Where Not to Get Lucky

Stuart Shim

February 20, 2019

Introduction

This project will examine which states have the highest rates of sexually transmitted diseases in the United States from 2000-2015. Specifically, this may help visitors, travelers, and tourists make future travel and leisure plans. This project hopes to address, are there particular US states or regions to avoid in order reduce infection by sexually transmitted diseases? In addition, using regression and k-NN modeling, this project will try to identify which sexually transmitted disease, are good methods and predictors of total overal rates of STDs in the United States, 2000-2015.

Data

The STDs Nationally Ranked By State data set is from the Centers for Disease Control and Prevention, Atlanta, Georgia. It contains a collection of data measured between 2000 and 2015, consisting of 800 observations of 15 variables, from all 50 US states. This data set comes from the 2000 -2015 STDs Nationally Ranked By State

This is the capstone project for the HarvardX certificate program in data science offered by EdX, February 2019.

```
### Data Preparation

#### Install Packages
```

```
install.packages ("tidyverse", repos = "http://cran.us.r-project.org")
```

```
## Installing package into 'C:/Users/StuartS_2/Documents/R/win-library/3.5'
## (as 'lib' is unspecified)
```

```
## package 'tidyverse' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
##  C:\Users\StuartS_2\AppData\Local\Temp\RtmpOypMG3\downloaded_packages
```

```
install.packages ("moderndive", repos= "http://cran.us.r-project.org")
```

```
## Installing package into 'C:/Users/StuartS_2/Documents/R/win-library/3.5'
## (as 'lib' is unspecified)
```

```
## package 'moderndive' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
##  C:\Users\StuartS_2\AppData\Local\Temp\RtmpOypMG3\downloaded_packages
```

```
install.packages ("ggplot2", repos= "http://cran.us.r-project.org")
```

```
## Installing package into 'C:/Users/StuartS_2/Documents/R/win-library/3.5'
## (as 'lib' is unspecified)
```

```
## package 'ggplot2' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
##  C:\Users\StuartS_2\AppData\Local\Temp\RtmpOypMG3\downloaded_packages
```

```
install.packages("caret", repos = "http://cran.us.r-project.org")
```

```
## Installing package into 'C:/Users/StuartS_2/Documents/R/win-library/3.5'
## (as 'lib' is unspecified)
```

```
## package 'caret' successfully unpacked and MD5 sums checked
##
## The downloaded binary packages are in
##  C:\Users\StuartS_2\AppData\Local\Temp\RtmpOypMG3\downloaded_packages
```

```
library (tidyverse)
```

```
## -- Attaching packages ---------------
```

```
## v ggplot2 3.1.0     v purrr   0.2.5
## v tibble  1.4.2     v dplyr   0.7.8
## v tidyr   0.8.2     v stringr 1.3.1
## v readr   1.3.1     v forcats 0.3.0
```

```
## -- Conflicts ------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library (moderndive)
library (ggplot2)
library (caret)
```

```
## Loading required package: lattice
```

```
##
## Attaching package: 'caret'
```

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

Obtaining and Exploring the data

Obtaining the data

```
# Reading the data

STDs_Nationally_Ranked_By_State <- read.csv("C:/Users/StuartS_2/Desktop/STDs_Nationally_Ranked_By_State
```

Exploring the data

This data set will be observed for its contents, values, and structure. In addition, basic visualizations will be created in order to identify broader national trends. The data set will be converted to a tibble in order to make additional data manipulation possible.

```
# Looking at the first rows and columns names of the data

head (STDs_Nationally_Ranked_By_State)
```

```
##   Sort Year      State Chlamydia_Count Chlamydia_Rate
## 1    1 2000    Alabama           15323          344.2
## 2    2 2000     Alaska            2569          409.3
## 3    3 2000    Arizona           12591          243.7
## 4    4 2000   Arkansas            6219          232.2
```

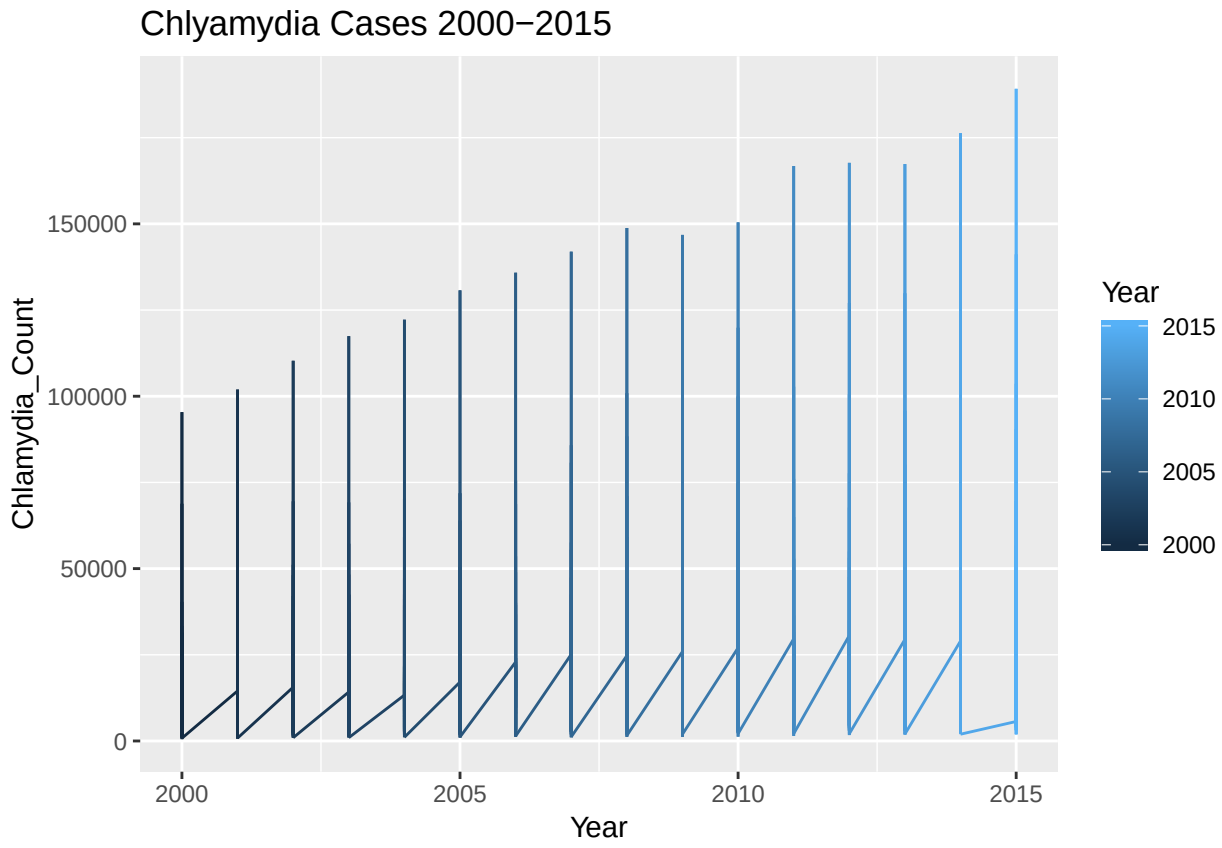
```
## 5    5 2000 California           95392          280.5
## 6    6 2000   Colorado           12000          277.3
##   Chlamydia_RankByCount Chlamydia_RankByRate Gonorrhea_Count
## 1                    14                    6           12063
## 2                    40                    2             361
## 3                    21                   22            4130
## 4                    31                   25            3642
## 5                     1                   12           21619
## 6                    22                   13            3112
##   Gonorrhea_Rate Gonorrhea_RankByCount Gonorrhea_RankByRate
## 1          271.0                    12                    3
## 2           57.5                    41                   35
## 3           79.9                    23                   28
## 4          136.0                    24                   17
## 5           63.6                     4                   32
## 6           71.9                    27                   30
##   Primary_Secondary_Syphilis_Count Primary_Secondary_Syphilis_Rate
## 1                              123                            2.8
## 2                                0                            0.0
## 3                              189                            3.7
## 4                              104                            3.9
## 5                              325                            1.0
## 6                               11                            0.3
##   Primary_Secondary_Syphilis_RankByCount
## 1                                     17
## 2                                     39
## 3                                     13
## 4                                     19
## 5                                      9
## 6                                     31
##   Primary_Secondary_Syphilis_RankByRate
## 1                                    13
## 2                                    NA
## 3                                    10
## 4                                     9
## 5                                    19
## 6                                    26
```

```r
# Determining the structure of the data

str(STDs_Nationally_Ranked_By_State)
```

