Appendix

# Read in dataset  
lifeExpec = read.csv("Life Expectancy Data.csv",header = TRUE)  
  
# Observe dataset in general  
dim(lifeExpec)

## [1] 2938 22

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 ...

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

# 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.

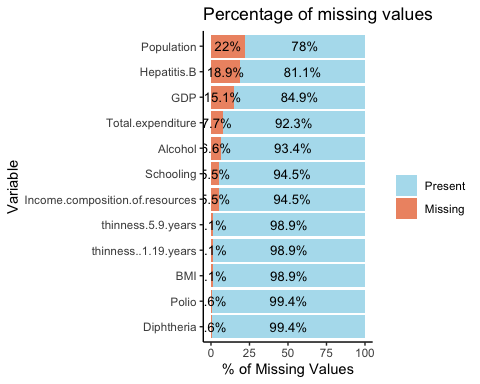
missing.values\_summary

## # 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")

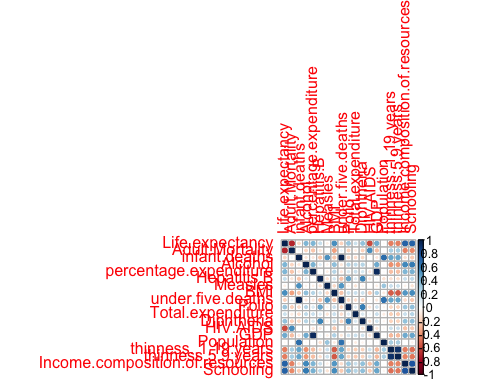
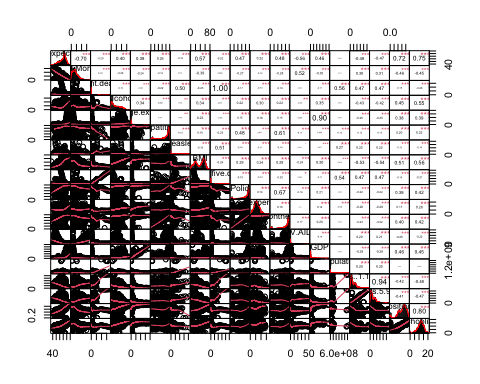
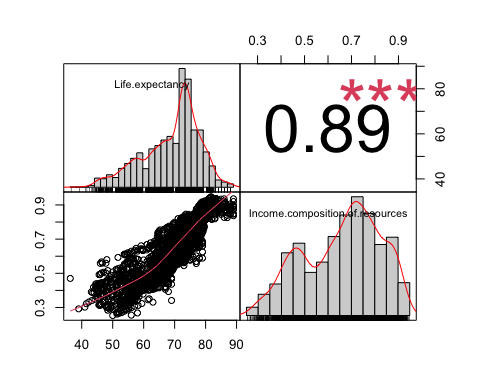


chart.Correlation(num\_col, histogram=TRUE, pch=19)

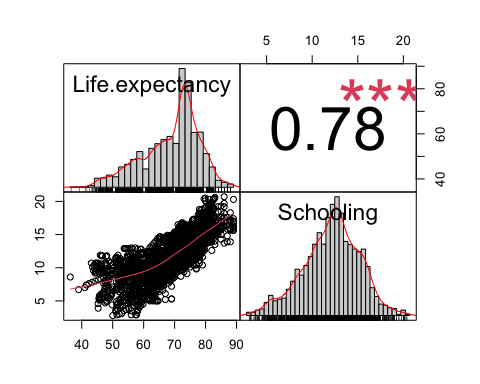


# Test on transformation on good candidate variables

# 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)

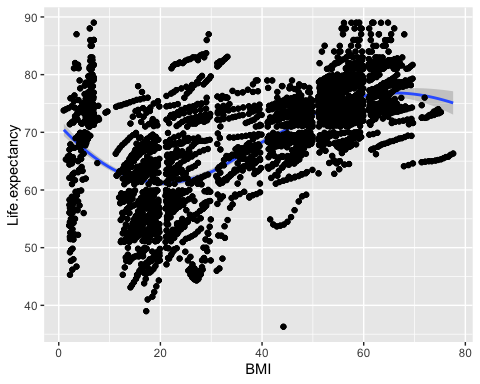


# Corr. coefficient between LifeEpactancy and Income.composition.of.resources changed from 0.72 to 0.89  
  
schooling <- subset(lifeExpec, select = c(Life.expectancy, Schooling))  
schooling <- schooling[schooling$Schooling != 0, ]  
  
chart.Correlation(schooling, histogram=TRUE, pch=19)



# 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\_jitter()



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)

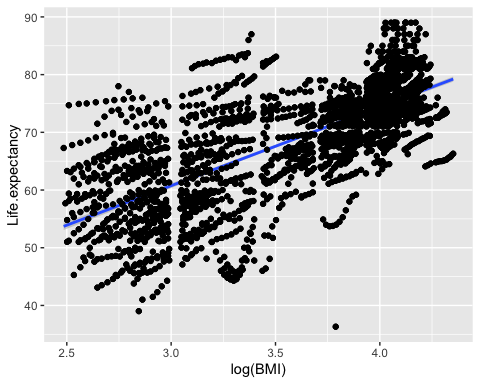
## Adding missing grouping variables: `Country`

dim(BMI\_clean)

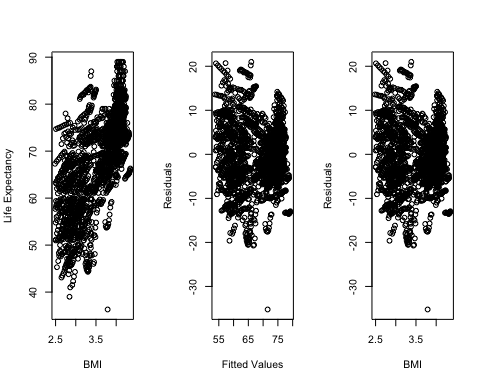
## [1] 2605 3

BMI\_clean %>% ggplot(aes(x=log(BMI), y=Life.expectancy)) + geom\_point() + geom\_smooth(method="lm") +geom\_jitter()

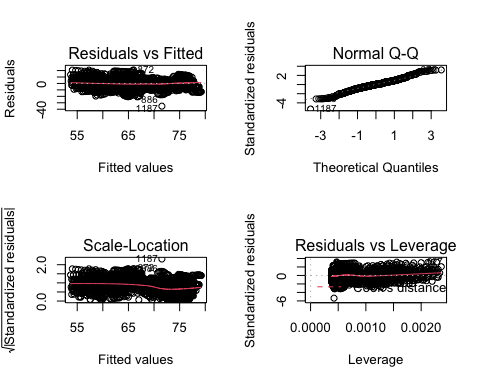
## `geom\_smooth()` using formula 'y ~ x'



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

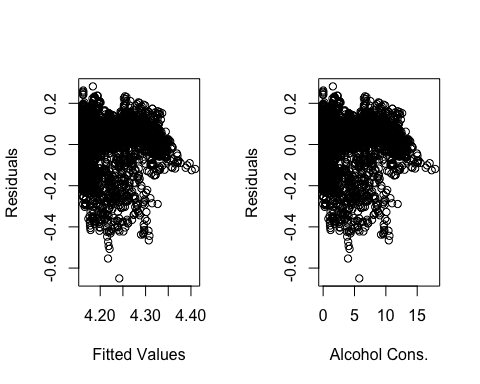
#193 NAs  
Alcohol\_clean <- lifeExpec %>% filter(!is.na(Alcohol)) %>% arrange(Alcohol)  
summary(Alcohol\_clean$Alcohol)

## 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)

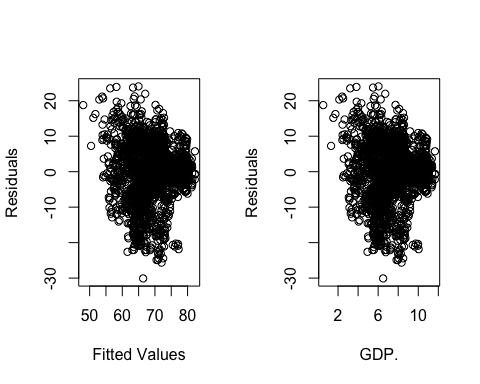
## Min. 1st Qu. Median Mean 3rd Qu. Max.   
## 1.68 463.85 1764.97 7494.21 5932.90 119172.74

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



cor(log(GDP), Life.expectancy)

## [1] 0.5983547

# GDP chang from .46 to .598

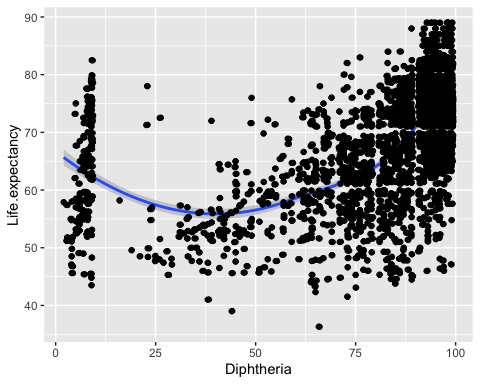
attach(lifeExpec)

## 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") + geom\_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 significant portion of the population. Thus these were removed.  
DIP\_clean <- lifeExpec %>% filter(Diphtheria>=25) %>% select(Life.expectancy, Diphtheria)

