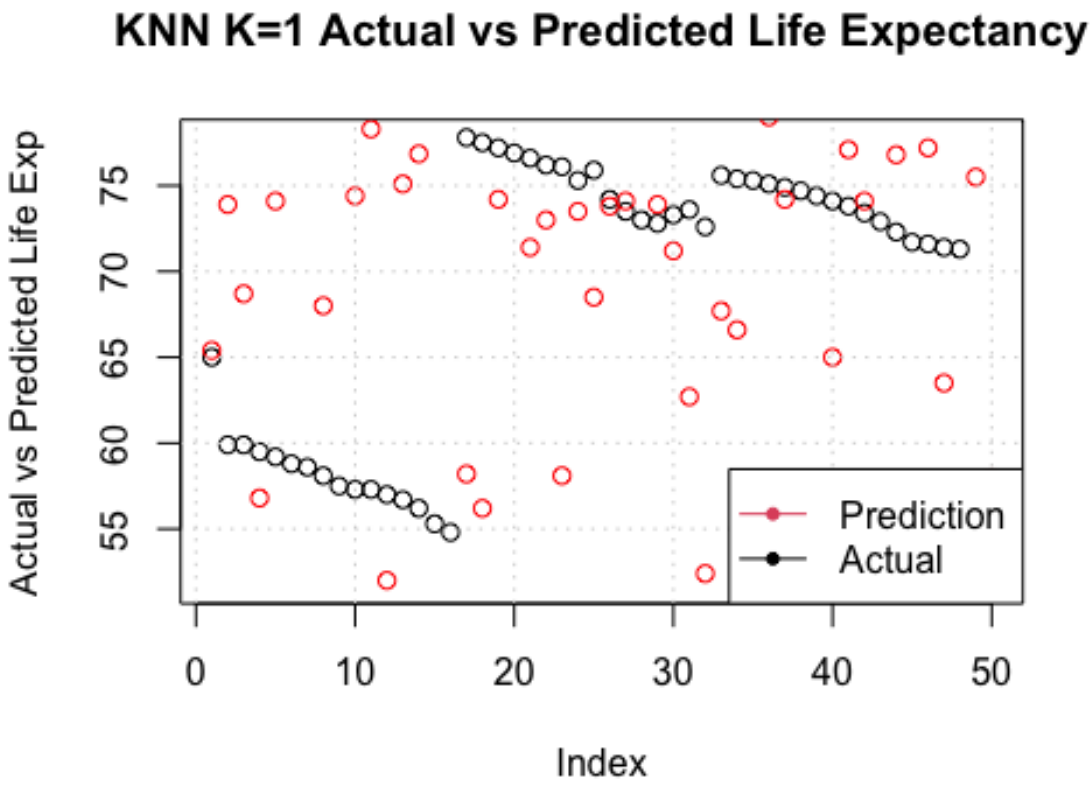



```r
#creating function for multiple k values
train_knn <- function(neighbors) {
  knnreg(Life.expectancy ~ ., data = lifeExpec_final, k = neighbors)
}

train_knn(neighbors = 5)

## 5-nearest neighbor regression model

knn_list <- lapply(1:50, train_knn)


#knn_val_pred <- lapply(knn_mod_list, predict, lifeEst_val)
knn_val_pred <- lapply(knn_list, predict, lifeEst_val)
knn_trn_pred <- lapply(knn_list, predict, lifeEst_est)

calc_rmse <- function(actual, predicted) (
  sqrt(mean((actual - predicted)^ 2))
)

sapply(knn_val_pred, calc_rmse, lifeEst_val$Life.expectancy)

##  [1] 0.306514 1.576745 1.989147 2.185706 2.341607 2.402107 2.499234 2.611717
##  [9] 2.681358 2.754214 2.830446 2.903354 2.936884 2.987867 3.013963 3.042504
## [17] 3.068280 3.116854 3.135562 3.167476 3.198770 3.220902 3.228075 3.246438
## [25] 3.274740 3.302256 3.320787 3.343251 3.364019 3.365576 