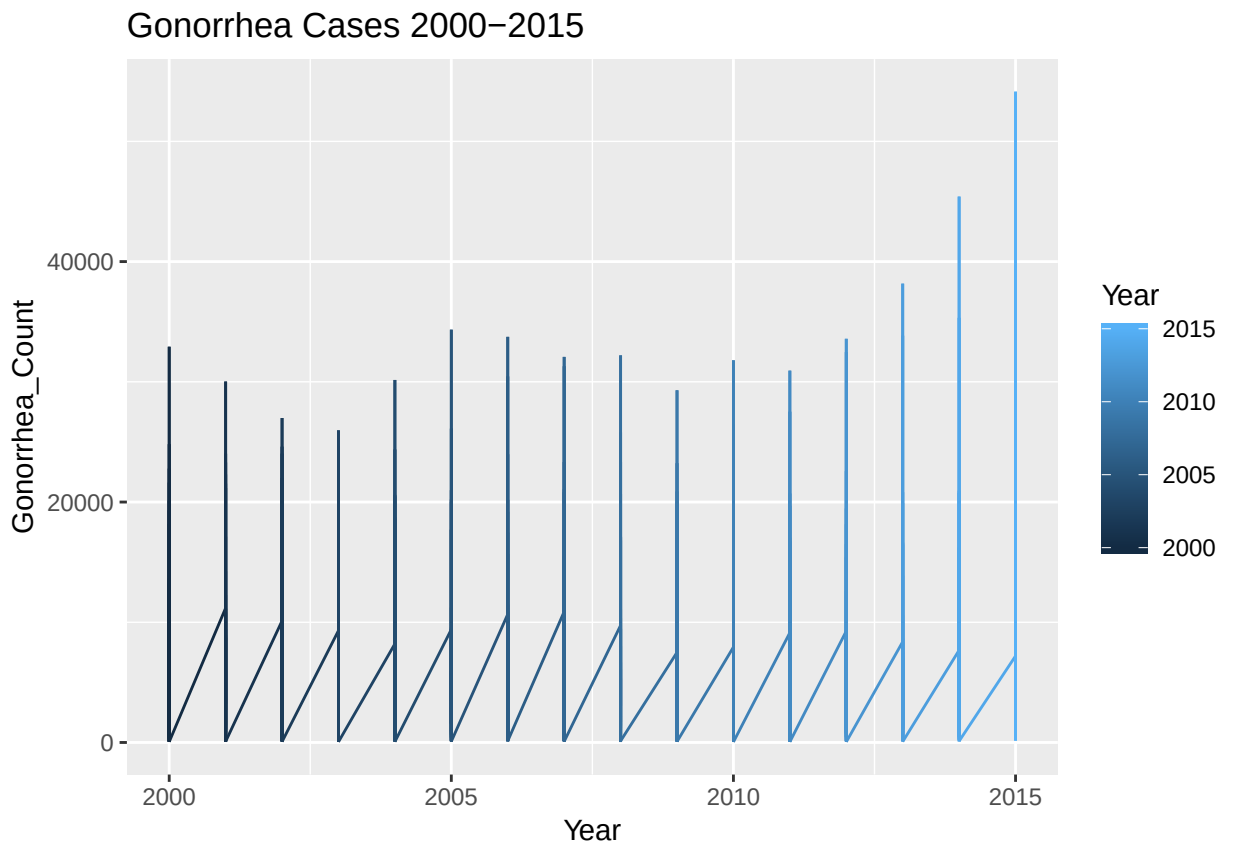
```
## 'data.frame':    800 obs. of  15 variables:
##  $ Sort                                : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Year                                : int  2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 ..
##  $ State                               : Factor w/ 50 levels "Alabama","Alaska",..: 1 2 3 4 5 6 7 8
##  $ Chlamydia_Count                     : int  15323 2569 12591 6219 95392 12000 7604 2856 33390 293
##  $ Chlamydia_Rate                      : num  344 409 244 232 280 ...
##  $ Chlamydia_RankByCount               : int  14 40 21 31 1 22 29 38 4 7 ...
##  $ Chlamydia_RankByRate                : int  6 2 22 25 12 13 28 4 33 5 ...
##  $ Gonorrhea_Count                     : int  12063 361 4130 3642 21619 3112 2912 1735 22781 20265
##  $ Gonorrhea_Rate                      : num  271 57.5 79.9 136 63.6 ...
##  $ Gonorrhea_RankByCount               : int  12 41 23 24 4 27 29 32 3 5 ...
##  $ Gonorrhea_RankByRate                : int  3 35 28 17 32 30 27 5 16 4 ...
##  $ Primary_Secondary_Syphilis_Count    : int  123 0 189 104 325 11 16 9 413 402 ...
```

```
##  $ Primary_Secondary_Syphilis_Rate       : num  2.8 0 3.7 3.9 1 0.3 0.5 1.1 2.6 4.9 ...
##  $ Primary_Secondary_Syphilis_RankByCount: int  17 39 13 19 9 31 28 32 3 5 ...
##  $ Primary_Secondary_Syphilis_RankByRate : int  13 NA 10 9 19 26 24 18 14 6 ...
```