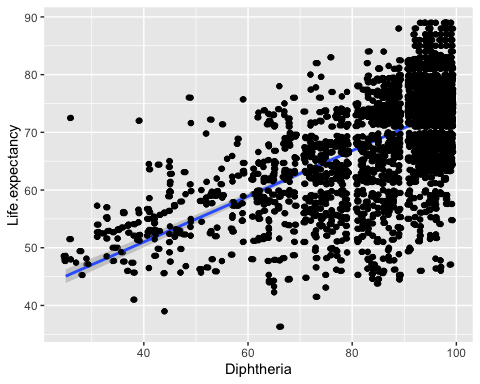
## Adding missing grouping variables: `Country`

dim(DIP\_clean)

## [1] 2730 3

DIP\_clean %>% ggplot(aes(x=Diphtheria, y=Life.expectancy)) + geom\_point() + geom\_smooth(method="lm") +geom\_jitter()

## `geom\_smooth()` using formula 'y ~ x'



attach(DIP\_clean)

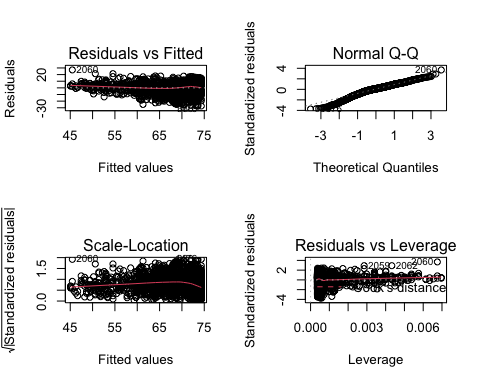
## The following objects are masked from lifeExpec:  
##   
## Country, Diphtheria, Life.expectancy

## 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

DIPlm <- lm(Life.expectancy~Diphtheria, data = DIP\_clean)  
par(mfrow=c(2,2))  
plot(DIPlm)



summary(DIPlm)

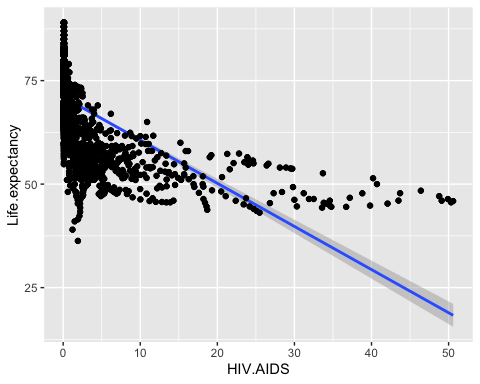
##   
## Call:  
## lm(formula = Life.expectancy ~ Diphtheria, data = DIP\_clean)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -27.5490 -3.6487 0.8532 4.7187 27.0321   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 35.184640 0.849772 41.41 <2e-16 \*\*\*  
## 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

# 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

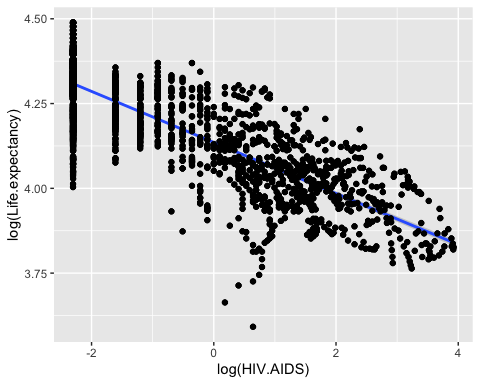
HIV %>% ggplot(aes(x=HIV.AIDS, y = Life.expectancy)) +geom\_point() + geom\_smooth(method = "lm") + geom\_jitter()

## `geom\_smooth()` using formula 'y ~ x'



HIV %>% ggplot(aes(x=log(HIV.AIDS), y = log(Life.expectancy))) +geom\_point() + geom\_smooth(method = "lm") + geom\_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

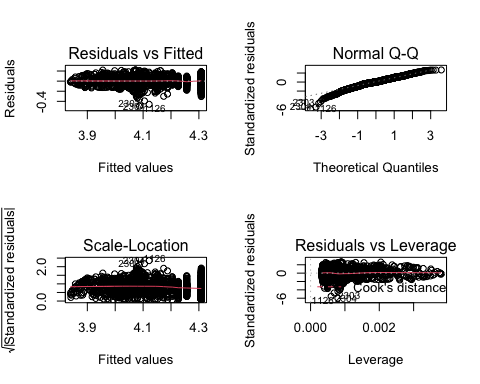
## The following objects are masked from lifeExpec:  
##   
## Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,  
## Diphtheria, GDP, Hepatitis.B, HIV.AIDS,  
## Income.composition.of.resources, infant.deaths, Life.expectancy,  
## Measles, percentage.expenditure, Polio, Population,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

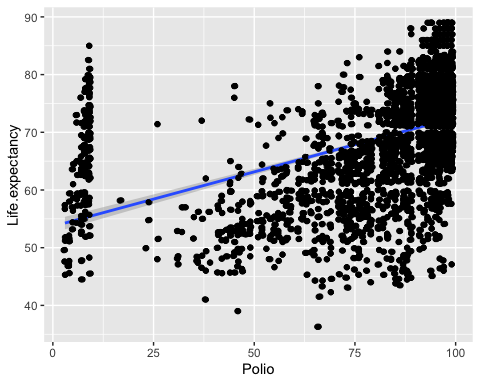
##   
## Call:  
## lm(formula = log(Life.expectancy) ~ log(HIV.AIDS))  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -0.49518 -0.04038 0.00212 0.05570 0.22195   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 4.1353235 0.0019156 2158.7 <2e-16 \*\*\*  
## log(HIV.AIDS) -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

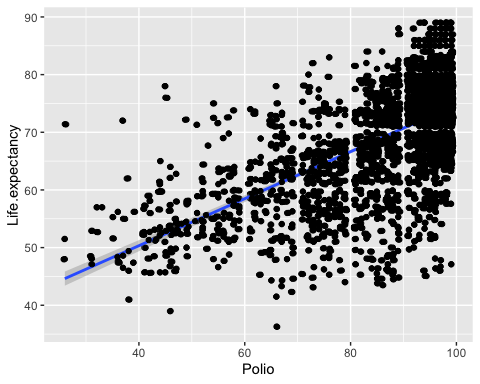
Polio1 %>% ggplot(aes(x=Polio, y = Life.expectancy)) +geom\_point() + geom\_smooth(method = "lm") + geom\_jitter()

## `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\_jitter()

## `geom\_smooth()` using formula 'y ~ x'



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

##   
## 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

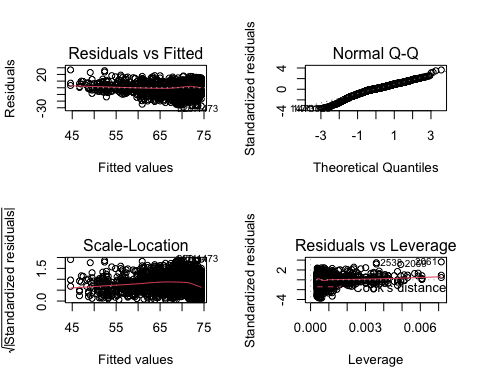
## The following objects are masked from lifeExpec:  
##   
## Adult.Mortality, Alcohol, BMI, continent, Country, CountrytoMatch,  
## Diphtheria, GDP, Hepatitis.B, HIV.AIDS,  
## Income.composition.of.resources, infant.deaths, Life.expectancy,  
## Measles, percentage.expenditure, Polio, Population,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

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 0.405 ...  
## $ 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

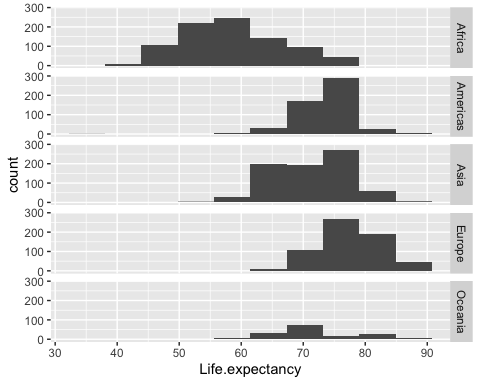
rowSums(is.na(data))

## [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 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 1  
## [75] 1 1 1 1 1 2 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 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 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 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 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 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 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 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 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 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 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 6 4 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 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  
## [778] 0 0 0 0 0 0 0 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 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 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 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 0 2 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 1 1 2 0 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 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 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 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 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 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 0 1 2 2 2 2 0 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 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 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 0 2 0 0 0 0 0 0 0 0  
## [1370] 0 0 0 0 0 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 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 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 0 0 2 0 0 0 0 0 0 0  
## [1481] 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 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 0 1 1 2 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 0 0 2 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 0 4 2 2 2 2 2  
## [1703] 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 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 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 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 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 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 0 2 0 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 0 0 2 0 0  
## [2036] 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 3 1 1 1 1 1 1 1  
## [2073] 1 1 1 1 1 1 1 1 6 4 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 0 1 2 0  
## [2147] 0 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 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 0 2 0 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 1 2 0 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 0 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  
## [2295] 0 0 0 1 1 1 1 1 1 1 2 1 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 1 2 0 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 0 0 5 5 5 5 6  
## [2406] 8 8 8 9 9 9 9 9 9 9 9 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  
## [2443] 0 0 0 1 1 1 5 3 3 3 3 3 3 3 3 3 3 4 4 4 4 4 2 0 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 0 2 0 0 0 0 1 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 1 3 1 1 1 1 1 1 1 0 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 2 3 3 3  
## [2591] 3 3 2 0 0 0 0 0 0 0 1 1 1 1 1 1 3 3 2 0 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 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  
## [2665] 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 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 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 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 4 2 0 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 0 0 4  
## [2850] 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 2 2 3 3 3 4 2 2 2 2 2  
## [2887] 2 2 2 2 2 2 2 2 2 2 2 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  
## [2924] 0 0 0 0 0