3.392567 3.401452
## [33] 3.423567 3.438009 3.448571 3.471555 3.486836 3.492804 3.500346 3.511069
## [41] 3.526076 3.535482 3.540822 3.548902 3.550561 3.565843 3.572830 3.583675
## [49] 3.599456 3.608142

#create vectors for RMSE val and pred
knn_rmse_val <- sapply(knn_val_pred, calc_rmse, lifeEst_val$Life.expectancy)
knn_rmse_trn <- sapply(knn_trn_pred, calc_rmse, lifeEst_est$Life.expectancy)
```

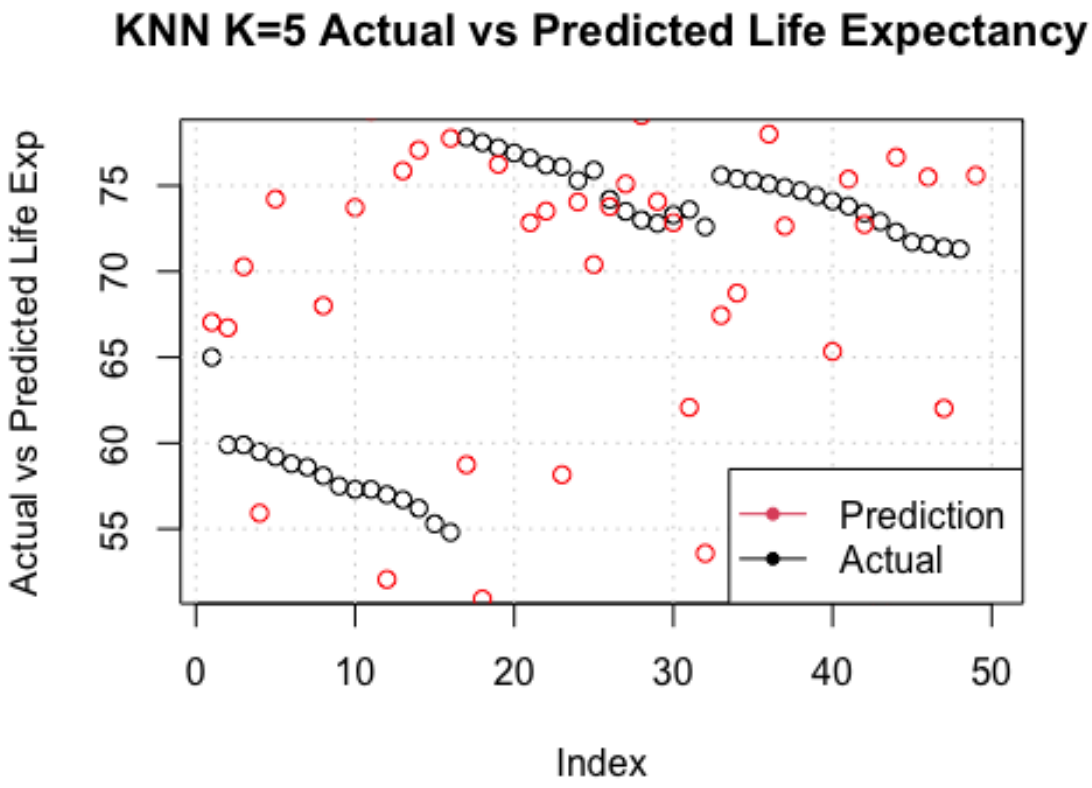
```r
#plot rmse
plot(1:50, knn_rmse_val, type = "b", col = "dodgerblue", pch = 20, ylim = range(c(knn_rmse_val,knn_rmse_trn))
, xlab = "k (number of neighbors)", ylab = "RMSE", main = "Validation and Training RMSE vs k")
lines(1:50, knn_rmse_trn, col = "darkorange")
grid()
legend('bottomright',
       c("Train RMSE","Validation RMSE"),
       col = c(2,1),
       lty = 1,
       pch = 20)
```



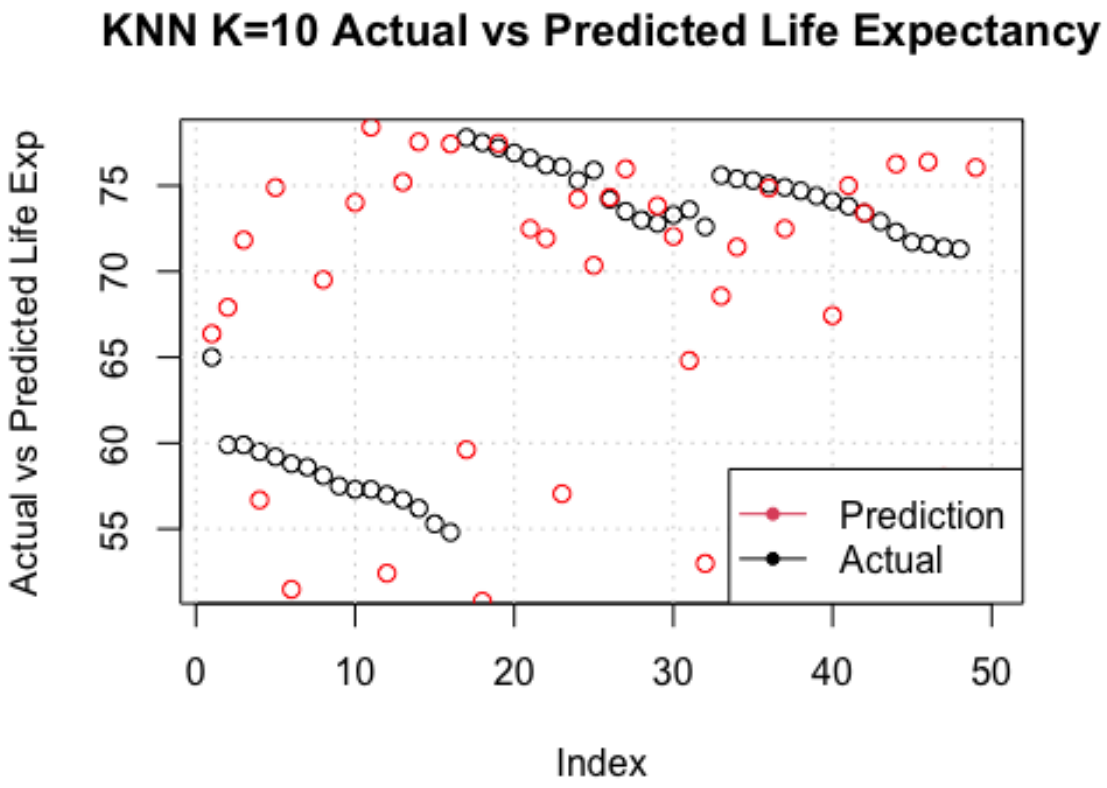

```r
#plot the predict function KNN K=1