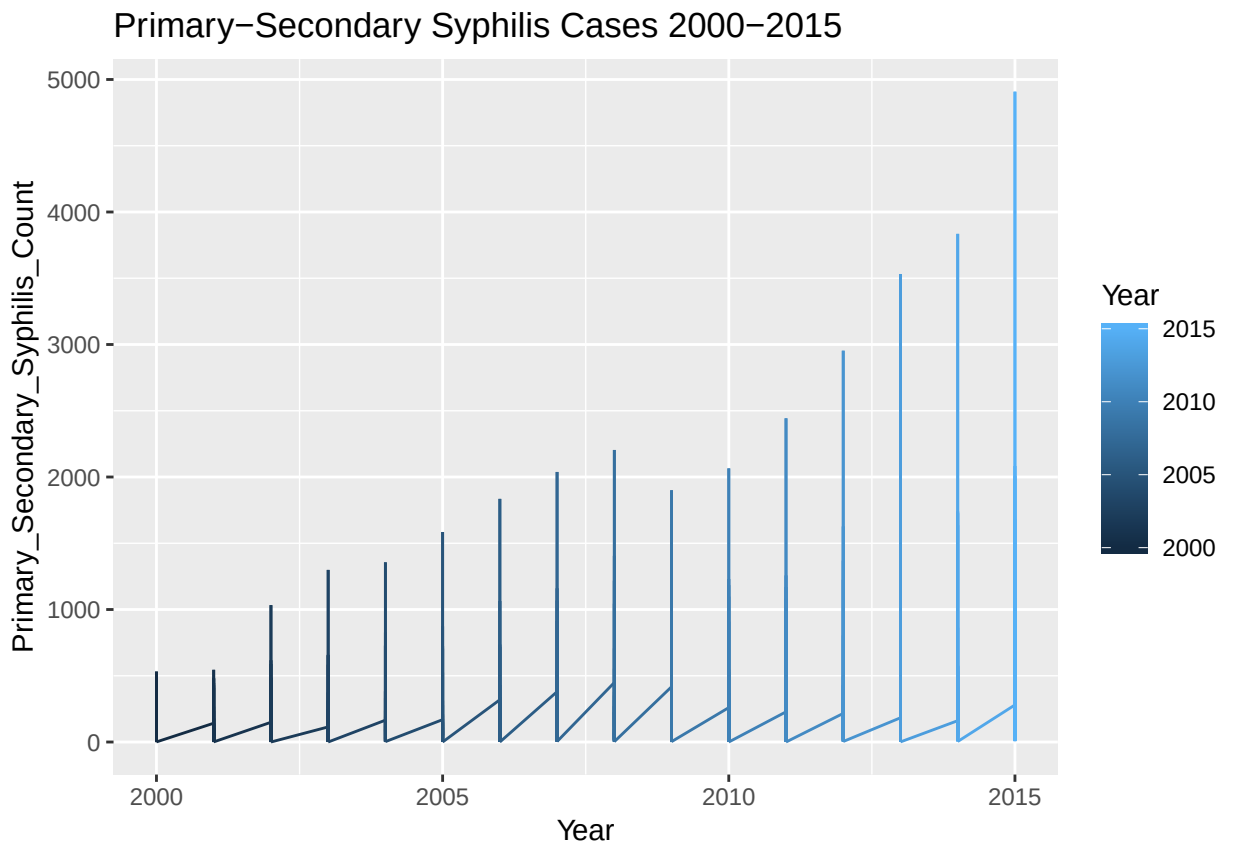
```
# Visualizing the data to identify broad national trends from 2000-2015

ggplot(STDs_Nationally_Ranked_By_State, aes(x = Year, y = Chlamydia_Count)) +
  geom_line(aes(color=Year)) +
  labs(x = "Year", y = "Chlamydia_Count", title = "Chlyamydia Cases 2000-2015")
```




```
ggplot(STDs_Nationally_Ranked_By_State, aes(x=Year, y= Gonorrhea_Count)) +        geom_line(aes(color=Y
  labs(x= "Year", y = "Gonorrhea_Count", title= "Gonorrhea Cases 2000-2015")
```




```
ggplot(STDs_Nationally_Ranked_By_State, aes(x = Year,
  y =Primary_Secondary_Syphilis_Count)) +
  geom_line(aes(color=Year)) +
  labs(x = "Year", y = "Primary_Secondary_Syphilis_Count", title =        "Primary-Secondary Syphilis Ca
```




```
# Creating a new object for data manipulation

std_data<- (STDs_Nationally_Ranked_By_State)

# Reducing the data into chlyamidia, gonorrhea, and syphlis rates by year and state

std_data <- select (std_data,  c(Year, State, Chlamydia_Rate, Gonorrhea_Rate, Primary_Secondary_Syphilis

# Transforming data into a tibble

as.tibble (std_data)
```

```
## # A tibble: 800 x 5
##     Year State     Chlamydia_Rate Gonorrhea_Rate Primary_Secondary_Syphili~
##    <int> <fct>              <dbl>          <dbl>                       <dbl>
##  1  2000 Alabama             344.          271                          2.8
##  2  2000 Alaska              409.           57.5                        0
##  3  2000 Arizona             244.           79.9                        3.7
##  4  2000 Arkansas            232.          136                          3.9
##  5  2000 Californ~           280.           63.6                        1
##  6  2000 Colorado            277.           71.9                        0.3
##  7  2000 Connecti~           223.           85.3                        0.5
##  8  2000 Delaware            363.          221.                         1.1
##  9  2000 Florida             208           142.                         2.6
## 10  2000 Georgia             356.          246.                         4.9
## # ... with 790 more rows
```

```r
# Observing the structure of the tibble

str (std_data)
```

```
## 'data.frame':    800 obs. of  5 variables:
##  $ Year                           : int  2000 2000 2000 2000 2000 2000 2000 2000 2000 2000 ...
##  $ State                          : Factor w/ 50 levels "Alabama","Alaska",..: 1 2 3 4 5 6 7 8 9 10
##  $ Chlamydia_Rate                 : num  344 409 244 232 280 ...
##  $ Gonorrhea_Rate                 : num  271 57.5 79.9 136 63.6 ...
##  $ Primary_Secondary_Syphilis_Rate: num  2.8 0 3.7 3.9 1 0.3 0.5 1.1 2.6 4.9 ...
```