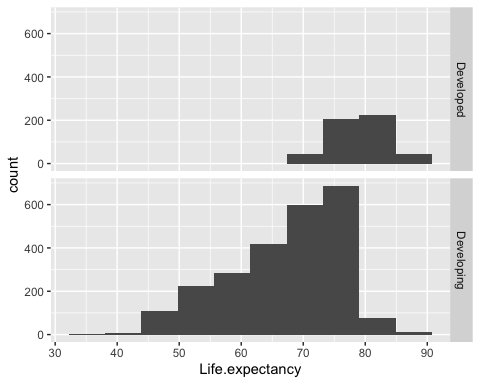
apply(is.na(data), 2, sum)

## 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

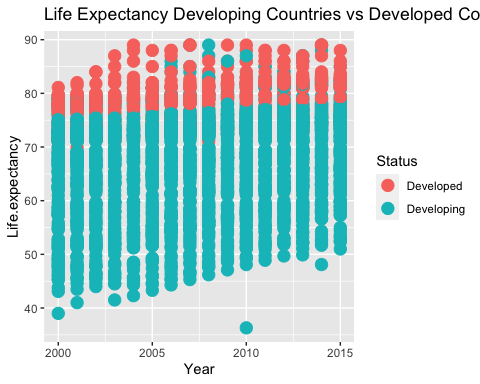
#life expectancy for all the countries  
ggplot(data, aes(Life.expectancy)) + geom\_histogram(bins = 10) + facet\_grid(vars(continent))



#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 Developing 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))

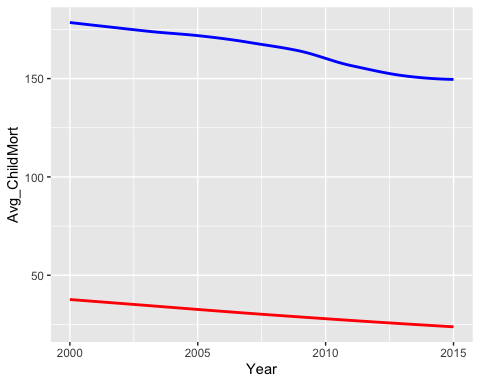
## # A tibble: 2 x 4  
## Status Avg\_lifexp Avg\_ChildMort Avg\_AdultMort  
## <chr> <dbl> <dbl> <dbl>  
## 1 Developed 79.2 1.49 79.7  
## 2 Developing 67.1 36.5 183.

#descriptive statistics by continent  
data %>% drop\_na(Life.expectancy) %>% group\_by(continent) %>% summarize(Avg\_lifexp = mean(Life.expectancy), Avg\_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\_ChildMort = mean(infant.deaths), Avg\_AdultMort = mean(Adult.Mortality)) %>% ggplot() + geom\_smooth(aes(Year, Avg\_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'



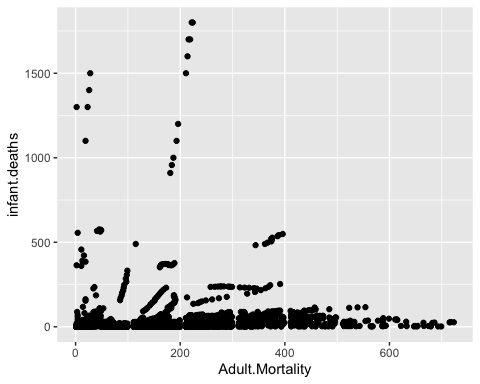
clean\_data <- data %>% select(-continent, -Country, -Year, -Status)

## 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

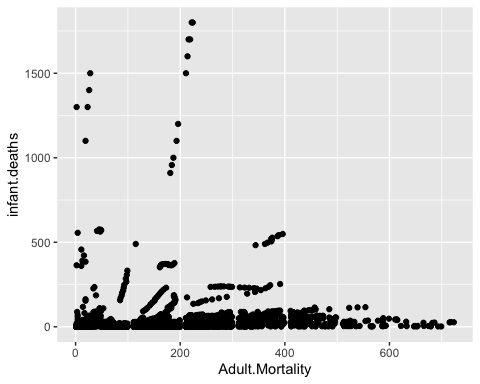
clean\_data %>% summarize(N = n(), cor(Adult.Mortality, infant.deaths, use = "pairwise.complete.obs"))

## # 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

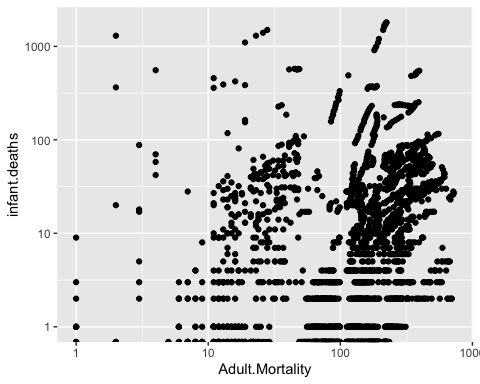
clean\_data %>% summarize(N = n(), cor(log(Adult.Mortality), log(infant.deaths), use = "pairwise.complete.obs"))

## # 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

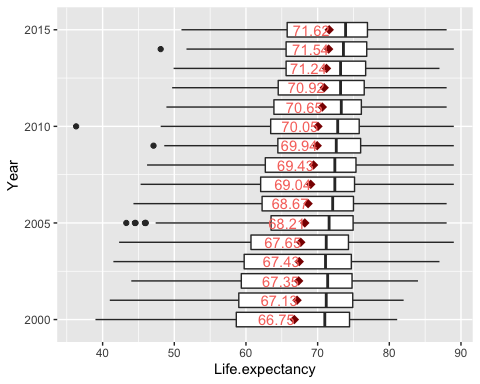
#relationship testing for adult mortality & infant deaths  
ggplot(clean\_data, aes(Adult.Mortality, infant.deaths)) + geom\_point()



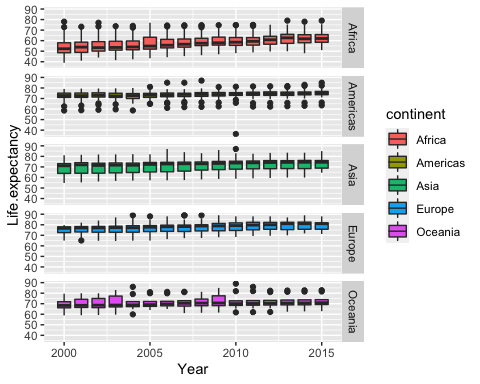
ggplot(clean\_data, aes(Adult.Mortality, infant.deaths)) + geom\_point() + scale\_x\_log10() + scale\_y\_log10()



# 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.expectancy - 2.5, col = "darkred")) +  
 theme(legend.position = "none") +  
 coord\_flip()



# 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 ~ .)



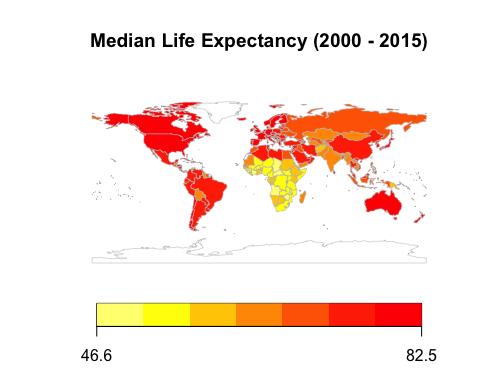
# Wold map displays life expectancy in general (median value from 2000 - 2015) for each country. Africa has the lowest life expectancy, follows by Asia.  
  
medianExpec <- aggregate(lifeExpec[, 4], list(lifeExpec$CountrytoMatch), median)  
names(medianExpec)[names(medianExpec)=="Group.1"] <- "Country"  
  
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

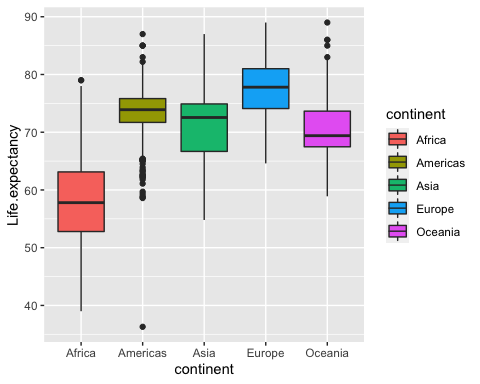
map <- joinCountryData2Map(  
 medianExpec,  
 joinCode = "NAME",  
 nameJoinColumn = "Country",  
 verbose = TRUE  
 )