pred01 <- predict(lifeEst_knn_01, lifeEst_val[1:50,])
actual <- lifeExpec_final[1:50,]


plot(actual$Life.expectancy, col = "black", ylab = "Actual vs Predicted Life Exp", main = "KNN K=1 Actual vs
Predicted Life Expectancy")
points(1:50,pred01, col = "red")
grid()
legend('bottomright',
       c("Prediction","Actual"),
       col = c(2,1),
       lty = 1,
       pch = 20)
```



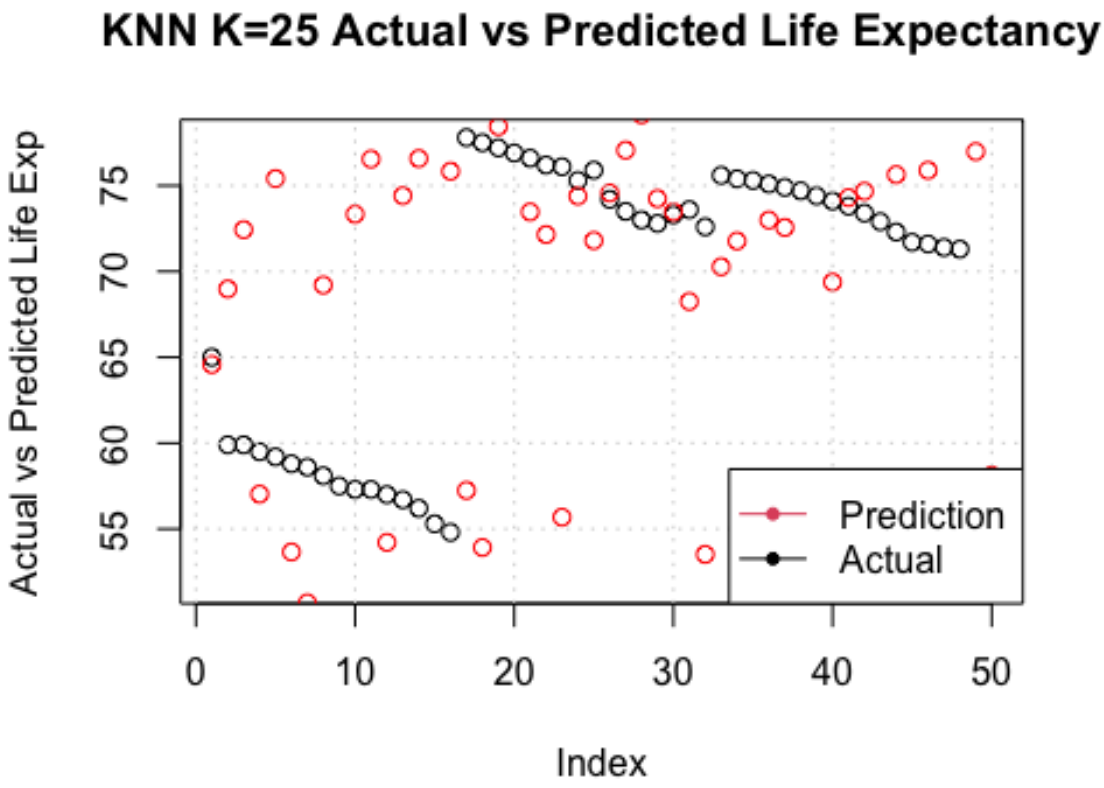

```r
#plot the predict function KNN K=5
pred05 <- predict(lifeEst_knn_05, lifeEst_val[1:50,])
actual <- lifeExpec_final[1:50,]


plot(actual$Life.expectancy, col = "black", ylab = "Actual vs Predicted Life Exp", main = "KNN K=5 Actual vs
Predicted Life Expectancy")
points(1:50,pred05, col = "red")
grid()
legend('bottomright',
       c("Prediction","Actual"),
       col = c(2,1),
       lty = 1,
       pch = 20)
```




```r
#plot the predict function KNN K=10
pred10 <- predict(lifeEst_knn_10, lifeEst_val[1:50,])
actual <- lifeExpec_final[1:50,]


plot(actual$Life.expectancy, col = "black", ylab = "Actual vs Predicted Life Exp", main = "KNN K=10 Actual vs
Predicted Life Expectancy")
points(1:50,pred10, col = "red")
grid()
legend('bottomright',
       c("Prediction","Actual"),
       col = c(2,1),
       lty = 1,
       pch = 20)
```




```r
#plot the predict function KNN K=25
pred25 <- predict(lifeEst_knn_25, lifeEst_val[1:50,])
actual <- lifeExpec_final[1:50,]


plot(actual$Life.expectancy, col = "black", ylab = "Actual vs Predicted Life Exp", main = "KNN K=25 Actual vs
Predicted Life Expectancy")
points(1:50,pred25, col = "red")
grid()
legend('bottomright',
       c("Prediction","Actual"),
       col = c(2,1),
       lty = 1,
       pch = 20)
```


KNN K=25 Actual vs Predicted Life Expectancy
Actual vs Predicted Life Exp
55
60
65
70
75
0
10
20
30
40
50
Index
Prediction
Actual