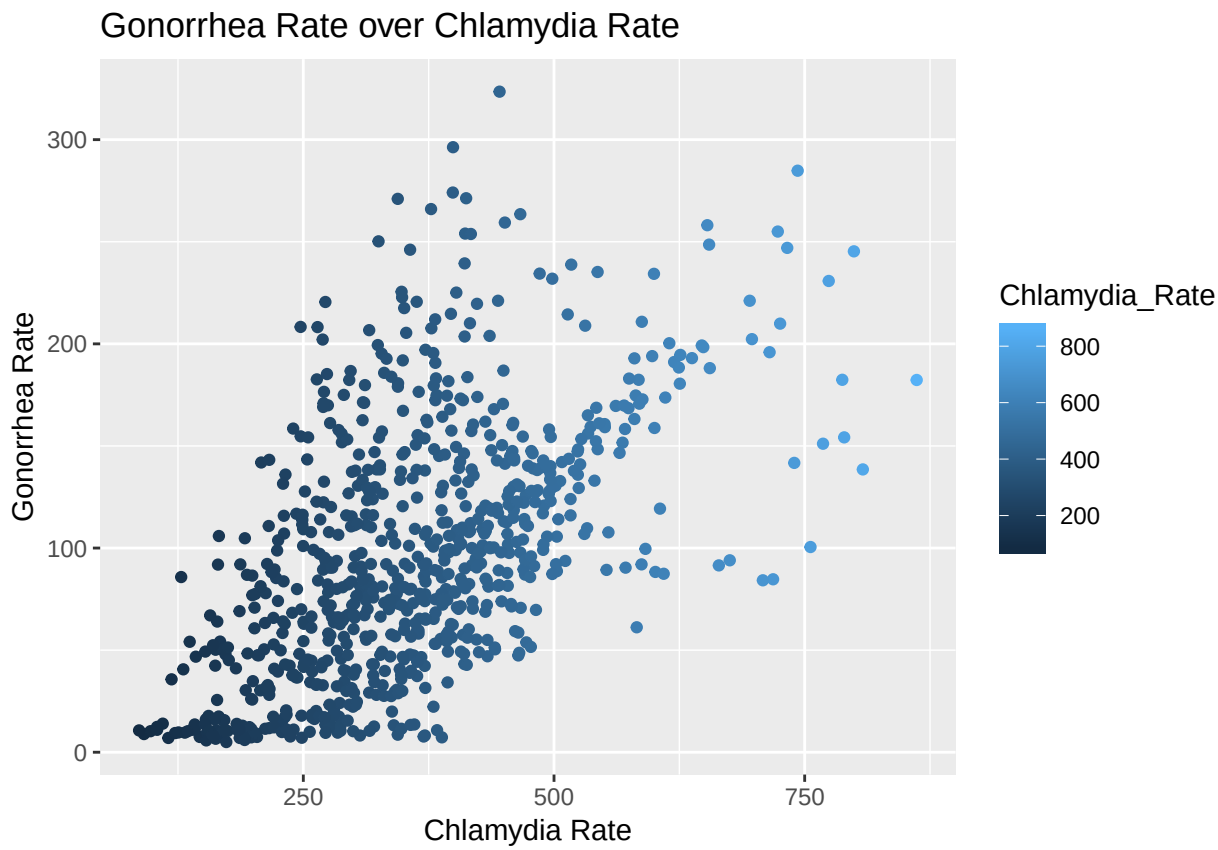
```r
glimpse (std_data)
```

```
## Observations: 800
## Variables: 5
## $ Year                           <int> 2000, 2000, 2000, 2000, 2000, ...
## $ State                          <fct> Alabama, Alaska, Arizona, Arka...
## $ Chlamydia_Rate                 <dbl> 344.2, 409.3, 243.7, 232.2, 28...
## $ Gonorrhea_Rate                 <dbl> 271.0, 57.5, 79.9, 136.0, 63.6...
## $ Primary_Secondary_Syphilis_Rate <dbl> 2.8, 0.0, 3.7, 3.9, 1.0, 0.3, ...
```