## 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

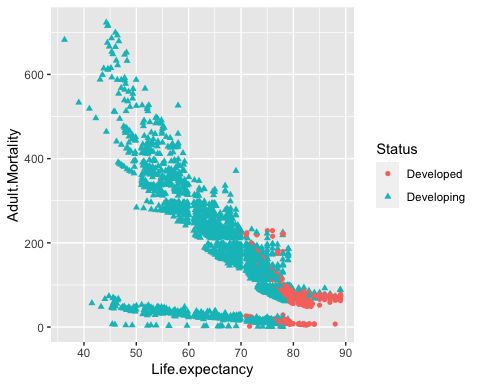
mapCountryData(map,  
 mapTitle = "Median Life Expectancy (2000 - 2015)",  
 nameColumnToPlot = "Life.expectancy",  
 catMethod = "fixedWidth"  
)



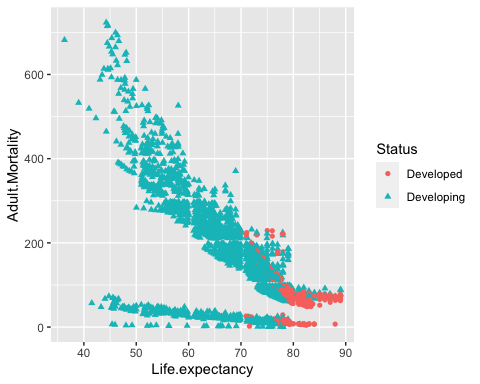
# Boxplot life expectancy vs. continent also shows the same trend  
lifeExpec %>% ggplot(aes(x=continent, y=Life.expectancy)) +   
 geom\_boxplot(aes(fill=continent))



# 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()

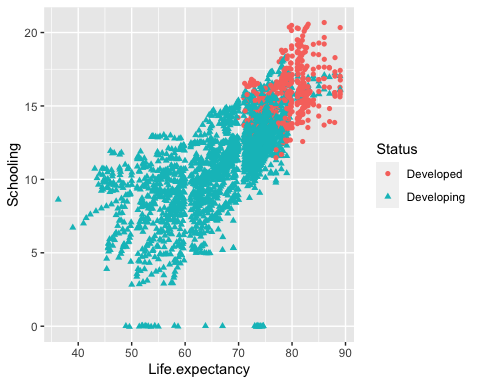


# Scatter plot life expectancy vs. adult mortality color code by countrys' status.  
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Adult.Mortality, shape=Status, color=Status)) +  
 geom\_jitter()



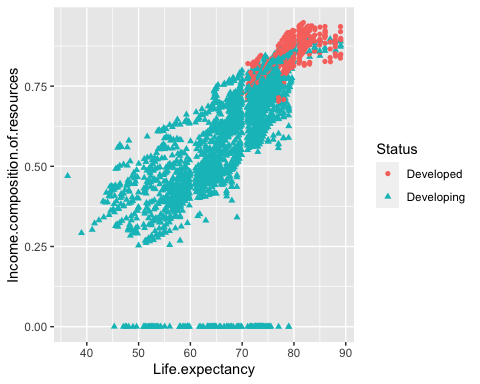
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Schooling, shape=Status, color=Status)) +  
 geom\_jitter()

## Warning: Removed 160 rows containing missing values (geom\_point).

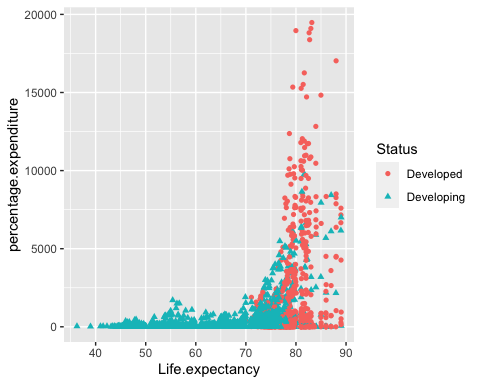


lifeExpec %>% ggplot(aes(x=Life.expectancy, y=Income.composition.of.resources, shape=Status, color=Status)) +  
 geom\_jitter()

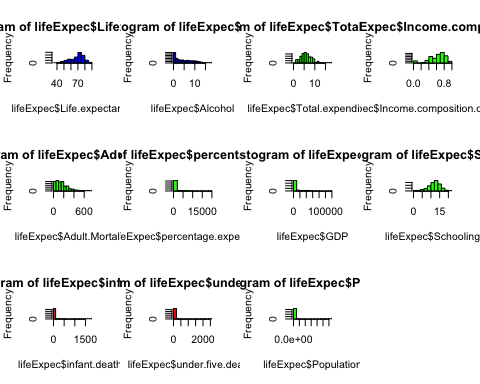
## Warning: Removed 160 rows containing missing values (geom\_point).



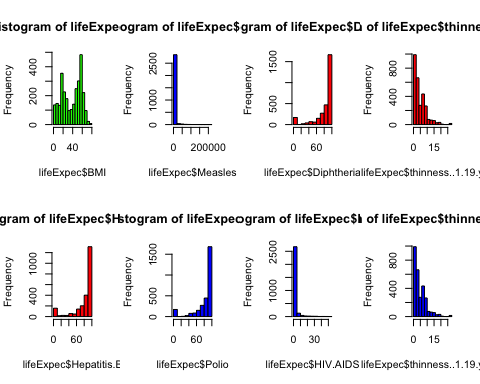
lifeExpec %>% ggplot(aes(x=Life.expectancy, y=percentage.expenditure, shape=Status, color=Status)) +  
 geom\_jitter()