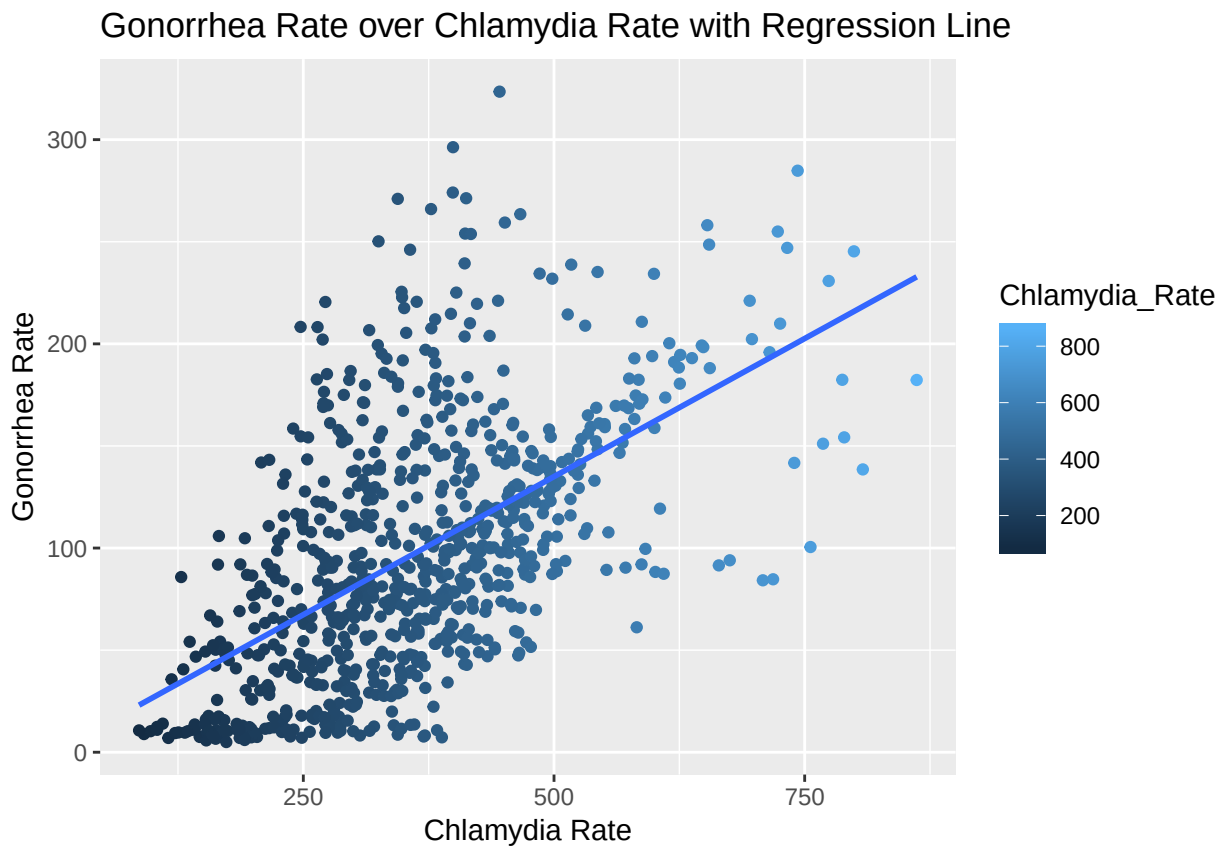
Analysis

The data set will be modeled using regression and K-NN models to help determine relative model quality, based on lower RMSE scoring.

```r
# Regression modelling
# Code to create scatterplot between chlamydia and gonorrhea rates

ggplot(std_data, aes(x=Chlamydia_Rate, y=Gonorrhea_Rate)) +
geom_point(aes(color=Chlamydia_Rate)) +
labs(x= "Chlamydia Rate", y="Gonorrhea Rate", title = "Gonorrhea Rate over Chlamydia Rate")
```




```
# Add a best fitting line

ggplot(std_data, aes(x=Chlamydia_Rate, y=Gonorrhea_Rate)) +
geom_point(aes(color=Chlamydia_Rate)) +
labs(x= "Chlamydia Rate", y="Gonorrhea Rate", title = "Gonorrhea Rate over Chlamydia Rate with Regressi
geom_smooth (method = "lm", se=FALSE)
```




```
# Computing slope and intercept of regression model using formula of form y~x

model_std_data <- lm(Gonorrhea_Rate ~ Chlamydia_Rate, data=std_data)

# Output

model_std_data
```

```
##
## Call:
## lm(formula = Gonorrhea_Rate ~ Chlamydia_Rate, data = std_data)
##
## Coefficients:
##    (Intercept)  Chlamydia_Rate
##        -0.2493          0.2705
```

```
# Output regression table using wrapper function

get_regression_table(model_std_data)
```

```
## # A tibble: 2 x 7
##   term           estimate std_error statistic p_value lower_ci upper_ci
##   <chr>             <dbl>     <dbl>     <dbl>   <dbl>    <dbl>    <dbl>
## 1 intercept        -0.249     5.34     -0.047   0.963  -10.7     10.2
## 2 Chlamydia_Rate    0.27      0.014    19.4     0        0.243    0.298
```

```
# Multiple regression adding syphilis rate to previous model
```

```r
# Fit model

model2_std_data <- lm(Gonorrhea_Rate ~ Chlamydia_Rate + Primary_Secondary_Syphilis_Rate, data=std_data)

# Output multiple regression model

model2_std_data
```

```
##
## Call:
## lm(formula = Gonorrhea_Rate ~ Chlamydia_Rate + Primary_Secondary_Syphilis_Rate,
##     data = std_data)
##
## Coefficients:
##                       (Intercept)                     Chlamydia_Rate
##                             6.991                              0.197
## Primary_Secondary_Syphilis_Rate
##                             6.578
```

```r
# Get regression table
get_regression_table(model2_std_data)
```

```
## # A tibble: 3 x 7
##   term               estimate std_error statistic p_value lower_ci upper_ci
##   <chr>                 <dbl>     <dbl>     <dbl>   <dbl>    <dbl>    <dbl>
## 1 intercept             6.99      5.19       1.35   0.179   -3.20    17.2
## 2 Chlamydia_Rate        0.197     0.016     12.3    0        0.166    0.228
## 3 Primary_Secondary~    6.58      0.788      8.35   0        5.03     8.12
```

```r
# Sum, calculate the mean of US chlamydia, gonorrhea, and syphilis rates

model3_std_data <- mutate (std_data, Total_Mean=((Chlamydia_Rate + Gonorrhea_Rate + Primary_Secondary_Sy

# Correlation between Total_Mean and chlamydia, gonorrhea, and syphilis rates

model3_std_data %>%
  summarize(correlation = cor(Chlamydia_Rate, Total_Mean))
```

```
##   correlation
## 1   0.9546932
```

```r
model3_std_data %>%
  summarize(correlation = cor(Gonorrhea_Rate, Total_Mean))
```

```
##   correlation
## 1   0.7851987
```

```r
model3_std_data %>%
  summarize(correlation = cor(Primary_Secondary_Syphilis_Rate, Total_Mean))
```

```
##   correlation
## 1   0.6041468
```

```r
# Arrange data from highest ranked states to lowest

arrange(model3_std_data, desc(Total_Mean))
```

```
##     Year          State Chlamydia_Rate Gonorrhea_Rate
```

```
## 1   2009    Mississippi         799.1         245.3
## 2   2010         Alaska         861.7         182.3
## 3   2007    Mississippi         743.0         284.8
## 4   2012    Mississippi         774.0         230.8
## 5   2008    Mississippi         723.2         255.0
## 6   2005    Mississippi         732.6         247.0
## 7   2014         Alaska         787.5         182.4
## 8   2011         Alaska         808.0         138.5
## 9   2013         Alaska         789.4         154.2
## 10  2010    Mississippi         725.5         209.9
## 11  2015      Louisiana         695.2         221.1
## 12  2015         Alaska         768.3         151.1
## 13  2011    Mississippi         715.0         195.9
## 14  2006    Mississippi         652.9         258.1
## 15  2011      Louisiana         697.4         202.3
## 16  2004    Mississippi         654.7         248.6
## 17  2009         Alaska         739.6         141.7
## 18  2010      Louisiana         648.9         198.4
## 19  2015 North Carolina         647.4         199.2
## 20  2012         Alaska         755.8         100.5
## 21  2014    Mississippi         655.4         188.1
## 22  2007 South Carolina         599.7         234.3
## 23  2012        Alabama         637.6         193.0
## 24  2014      Louisiana         626.0         194.6
## 25  2009      Louisiana         615.0         200.3
## 26  2013      Louisiana         624.5         188.4
## 27  2011        Alabama         619.8         191.1
## 28  2011 South Carolina         625.5         180.5
## 29  2007         Alaska         718.5          84.7
## 30  2008 South Carolina         587.6         210.8
## 31  2012      Louisiana         597.9         194.0
## 32  2008         Alaska         708.3          84.2
## 33  2013        Alabama         611.0         173.7
## 34  2007        Alabama         543.5         235.2
## 35  2015    Mississippi         580.2         192.9
## 36  2000    Mississippi         445.7         323.5
## 37  2006         Alaska         675.3          94.0
## 38  2009 South Carolina         584.4         182.4
## 39  2014 South Carolina         588.2         172.8
## 40  2011 North Carolina         574.9         183.0
## 41  2014        Alabama         600.2         158.8
## 42  2010 South Carolina         581.5         174.7
## 43  2013    Mississippi         585.1         170.7
## 44  2006 South Carolina         517.2         238.8
## 45  2005         Alaska         664.4          91.5
## 46  2008        Alabama         531.1         208.9
## 47  2010        Alabama         574.3         168.5
## 48  2012 South Carolina         580.2         163.2
## 49  2015 South Carolina         569.9         169.8
## 50  2008      Louisiana         513.7         214.4
## 51  2015        Georgia         570.8         158.3
## 52  2011        Georgia         561.6         169.6
## 53  2006        Alabama         498.3         231.9
## 54  2003      Louisiana         466.4         263.5
```

```
## 55  2015     New Mexico         605.7         119.3
## 56  2004      Louisiana         485.7         234.4
## 57  2013       Delaware         568.4         151.6
## 58  2007      Louisiana         451.0         259.4
## 59  2009        Alabama         550.7         159.2
## 60  2012       Arkansas         565.4         146.6
## 61  2011       Arkansas         550.5         160.7
## 62  2015       Oklahoma         542.2         168.7
## 63  2015       Arkansas         545.0         161.1
## 64  2010       Arkansas         533.8         165.0
## 65  2000      Louisiana         399.3         296.3
## 66  2014       Oklahoma         536.6         159.4
## 67  2013 South Carolina         541.8         152.3
## 68  2012        Georgia         534.0         156.1
## 69  2004         Alaska         609.4          87.4
## 70  2015        Alabama         543.6         148.4
## 71  2002         Alaska         591.2          99.6
## 72  2003         Alaska         601.1          88.3
## 73  2001    Mississippi         412.4         271.3
## 74  2014       Arkansas         527.3         153.4
## 75  2013     New Mexico         587.3          92.0
## 76  2015       Illinois         540.4         133.0
## 77  2006      Louisiana         417.1         253.8
## 78  2015          Texas         523.6         147.3
## 79  2001      Louisiana         399.1         274.1
## 80  2012 North Carolina         524.0         148.3
## 81  2012       Illinois         526.1         141.0
## 82  2014        Georgia         519.9         137.8
## 83  2002      Louisiana         411.4         254.0
## 84  2013        Georgia         514.8         143.7
## 85  2004 South Carolina         444.2         221.1
## 86  2014     New Mexico         554.3         107.7
## 87  2012     New Mexico         571.4          90.4
## 88  2013       Arkansas         523.8         135.9
## 89  2015       New York         524.7         129.4
## 90  2009       Arkansas         496.8         154.4
## 91  2008       Arkansas         495.1         158.1
## 92  2012      Tennessee         507.9         142.1
## 93  2002    Mississippi         410.9         239.4
## 94  2001 South Carolina         377.4         266.0
## 95  2014       Illinois         516.5         124.0
## 96  2010     New Mexico         582.5          61.2
## 97  2009       Delaware         533.0         109.7
## 98  2011       Illinois         506.1         132.8
## 99  2011     New Mexico         552.4          89.3
## 100 2003    Mississippi         423.2         219.6
## 101 2007        Georgia         449.6         186.9
## 102 2011       New York         530.3         106.9
## 103 2005 South Carolina         435.8         203.9
## 104 2013 North Carolina         496.5         140.1
## 105 2015     California         487.5         139.5
## 106 2012       New York         516.5         116.0
## 107 2015           Ohio         489.3         142.9
## 108 2015       Delaware         492.2         140.0
```

```
## 109 2014          Texas         496.1         133.6
## 110 2010       Michigan         496.3         136.7
## 111 2011       Michigan         501.5         130.5
## 112 2013          Texas         498.3         129.8
## 113 2001        Georgia         402.6         225.1
## 114 2006        Georgia         416.2         210.1
## 115 2014 North Carolina         478.7         146.4
## 116 2015       Missouri         477.4         147.5
## 117 2013       Illinois         495.5         127.9
## 118 2009       Illinois         468.9         154.6
## 119 2010        Georgia         459.3         161.3
## 120 2012          Texas         494.8         126.5
## 121 2014       Delaware         483.2         138.2
## 122 2011          Texas         496.6         123.0
## 123 2008       Illinois         458.6         160.2
## 124 2008       Michigan         449.1         170.6
## 125 2003        Georgia         410.9         203.6
## 126 2013       Oklahoma         479.1         139.0
## 127 2010       Delaware         504.3         114.1
## 128 2014           Ohio         474.1         140.3
## 129 2000        Alabama         344.2         271.0
## 130 2008        Georgia         440.1         168.0
## 131 2014       New York         502.8         105.6
## 132 2002        Georgia         397.2         214.7
## 133 2010          Texas         483.7         128.3
## 134 2011      Tennessee         490.1         120.8
## 135 2014        Arizona         488.9         117.0
## 136 2015        Arizona         481.1         122.5
## 137 2012       Michigan         481.6         127.4
## 138 2015      Tennessee         477.5         128.0
## 139 2010       New York         511.3          93.7
## 140 2009       Michigan         458.5         147.5
## 141 2013           Ohio         460.2         144.0
## 142 2000        Georgia         356.5         246.1
## 143 2012           Ohio         460.3         142.9
## 144 2011           Ohio         456.4         145.0
## 145 2014   South Dakota         493.1         105.6
## 146 2009      Tennessee         471.9         125.9
## 147 2010 North Carolina         448.2         150.4
## 148 2006       Delaware         423.6         174.0
## 149 2005      Louisiana         381.5         212.0
## 150 2007           Ohio         413.7         183.7
## 151 2010       Illinois         469.9         122.2
## 152 2008      Tennessee         451.1         141.3
## 153 2013       New York         489.5         101.8
## 154 2011       Missouri         465.6         130.3
## 155 2007      Tennessee         436.4         155.3
## 156 2007       Illinois         431.6         161.9
## 157 2011       Delaware         502.0          92.1
## 158 2012       Missouri         463.1         131.2
## 159 2006     New Mexico         502.9          88.7
## 160 2010       Maryland         459.6         130.1
## 161 2015         Nevada         455.3         127.9
## 162 2012       Delaware         489.2          99.1
```

```
## 163 2015         Hawaii         498.3          87.3
## 164 2009 North Carolina         437.5         147.9
## 165 2011       Maryland         471.3         111.9
## 166 2014       Missouri         462.9         122.2
## 167 2010           Ohio         443.1         142.9
## 168 2015   South Dakota         462.9         122.8
## 169 2005        Alabama         377.7         207.6
## 170 2014     California         459.9         118.5
## 171 2014      Tennessee         474.0         110.8
## 172 2013      Tennessee         470.4         114.2
## 173 2015        Florida         454.8         121.3
## 174 2000       Delaware         363.1         220.6
## 175 2006      Tennessee         419.3         160.5
## 176 2004       Michigan         409.2         172.4
## 177 2013       Missouri         453.8         125.3
## 178 2008 North Carolina         406.8         173.2
## 179 2004        Georgia         394.7         181.7
## 180 2015       Maryland         459.3         114.8
## 181 2006 North Carolina         379.6         195.5
## 182 2001        Alabama         325.0         250.2
## 183 2006       Illinois         417.6         157.3
## 184 2015       Michigan         469.1         104.2
## 185 2002        Alabama         348.0         225.5
## 186 2002       