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, Income.composition.of.resources, and Schooling  
lifeExpec\_final <- subset(lifeExpec, select = -c(Country, CountrytoMatch, Year, Adult.Mortality, Alcohol, percentage.expenditure, infant.deaths, Hepatitis.B, Measles, under.five.deaths, Total.expenditure, Population, thinness..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  
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## [385] 65.70000 65.10000 64.50000 63.90000 63.30000 62.70000 62.10000 61.50000  
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## [2089] 28.20000 27.70000 27.20000 26.70000 26.20000 25.70000 25.20000 24.70000  
## [2097] 53.40000 52.70000 52.10000 51.50000 41.95655 41.95655 49.90000 49.50000  
## [2105] 49.10000 48.70000 48.30000 47.90000 47.60000 47.20000 46.80000 46.50000  
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## [2121] 55.00000 54.40000 53.90000 53.40000 52.90000 52.40000 51.90000 51.40000  
## [2129] 41.95655 59.90000 59.30000 58.70000 58.10000 57.50000 57.00000 56.60000  
## [2137] 56.10000 55.70000 55.30000 55.00000 54.70000 54.50000 54.20000 54.00000  
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## [2153] 16.50000 15.90000 15.40000 14.90000 14.50000 14.10000 13.70000 13.20000  
## [2161] 47.50000 46.70000 45.90000 45.20000 44.50000 43.80000 43.00000 42.20000  
## [2169] 41.30000 41.95655 39.60000 39.00000 38.40000 37.90000 37.30000 36.80000  
## [2177] 54.10000 53.10000 52.20000 51.20000 41.95655 49.30000 48.40000 47.50000  
## [2185] 46.60000 45.70000 44.70000 43.80000 42.90000 42.00000 41.00000 41.95655  
## [2193] 74.70000 74.30000 73.80000 73.40000 72.90000 72.50000 72.00000 71.40000  
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## [2225] 68.20000 67.30000 66.40000 65.60000 64.70000 63.90000 63.10000 62.40000  
## [2233] 61.60000 41.95655 41.95655 59.40000 58.50000 57.70000 56.90000 56.20000  
## [2241] 24.30000 23.80000 23.20000 22.70000 22.20000 21.70000 21.20000 41.95655  
## [2249] 41.95655 19.90000 19.50000 19.10000 18.70000 18.30000 17.90000 17.50000  
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## [2281] 31.20000 41.95655 41.95655 29.20000 28.70000 28.10000 27.60000 27.10000  
## [2289] 24.40000 23.80000 23.30000 22.70000 22.20000 21.70000 21.20000 41.95655  
## [2297] 41.95655 19.70000 19.20000 18.80000 18.40000 17.90000 17.50000 17.20000  
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## [2313] 41.95655 41.95655 41.95655 29.90000 29.60000 29.20000 28.90000 28.50000  
## [2321] 59.10000 58.40000 57.80000 57.20000 56.50000 55.90000 55.30000 54.80000  
## [2329] 54.20000 53.70000 53.10000 52.60000 52.10000 51.60000 51.10000 41.95655  
## [2337] 41.95655 59.50000 58.90000 58.20000 57.60000 57.00000 56.40000 55.80000  
## [2345] 55.20000 54.70000 54.10000 53.50000 52.90000 52.30000 51.80000 51.20000  
## [2353] 41.95655 49.70000 48.90000 48.10000 47.20000 46.40000 45.50000 44.70000  
## [2361] 43.80000 43.00000 42.10000 41.30000 41.95655 39.60000 38.70000 37.90000  
## [2369] 24.30000 23.80000 23.30000 22.90000 22.40000 22.00000 21.50000 21.10000  
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## [2393] 45.00000 44.30000 43.60000 42.90000 42.20000 41.60000 41.95655 41.95655  
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## [2409] 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655  
## [2417] 66.60000 66.00000 65.40000 64.80000 64.10000 63.50000 62.90000 62.30000  
## [2425] 61.70000 61.10000 41.95655 59.90000 59.30000 58.80000 58.20000 57.60000  
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## [2441] 17.90000 17.20000 16.60000 16.10000 15.60000 15.10000 14.60000 14.10000  
## [2449] 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655  
## [2457] 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655 41.95655  
## [2465] 58.30000 57.70000 57.00000 56.30000 55.50000 54.80000 54.10000 53.30000  
## [2473] 52.60000 51.80000 51.10000 41.95655 49.70000 49.00000 48.30000 47.60000  
## [2481] 32.30000 31.80000 31.20000 41.95655 41.95655 29.70000 29.30000 28.90000  
## [2489] 28.50000 28.20000 27.80000 27.40000 27.10000 26.70000 26.30000 25.90000  
## [2497] 59.50000 59.00000 58.50000 58.10000 57.70000 57.30000 56.90000 56.50000  
## [2505] 56.10000 55.70000 55.30000 54.90000 54.40000 53.90000 53.40000 52.80000  
## [2513] 57.40000 57.00000 56.60000 56.20000 55.80000 55.40000 55.00000 54.60000  
## [2521] 54.10000 53.70000 53.20000 52.80000 52.30000 51.80000 51.30000 41.95655  
## [2529] 57.10000 56.20000 55.20000 54.20000 53.20000 52.30000 51.30000 41.95655  
## [2537] 49.40000 48.50000 47.60000 46.80000 46.00000 45.30000 44.60000 43.90000  
## [2545] 41.95655 39.90000 39.00000 38.20000 37.40000 36.60000 35.90000 35.30000  
## [2553] 34.70000 34.10000 33.50000 33.00000 32.50000 32.10000 31.60000 31.30000  
## [2561] 33.60000 32.40000 31.30000 41.95655 29.00000 27.90000 26.80000 25.70000  
## [2569] 24.60000 23.60000 22.60000 21.70000 41.95655 41.95655 19.40000 18.70000  
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## [2585] 55.90000 55.40000 54.90000 54.50000 54.10000 53.60000 53.20000 52.70000  
## [2593] 17.40000 17.00000 16.60000 16.20000 15.80000 15.50000 15.10000 14.70000  
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## [2609] 24.30000 23.70000 23.10000 22.60000 22.00000 21.40000 41.95655 41.95655  
## [2617] 19.80000 19.30000 18.90000 18.40000 17.90000 17.50000 17.10000 16.60000  
## [2625] 75.20000 74.80000 74.30000 73.80000 73.30000 72.70000 72.10000 71.50000  
## [2633] 41.95655 41.95655 69.40000 68.60000 67.80000 67.00000 66.20000 65.50000  
## [2641] 47.10000 46.00000 45.00000 44.00000 43.00000 42.00000 41.10000 41.95655  
## [2649] 39.30000 38.40000 37.60000 36.80000 36.00000 35.20000 34.40000 33.60000  
## [2657] 61.20000 41.95655 59.30000 58.30000 57.40000 56.50000 55.60000 54.70000  
## [2665] 53.90000 53.10000 52.20000 51.40000 41.95655 49.70000 48.90000 48.10000  
## [2673] 66.10000 65.30000 64.50000 63.70000 62.80000 61.90000 61.10000 41.95655  
## [2681] 59.30000 58.50000 57.60000 56.80000 55.90000 55.10000 54.30000 53.50000  
## [2689] 48.60000 47.70000 46.70000 45.90000 45.00000 44.20000 43.40000 42.70000  
## [2697] 42.00000 41.30000 41.95655 41.95655 39.40000 38.70000 38.10000 37.50000  
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## [2729] 57.20000 56.80000 56.40000 56.10000 55.70000 55.40000 55.10000 54.80000  
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## [2745] 55.10000 55.80000 56.60000 57.00000 56.80000 56.00000 55.00000 54.10000  
## [2753] 66.60000 66.00000 65.40000 64.80000 64.20000 63.60000 63.10000 62.50000  
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## [2777] 19.10000 18.60000 18.10000 17.70000 17.20000 16.80000 16.40000 16.00000  
## [2785] 69.60000 69.10000 68.60000 68.00000 67.50000 66.90000 66.30000 65.70000  
## [2793] 65.10000 64.40000 63.80000 63.10000 62.40000 61.70000 41.95655 41.95655  
## [2801] 64.00000 63.40000 62.90000 62.30000 61.80000 61.20000 41.95655 41.95655  
## [2809] 59.50000 58.90000 58.30000 57.70000 57.00000 56.30000 55.70000 55.00000  
## [2817] 44.70000 43.90000 43.00000 42.20000 41.40000 41.95655 41.95655 39.30000  
## [2825] 38.70000 38.10000 37.50000 37.00000 36.40000 35.90000 35.30000 34.80000  
## [2833] 53.30000 52.50000 51.70000 41.95655 49.90000 49.10000 48.20000 47.40000  
## [2841] 46.60000 45.70000 44.90000 44.10000 43.30000 42.60000 41.90000 41.10000  
## [2849] 62.10000 61.50000 61.00000 41.95655 59.90000 59.30000 58.80000 58.20000  
## [2857] 57.60000 57.10000 56.50000 55.90000 55.30000 54.70000 54.10000 53.40000  
## [2865] 17.50000 16.70000 16.00000 15.30000 14.70000 14.00000 13.40000 12.90000  
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## [2881] 41.30000 41.95655 39.60000 38.70000 37.90000 37.20000 36.40000 35.70000  
## [2889] 35.10000 34.50000 33.90000 33.30000 32.70000 32.20000 31.70000 31.20000  
## [2897] 23.40000 22.80000 22.30000 21.70000 21.20000 41.95655 41.95655 19.70000  
## [2905] 19.20000 18.80000 18.40000 18.00000 17.60000 17.30000 17.10000 16.80000  
## [2913] 31.80000 31.30000 41.95655 41.95655 29.90000 29.40000 29.00000 28.60000  
## [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  
## [64] 0.3820000 0.7840000 0.7820000 0.7810000 0.7780000 0.7820000 0.7830000  
## [71] 0.7880000 0.7860000 0.7810000 0.7730000 0.6583378 0.6583378 0.6583378  
## [78] 0.6583378 0.6583378 0.6583378 0.8260000 0.8250000 0.8230000 0.8220000  
## [85] 0.8160000 0.8020000 0.7940000 0.7920000 0.7880000 0.7820000 0.7800000  
## [92] 0.7750000 0.7700000 0.7760000 0.7710000 0.7640000 0.7410000 0.7390000  
## [99] 0.7360000 0.7320000 0.7290000 0.7200000 0.7250000 0.7210000 0.7070000  
## [106] 0.6920000 0.6790000 0.6680000 0.6570000 0.6450000 0.6440000 0.6390000  
## [113] 0.9370000 0.9360000 0.9330000 0.9300000 0.9270000 0.9270000 0.9250000  
## [120] 0.9210000 0.9180000 0.9150000 0.9100000 0.9080000 0.9050000 0.9020000  
## [127] 0.8990000 0.8970000 0.8920000 0.8920000 0.8870000 0.8840000 0.8800000  
## [134] 0.8720000 0.8700000 0.8640000 0.8600000 0.8540000 0.8480000 0.8410000  
## [141] 0.8370000 0.8470000 0.8370000 0.8330000 0.7580000 0.7520000 0.7450000  
## [148] 0.7420000 0.7410000 0.7370000 0.7280000 0.7190000 0.7080000 0.6820000  
## [155] 0.6750000 0.6680000 0.6590000 0.6510000 0.6420000 0.6360000 0.7900000  
## [162] 0.7890000 0.7900000 0.7890000 0.7880000 0.7880000 0.7910000 0.7910000  
## [169] 0.7900000 0.7880000 0.7860000 0.7840000 0.7830000 0.7810000 0.7790000  
## [176] 0.6583378 0.8230000 0.8200000 0.8150000 0.8120000 0.8120000 0.8100000  
## [183] 0.8140000 0.8150000 0.8130000 0.8100000 0.8060000 0.8030000 0.7980000  
## [190] 0.7960000 0.7940000 0.7860000 0.5750000 0.5700000 0.5650000 0.5570000  
## [197] 0.5450000 0.5350000 0.5230000 0.5200000 0.5130000 0.5060000 0.4990000  
## [204] 0.4910000 0.4840000 0.4760000 0.4680000 0.4590000 0.7940000 0.7930000  
## [211] 0.7920000 0.7850000 0.7800000 0.7810000 0.7790000 0.7750000 0.7710000  
## [218] 0.7660000 0.7610000 0.7570000 0.7530000 0.7490000 0.7500000 0.7410000  
## [225] 0.7980000 0.7960000 0.7960000 0.7930000 0.7870000 0.7800000 0.7710000  
## [232] 0.7550000 0.7390000 0.7230000 0.7130000 0.7030000 0.6950000 0.6870000  
## [239] 0.6810000 0.6750000 0.8950000 0.8900000 0.8890000 0.8860000 0.8840000  
## [246] 0.8780000 0.8760000 0.8740000 0.8710000 0.8650000 0.8610000 0.8800000  
## [253] 0.8780000 0.8750000 0.8730000 0.8690000 0.7060000 0.7050000 0.7060000  
## [260] 0.7020000 0.7000000 0.7000000 0.7000000 0.6990000 0.7000000 0.6920000  
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## [274] 0.4750000 0.4660000 0.4580000 0.4540000 0.4510000 0.4480000 0.4440000  
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## [288] 0.3890000 0.6040000 0.5960000 0.5890000 0.5810000 0.5720000 0.6583378  
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## [302] 0.6583378 0.6583378 0.6583378 0.6710000 0.6660000 0.6610000 0.6550000  
## [309] 0.6490000 0.6430000 0.6360000 0.6320000 0.6260000 0.6250000 0.6220000  
## [316] 0.6200000 0.6170000 0.6100000 0.6070000 0.6000000 0.7470000 0.7420000  
## [323] 0.7350000 0.7280000 0.7110000 0.7170000 0.7160000 0.7100000 0.7030000  
## [330] 0.6970000 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378 0.6583378  
## [337] 0.6980000 0.6970000 0.6930000 0.6870000 0.6780000 0.6690000 0.6610000  
## [344] 0.6460000 0.6300000 0.6100000 0.5930000 0.5800000 0.5670000 0.5580000  
## [351] 0.5600000 0.5590000 0.7540000 0.7470000 0.7340000 0.7300000 0.7240000  
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## [365] 0.6990000 0.6920000 0.6850000 0.6770000 0.8640000 0.8630000 0.8600000  