Illinois         381.7         190.7
## 187 2014   North Dakota         477.1          95.9
## 188 2002 South Carolina         348.5         222.8
## 189 2007     New Mexico         480.2          91.2
## 190 2014       Maryland         462.6         103.0
## 191 2006       Missouri         393.3         174.6
## 192 2003           Ohio         371.8         197.1
## 193 2013   South Dakota         471.2          94.1
## 194 2001       Delaware         350.6         217.5
## 195 2012        Indiana         452.7         112.6
## 196 2007       Missouri         396.5         168.0
## 197 2013        Arizona         466.4          97.8
## 198 2010      Tennessee         449.9         113.1
## 199 2005           Ohio         382.3         183.1
## 200 2005        Georgia         380.1         179.6
## 201 2013       Michigan         453.6         106.9
## 202 2008       Delaware         443.0         119.7
## 203 2012   South Dakota         476.2          85.8
## 204 2009       New York         471.1          87.0
## 205 2013       Maryland         454.1         101.8
## 206 2012       Oklahoma         444.2         117.1
## 207 2008       Maryland         437.9         118.3
## 208 2012        Arizona         469.6          89.6
## 209 2015        Indiana         437.9         118.9
## 210 2003 South Carolina         352.6         205.4
## 211 2012       Maryland         455.3          97.6
## 212 2008           Ohio         410.2         146.3
## 213 2009           Ohio         417.9         138.5
## 214 2005       Illinois         397.7         157.5
## 215 2008       Missouri         419.8         135.6
## 216 2005       Michigan         383.0         174.9
```

```
## 217 2010       Missouri         435.1         119.6
## 218 2003       Illinois         381.7         172.4
## 219 2012   Pennsylvania         431.6         120.8
## 220 2004     New Mexico         482.0          69.7
## 221 2005       Missouri         388.7         164.3
## 222 2009        Georgia         405.2         139.2
## 223 2007       Delaware         402.3         149.5
## 224 2008          Texas         414.6         132.4
## 225 2009          Texas         427.4         118.2
## 226 2014         Nevada         424.4         114.3
## 227 2008       Oklahoma         406.4         142.4
## 228 2013     California         439.9         100.3
## 229 2014       Michigan         447.2          97.9
## 230 2014        Indiana         434.0         110.9
## 231 2008       New York         453.3          87.8
## 232 2014        Florida         430.6         107.1
## 233 2005 North Carolina         365.1         176.5
## 234 2001       Illinois         349.2         191.9
## 235 2009       Missouri         432.0         108.4
## 236 2012     California         444.9          89.1
## 237 2013        Indiana         428.7         109.3
## 238 2005      Tennessee         391.2         145.8
## 239 2014       Virginia         436.4          99.9
## 240 2008     New Mexico         466.8          70.7
## 241 2004       Illinois         372.9         162.8
## 242 2007       Maryland         412.0         120.5
## 243 2008       Virginia         401.8         133.1
## 244 2011       Virginia         453.9          81.5
## 245 2003         Hawaii         435.7         100.4
## 246 2004       Missouri         373.7         161.6
## 247 2009       Oklahoma         407.5         126.7
## 248 2014         Hawaii         457.2          72.6
## 249 2009       Maryland         416.7         112.2
## 250 2011        Arizona         457.6          71.4
## 251 2011        Indiana         428.8         101.3
## 252 2013         Nevada         427.0          98.4
## 253 2004      Tennessee         385.4         145.1
## 254 2015       Colorado         445.4          81.9
## 255 2013         Hawaii         476.9          51.6
## 256 2013        Florida         415.1         107.8
## 257 2005       Oklahoma         380.5         148.4
## 258 2009     New Mexico         472.4          53.8
## 259 2005     New Mexico         444.3          81.5
## 260 2011     California         447.7          73.9
## 261 2011   Pennsylvania         416.3         108.4
## 262 2004 North Carolina         344.5         180.7
## 263 2002           Ohio         333.0         192.7
## 264 2000       Illinois         324.3         199.4
## 265 2007       Michigan         370.9         153.7
## 266 2015       Virginia         424.5          97.3
## 267 2010         Hawaii         464.4          58.6
## 268 2004           Ohio         344.3         179.0
## 269 2007 North Carolina         337.8         183.9
## 270 2006       Maryland         389.2         130.5
```

```
## 271 2003        Alabama         315.7         206.7
## 272 2002       Delaware         328.1         195.2
## 273 2015   Pennsylvania         418.1         100.0
## 274 2012         Hawaii         461.2          59.3
## 275 2015   North Dakota         427.2          92.5
## 276 2006       Michigan         364.0         155.3
## 277 2008        Florida         387.5         127.3
## 278 2012       Virginia         431.8          85.0
## 279 2013   Pennsylvania         407.8         108.7
## 280 2005       Delaware         408.5         110.0
## 281 2004       Maryland         362.2         150.6
## 282 2010        Florida         403.2         108.8
## 283 2011      Wisconsin         432.9          84.2
## 284 2006           Ohio         349.4         167.2
## 285 2004         Hawaii         422.0          94.9
## 286 2001           Ohio         330.6         185.8
## 287 2012        Florida         407.4         102.1
## 288 2005         Hawaii         434.7          81.1
## 289 2009         Hawaii         465.3          48.7
## 290 2015      Wisconsin         423.5          91.4
## 291 2011        Florida         404.4         104.7
## 292 2015       Nebraska         422.9          90.5
## 293 2007       New York         418.3          91.7
## 294 2015     Washington         406.4         101.6
## 295 2008         Hawaii         464.4          47.4
## 296 2009        Florida         393.4         112.6
## 297 2003       Delaware         371.3         138.0
## 298 2010       Oklahoma         387.9         118.5
## 299 2001         Alaska         433.1          72.1
## 300 2014       Kentucky         401.9          99.0
## 301 2015       Kentucky         395.2         106.0
## 302 2011       Oklahoma         389.1         112.4
## 303 2006       Oklahoma         363.0         138.3
## 304 2007       Arkansas         351.1         147.0
## 305 2006         Hawaii         431.6          68.8
## 306 2010      Wisconsin         410.9          90.0
## 307 2015         Oregon         410.7          81.4
## 308 2012      Wisconsin         415.4          82.4
## 309 2014   Pennsylvania         395.6          99.5
## 310 2000 North Carolina         272.0         220.5
## 311 2007          Texas         358.9         134.2
## 312 2003      Tennessee         348.9         145.8
## 313 2012       Kentucky         395.3          98.0
## 314 2012         Nevada         408.9          83.1
## 315 2015   Rhode Island         433.6          55.0
## 316 2013       Virginia         407.0          84.9
## 317 2009       Virginia         392.0          98.8
## 318 2013      Wisconsin         411.6          80.3
## 319 2003 North Carolina         311.5         179.8
## 320 2007         Hawaii         440.9          51.3
## 321 2011   South Dakota         418.7          73.9
## 322 2015        Montana         408.8          82.5
## 323 2011         Hawaii         441.2          50.4
## 324 2013       Kentucky         391.2          98.5
```