## [372] 0.8520000 0.8460000 0.8450000 0.8410000 0.8400000 0.8400000 0.8370000  
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## [456] 0.6150000 0.6020000 0.5960000 0.5820000 0.5740000 0.5720000 0.5690000  
## [463] 0.5620000 0.6583378 0.5580000 0.5530000 0.5460000 0.5400000 0.5330000  
## [470] 0.5190000 0.5200000 0.5110000 0.4950000 0.4830000 0.4700000 0.4580000  
## [477] 0.4450000 0.4270000 0.4120000 0.4010000 0.5140000 0.5070000 0.5010000  
## [484] 0.4960000 0.4860000 0.4800000 0.4730000 0.4660000 0.4560000 0.4560000  
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## [645] 0.8080000 0.8030000 0.8030000 0.8000000 0.7930000 0.7830000 0.7770000  
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## [673] 0.8540000 0.8500000 0.8500000 0.8500000 0.8470000 0.8530000 0.8490000  
## [680] 0.8440000 0.8360000 0.8290000 0.8260000 0.8230000 0.8150000 0.8050000  
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## [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  
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## [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  
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## [2675] 0.7540000 0.7500000 0.7370000 0.7150000 0.7090000 0.7050000 0.6970000  
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## [2689] 0.6880000 0.6830000 0.6780000 0.6720000 0.6650000 0.6583378 0.6583378  
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## [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  
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## [2878] 0.5840000 0.5760000 0.5690000 0.4990000 0.5000000 0.4980000 0.4940000  
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## [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  
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## [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  
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## [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  
## [217] 15.00000 14.80000 14.60000 14.40000 14.20000 14.00000 14.00000 14.00000  
## [225] 15.60000 15.70000 15.70000 15.60000 15.50000 15.50000 15.40000 15.10000  
## [233] 14.90000 14.60000 14.40000 14.10000 13.90000 13.60000 13.30000 13.10000  
## [241] 16.60000 16.30000 16.30000 16.20000 16.10000 15.90000 15.80000 15.80000  
## [249] 15.80000 15.70000 15.70000 18.80000 18.60000 18.80000 18.20000 18.00000  
## [257] 12.80000 12.80000 12.90000 12.50000 12.40000 12.40000 12.70000 12.80000  
## [265] 12.80000 12.30000 12.80000 12.50000 12.20000 11.90000 11.80000 11.70000  
## [273] 10.70000 10.70000 10.30000 10.00000 9.80000 9.50000 9.30000 9.10000  
## [281] 8.90000 8.70000 8.50000 8.10000 7.70000 7.30000 6.60000 6.40000  
## [289] 12.50000 12.50000 12.60000 12.30000 11.90000 11.40000 10.90000 10.50000  
## [297] 10.10000 9.60000 9.20000 8.80000 8.40000 8.00000 7.60000 7.30000  
## [305] 13.80000 13.80000 13.80000 13.80000 13.80000 13.80000 13.80000 14.00000  
## [313] 14.10000 14.30000 14.40000 14.60000 14.40000 14.00000 13.70000 13.30000  
## [321] 14.20000 14.20000 14.20000 13.90000 13.40000 13.30000 13.30000 13.10000  
## [329] 12.90000 12.70000 12.50000 12.30000 12.10000 11.90000 11.60000 12.11342  
## [337] 12.60000 12.60000 12.60000 12.50000 12.40000 12.30000 12.20000 12.10000  
## [345] 12.10000 11.90000 11.90000 11.80000 11.80000 11.90000 11.80000 11.70000  
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## [361] 13.50000 13.80000 13.80000 14.00000 14.80000 14.60000 14.30000 14.10000  
## [369] 14.90000 15.00000 14.90000 14.40000 14.10000 14.20000 14.10000 14.20000  
## [377] 14.30000 14.30000 14.10000 13.70000 13.40000 13.30000 13.40000 13.40000  
## [385] 15.00000 14.80000 14.40000 14.30000 14.20000 13.90000 13.80000 13.80000  
## [393] 13.50000 13.50000 13.50000 13.30000 12.90000 12.90000 12.90000 12.90000  
## [401] 7.70000 7.70000 7.50000 7.20000 6.70000 6.30000 5.90000 5.40000  
## [409] 4.90000 4.70000 4.30000 3.90000 3.80000 3.60000 3.50000 3.40000  
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## [425] 7.20000 5.90000 5.60000 5.20000 4.70000 4.40000 4.50000 4.50000  
## [433] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342  
## [441] 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342 12.11342  
## [449] 13.50000 13.50000 13.60000 13.20000 13.10000 12.70000 12.40000 12.20000  
## [457] 11.90000 11.90000 11.20000 11.10000 11.30000 11.30000 11.00000 11.30000  
## [465] 10.90000 10.90000 10.80000 10.70000 10.70000 10.60000 10.50000 10.50000  
## [473] 10.30000 10.10000 10.00000 9.70000 9.30000 8.20000 7.60000 7.20000  
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## [489] 8.00000 8.20000 8.30000 8.20000 8.10000 8.40000 7.10000 6.90000  
## [497] 16.30000 15.90000 15.90000 15.90000 15.90000 15.90000 15.90000 15.80000  
## [505] 15.80000 15.80000 15.80000 15.80000 15.80000 15.80000 15.80000 15.90000  
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## [521] 6.20000 6.00000 5.90000 5.70000 5.60000 5.40000 5.30000 5.20000  
## [529] 7.30000 7.30000 7.30000 7.30000 6.70000 6.70000 6.30000 6.00000  
## [537] 5.70000 5.50000 5.60000 5.60000 5.40000 5.10000 4.90000 4.70000  
## [545] 16.30000 16.20000 15.60000 15.50000 15.40000 15.20000 15.30000 15.20000  
## [553] 14.80000 14.90000 14.60000 14.30000 14.00000 13.90000 13.70000 13.50000  
## [561] 13.50000 13.10000 12.70000 12.40000 12.80000 12.50000 12.20000 11.90000  
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## [649] 14.30000 13.90000 13.60000 13.30000 12.90000 12.60000 12.30000 12.20000  
## [657] 13.90000 14.00000 14.70000 15.70000 16.50000 17.60000 17.70000 17.10000  
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## [737] 19.20000 19.20000 18.70000 18.40000 16.90000 16.80000 16.80000 16.80000  
## [745] 16.70000 16.90000 16.60000 16.50000 16.30000 16.60000 16.20000 16.50000  
## [753] 6.30000 6.30000 6.30000 6.30000 5.90000 5.50000 5.30000 5.00000  
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## [785] 14.00000 14.00000 13.40000 13.30000 13.20000 13.10000 13.10000 13.00000  
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## [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  
## [301] 9.977417e+02 8.856382e+02 8.793877e+01 7.658632e+02 7.494211e+03  
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## [321] 4.574979e+03 5.193949e+03 5.358655e+02 4.716673e+03 5.515683e+01  
## [326] 4.611473e+03 4.697897e+03 5.753166e+02 4.182922e+02 3.443217e+02  
## [331] 2.968412e+03 2.656427e+02 2.214732e+03 1.761538e+03 1.524412e+03  
## [336] 1.461755e+03 6.532651e+03 7.497762e+03 7.762578e+01 7.292315e+02  
## [341] 7.645215e+03 6.346156e+03 5.185730e+03 5.623380e+03 5.714479e+03  
## [346] 5.374555e+03 5.351254e+03 4.896584e+03 4.163660e+03 3.556184e+02  
## [351] 3.128978e+03 3.349688e+03 8.757262e+03 1.226617e+03 1.221694e+04  
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## [361] 7.313558e+03 5.861460e+02 4.771827e+02 3.623477e+03 3.595876e+02  
## [366] 2.819650e+03 3.146952e+03 3.739119e+03 3.967895e+03 4.159865e+03  
## [371] 4.459728e+04 4.765126e+04 4.717273e+03 3.526811e+04 2.796548e+04  
## [376] 3.795129e+04 3.267237e+04 3.989669e+02 2.612133e+03 2.189665e+04  
## [381] 1.855557e+04 1.684622e+04 1.646813e+04 1.884483e+02 6.993477e+03  
## [386] 7.853335e+03 7.674866e+03 7.378255e+03 7.813835e+03 6.843263e+03  
## [391] 6.955988e+03 7.296122e+03 5.932900e+03 4.513136e+03 3.893690e+03  
## [396] 3.381578e+03 2.714682e+02 2.875348e+02 1.764974e+03 1.692859e+02  
## [401] 6.155922e+02 7.514641e+01 6.994528e+02 6.738227e+02 6.668428e+02  
## [406] 5.754465e+02 5.527456e+02 5.697613e+02 4.751112e+02 4.226332e+02  
## [411] 4.699887e+01 3.713239e+02 3.323444e+02 2.676354e+01 2.354912e+02  
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## [426] 1.658794e+02 1.557434e+01 1.274297e+02 1.128494e+02 1.224336e+02  
## [431] 1.337428e+02 1.359984e+02 7.494211e+03 7.494211e+03 7.494211e+03  
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## [441] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03  
## [446] 7.494211e+03 7.494211e+03 7.494211e+03 2.954119e+03 3.529618e+03  
## [451] 3.558796e+03 3.484828e+02 3.674295e+02 3.312826e+03 3.444557e+03  
## [456] 3.638959e+03 3.112286e+03 2.342899e+02 2.481346e+02 1.976459e+03  
## [461] 1.768921e+03 1.373516e+03 1.268885e+03 1.239378e+03 1.163190e+03  
## [466] 1.986871e+02 1.284196e+02 9.524413e+01 8.824915e+02 7.856929e+02  
## [471] 7.382327e+02 7.457878e+02 6.316758e+02 5.398792e+02 4.742239e+02  
## [476] 4.861518e+01 3.624214e+02 3.396770e+02 3.212263e+02 3.685949e+00  
## [481] 1.244429e+03 1.441142e+03 1.365344e+03 1.255648e+03 1.295650e+03  
## [486] 1.182869e+03 1.231954e+02 1.233524e+03 1.117119e+02 1.298916e+01  
## [491] 9.521872e+02 9.321172e+01 8.248689e+02 6.763977e+02 6.146729e+02  
## [496] 6.841440e+01 4.331574e+04 5.444338e+02 5.241372e+04 5.249669e+04  
## [501] 5.282218e+03 4.744748e+04 4.773454e+03 4.659634e+04 4.454453e+04  
## [506] 4.386699e+03 3.618959e+04 3.197987e+04 2.817215e+04 2.416784e+04  
## [511] 2.369159e+04 2.412417e+04 3.483814e+02 3.771323e+02 3.374850e+02  
## [516] 4.864111e+02 4.943368e+02 4.464434e+02 4.499618e+02 4.568614e+02  
## [521] 3.971485e+02 3.476737e+02 3.271149e+02 3.132160e+02 2.862582e+02  
## [526] 2.537683e+02 2.431586e+02 2.435429e+02 7.772488e+02 1.259985e+02  
## [531] 9.861318e+02 9.734726e+02 9.892364e+02 8.965697e+02 8.445594e+01  
## [536] 9.297724e+02 8.168388e+01 7.121848e+02 6.624214e+01 4.546766e+02  
## [541] 2.925914e+02 2.285482e+01 1.973156e+02 1.662318e+02 1.365323e+04  
## [546] 1.481738e+04 1.594140e+04 1.543193e+04 1.475692e+03 1.286178e+03  
## [551] 1.243328e+03 1.781367e+03 1.526877e+03 9.484681e+03 7.615347e+03  
## [556] 6.218283e+02 4.787700e+03 4.463546e+03 4.595666e+03 5.113685e+02  
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## [576] 9.593722e+02 6.445256e+02 7.913383e+03 8.358630e+01 7.884984e+03  
## [581] 7.227740e+03 6.256554e+02 5.148422e+03 5.433725e+03 4.674220e+03  
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## [591] 2.395857e+03 2.472198e+03 7.276464e+02 8.529544e+02 8.343419e+02  
## [596] 7.886327e+02 8.297587e+02 7.691743e+02 7.785454e+02 7.959752e+02  
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## [616] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03  
## [621] 7.494211e+03 7.494211e+03 7.494211e+03 7.494211e+03 1.146363e+03  
## [626] 1.647442e+03 1.569666e+03 9.985370e+03 9.186596e+03 8.199415e+03  
## [631] 6.893962e+02 6.911136e+03 6.126234e+02 5.245187e+03 4.697111e+03  
## [636] 4.425575e+03 4.167714e+03 4.621497e+02 3.981528e+03 3.883637e+02  
## [641] 1.157967e+04 1.346747e+04 1.357475e+04 1.323598e+04 1.453918e+04  
## [646] 1.355746e+03 1.415714e+04 1.589387e+04 1.354670e+04 1.136342e+04  
## [651] 1.224246e+03 9.365742e+03 7.858814e+02 6.537164e+02 5.245421e+03  
## [656] 4.919629e+03 7.622612e+02 7.551990e+01 6.761534e+02 6.425941e+03  
## [661] 6.759244e+02 5.676141e+03 5.484776e+03 5.376448e+03 5.184494e+03  
## [666] 4.669692e+03 3.779577e+03 3.397163e+02 3.192669e+03 2.994340e+03  
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## [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  
## [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

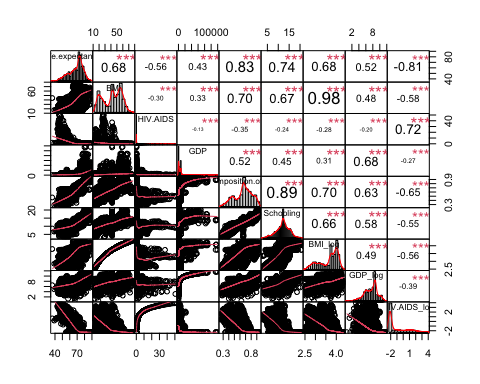
lifeExpec\_final$HIV.AIDS[is.na(lifeExpec\_final$HIV.AIDS)]<-mean(lifeExpec\_final$HIV.AIDS,na.rm=TRUE)  
lifeExpec\_final$HIV.AIDS

## [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

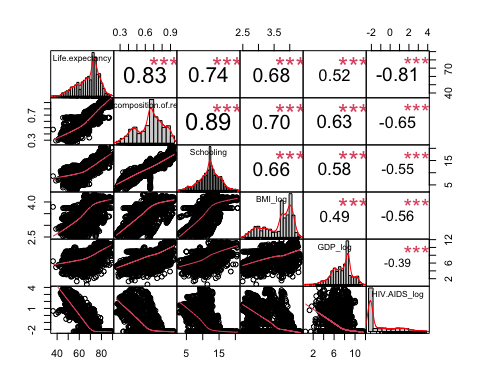
lifeExpec\_final$HIV.AIDS\_log <- log(lifeExpec\_final$HIV.AIDS)

# 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)



## 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

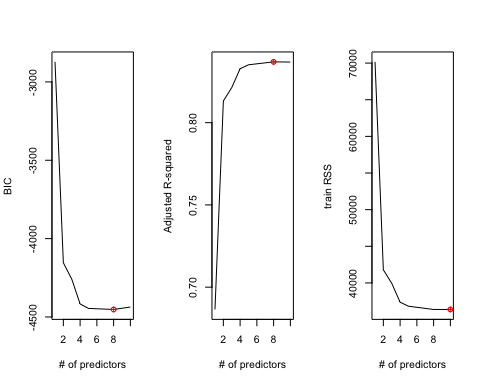
summary(model.fwd)$rss

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

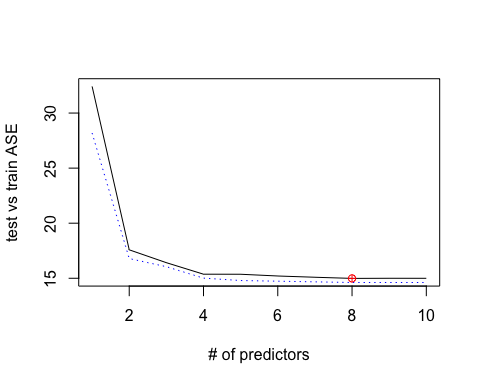
summary(model.fwd)$bic

## [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



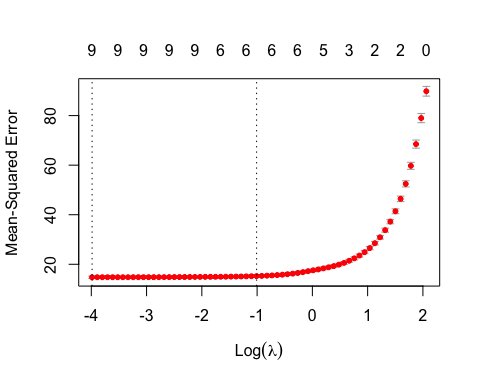
coef(model.fwd,8)

## (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.AIDS\_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

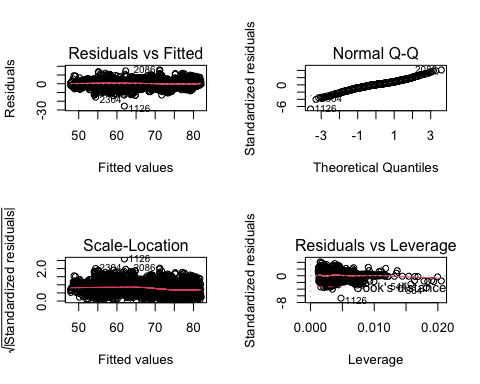
coef(lasso.mod,s=bestlambda)

## 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

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

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>

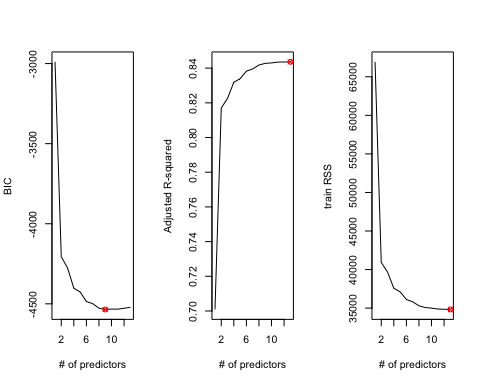
lifeExpec[544,]

## # 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>

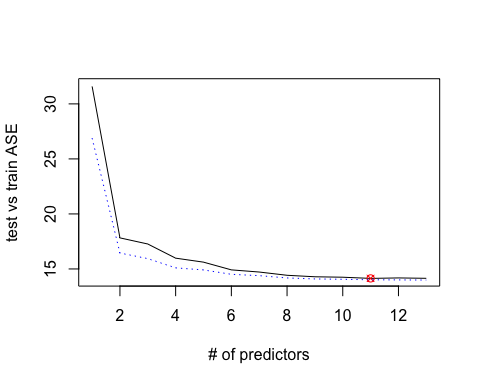
lifeExpec[864,]

## # 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.resources\*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)



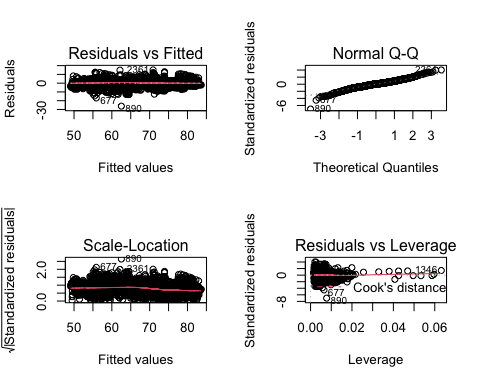
#Cross validation function  
predict.regsubsets =function (object , newdata ,id ,...){  
 form=as.formula (object$call [[2]])  
 mat=model.matrix(form ,newdata)  
 coefi=coef(object ,id=id)  
 xvars=names(coefi)  
 mat[,xvars]%\*%coefi  
}  
  
#test versus train   
testASEb<-c()  
for (i in 1:13){  
 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\*BMI\_log, data = train)  
  
#base check of model summary with VIF  
par(mfrow=c(2,2))  
plot(vifcheckmodel)



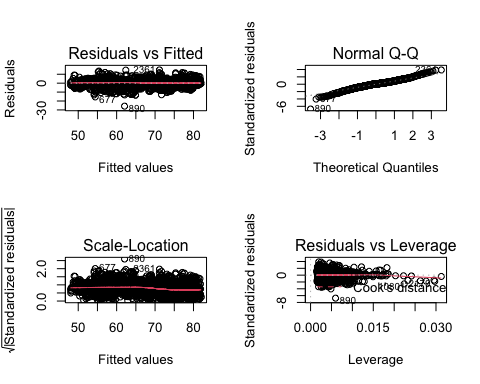
summary(vifcheckmodel)

##   
## 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)



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

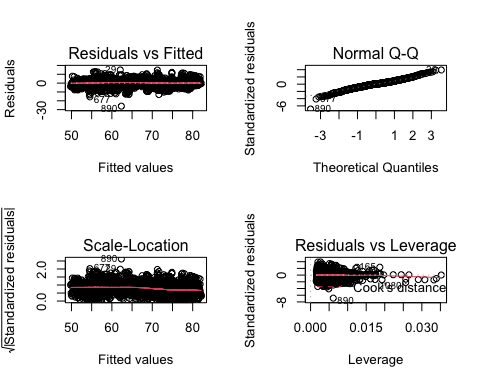
vif(vifcheckmodelb)

## 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

#Final model with VIF handled.  
finalcpmodelb <- lm(Life.expectancy ~ Status + continent + Income.composition.of.resources\*HIV.AIDS\_log + Schooling\*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.resources)  
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)  
  
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

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

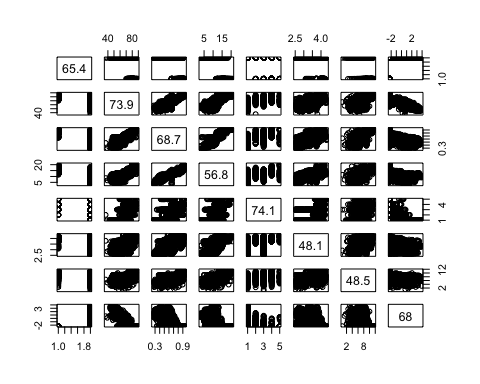
#calculating the distance between the 3rd observation and 4th observation  
sqrt(sum((lifeEst\_knn\_10$learn$X[3,] - lifeEst\_knn\_10$learn$X[4,])^4))

## [1] 0.01060735

#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

#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))



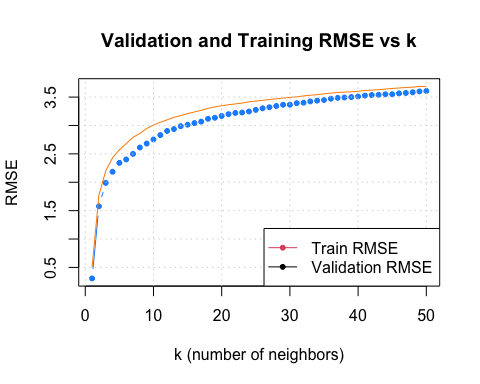
#creating function for multiple k values  
train\_knn <- function(neighbors) {  
 knnreg(Life.expectancy ~ ., data = lifeExpec\_final, k = neighbors)  
}  
  
train\_knn(neighbors = 5)

## 5-nearest neighbor regression model

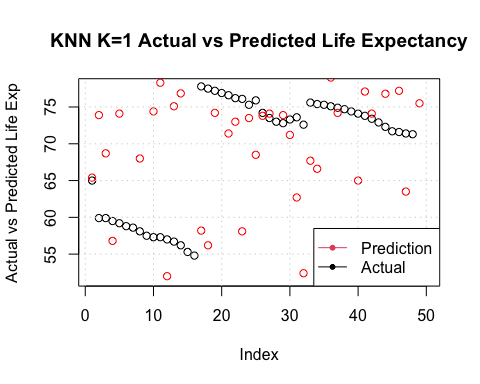
knn\_list <- lapply(1:50, train\_knn)  
  
  
#knn\_val\_pred <- lapply(knn\_mod\_list, predict, lifeEst\_val)  
knn\_val\_pred <- lapply(knn\_list, predict, lifeEst\_val)  
knn\_trn\_pred <- lapply(knn\_list, predict, lifeEst\_est)  
  
calc\_rmse <- function(actual, predicted) (  
 sqrt(mean((actual - 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

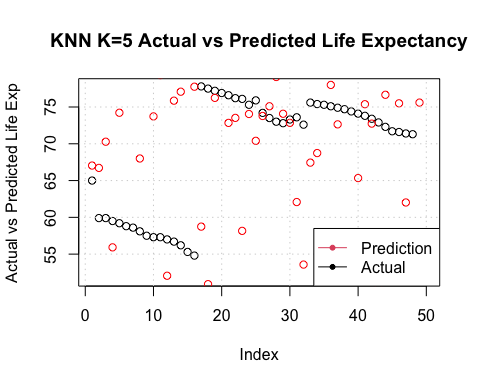
#create vectors for RMSE val and pred  
knn\_rmse\_val <- sapply(knn\_val\_pred, calc\_rmse, lifeEst\_val$Life.expectancy)  
knn\_rmse\_trn <- sapply(knn\_trn\_pred, calc\_rmse, lifeEst\_est$Life.expectancy)  
  
#plot rmse   
plot(1:50, knn\_rmse\_val, type = "b", col = "dodgerblue", pch = 20, ylim = 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)



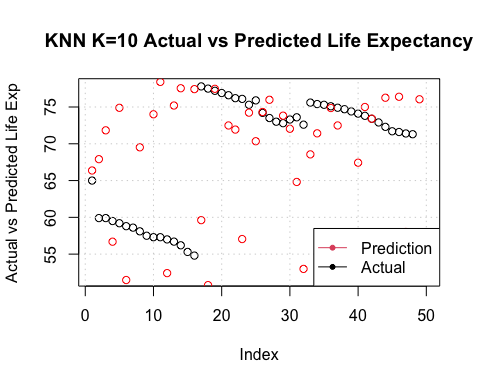
#plot the predict function KNN K=1  
pred01 <- predict(lifeEst\_knn\_01, lifeEst\_val[1:50,])  
actual <- lifeExpec\_final[1:50,]  
  
  
plot(actual$Life.expectancy, col = "black", ylab = "Actual vs Predicted Life Exp", main = "KNN K=1 Actual vs Predicted Life Expectancy")  
points(1:50,pred01, col = "red")  
grid()  
legend('bottomright',   
 c("Prediction","Actual"),  
 col = c(2,1),  
 lty = 1,  
 pch = 20)



#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)



#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)



#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)