```
## 325 2013   North Dakota         419.1          70.3
## 326 2006        Arizona         390.7          96.5
## 327 2011       Kentucky         383.2         104.2
## 328 2006      Wisconsin         363.4         124.7
## 329 2010       Virginia         390.7          93.9
## 330 2000          Texas         328.4         157.1
## 331 2002 North Carolina         297.2         186.7
## 332 2008        Indiana         347.4         137.5
## 333 2001       Michigan         310.7         171.1
## 334 2015         Kansas         394.8          87.3
## 335 2002       Maryland         309.5         171.4
## 336 2010     California         407.0          71.5
## 337 2010       Kentucky         379.6         100.7
## 338 2011       Colorado         433.7          47.0
## 339 2008      Wisconsin         373.1         108.2
## 340 2010   Pennsylvania         377.0         102.2
## 341 2014       Nebraska         401.3          78.1
## 342 2012       Colorado         422.7          55.2
## 343 2004        Alabama         295.8         182.3
## 344 2000      Tennessee         264.2         208.2
## 345 2007       Oklahoma         346.4         133.4
## 346 2008     California         404.8          70.2
## 347 2002     New Mexico         399.8          78.8
## 348 2003       Missouri         325.5         154.1
## 349 2007     California         388.3          85.6
## 350 2014       Colorado         415.0          60.2
## 351 2005      Wisconsin         371.4         106.5
## 352 2007        Arizona         392.3          79.9
## 353 2001 North Carolina         269.3         202.1
## 354 2014   Rhode Island         413.6          56.1
## 355 2014      Wisconsin         403.2          71.0
## 356 2014     Washington         381.2          89.2
## 357 2014         Kansas         384.1          88.7
## 358 2012   North Dakota         425.2          49.0
## 359 2005       Arkansas         309.1         162.6
## 360 2002       Michigan         321.1         147.0
## 361 2004       Delaware         361.3         109.4
## 362 2007      Wisconsin         349.1         120.5
## 363 2013       Nebraska         393.5          74.6
## 364 2001       Maryland         290.4         175.0
## 365 2006     California         372.6          92.5
## 366 2001          Texas         326.4         140.5
## 367 2015      Minnesota         389.3          75.1
## 368 2011         Nevada         389.1          74.1
## 369 2007         Nevada         370.9          91.9
## 370 2008       Colorado         388.3          76.1
## 371 2000         Alaska         409.3          57.5
## 372 2012         Kansas         387.8          77.6
## 373 2007        Indiana         326.4         138.5
## 374 2003     New Mexico         399.0          62.4
## 375 2009     California         397.2          62.8
## 376 2000       Maryland         273.6         185.2
## 377 2005     California         364.2          95.7
## 378 2003       Michigan         323.1         138.5
```

```
## 379 2015          Iowa         388.9          72.3
## 380 2009        Kansas         372.9          88.9
## 381 2012  Rhode Island         410.3          48.2
## 382 2009     Wisconsin         369.7          92.0
## 383 2000 South Carolina         247.3         208.3
## 384 2005      Maryland         329.1         126.6
## 385 2014        Oregon         394.6          59.0
## 386 2010       Arizona         407.2          49.3
## 387 2005       Arizona         370.2          86.2
## 388 2010       Indiana         355.4         101.1
## 389 2008        Nevada         371.9          83.5
## 390 2013        Kansas         381.6          74.9
## 391 2013  Rhode Island         410.6          43.2
## 392 2003      Maryland         305.5         145.8
## 393 2014       Montana         413.0          42.8
## 394 2009      Colorado         398.0          56.2
## 395 2006         Texas         321.4         129.5
## 396 2006       Indiana         314.5         138.3
## 397 2006        Nevada         336.5         111.8
## 398 2001     Tennessee         270.6         176.5
## 399 2005       Indiana         321.6         129.8
## 400 2011   Connecticut         381.9          68.5
## 401 2010  South Dakota         392.9          57.6
## 402 2013      Colorado         393.0          54.4
## 403 2006      New York         355.9          90.4
## 404 2006      Arkansas         293.8         153.2
## 405 2011        Kansas         371.5          77.4
## 406 2000      Michigan         263.5         182.6
## 407 2009        Nevada         380.0          65.3
## 408 2007       Florida         315.5         127.8
## 409 2009       Indiana         338.3         106.4
## 410 2014     Minnesota         367.3          75.1
## 411 2009       Arizona         394.2          49.3
## 412 2003      Arkansas         288.2         156.0
## 413 2007  Pennsylvania         341.6         102.2
## 414 2002         Texas         319.2         123.9
## 415 2011      Nebraska         371.2          74.0
## 416 2010      Colorado         387.0          55.5
## 417 2000          Ohio         274.5         169.9
## 418 2003      Oklahoma         313.6         129.6
## 419 2002      Oklahoma         309.2         133.4
## 420 2012      Nebraska         366.2          77.6
## 421 2004     Wisconsin         351.2          92.3
## 422 2002      Missouri         285.2         157.8
## 423 2001      Arkansas         270.2         170.9
## 424 2004      Arkansas         288.5         151.8
## 425 2005        Nevada         313.6         123.4
## 426 2001      Oklahoma         302.0         137.9
## 427 2002     Tennessee         276.7         161.2
## 428 2002      Arkansas         269.8         169.1
## 429 2005         Texas         319.5         116.1
## 430 2014   Connecticut         372.1          64.9
## 431 2012          Iowa         371.5          65.5
## 432 2008       Arizona         381.1          53.1
```

```
## 433 2008    Connecticut         357.6          80.0
## 434 2004         Nevada         298.5         137.3
## 435 2014           Iowa         382.0          53.1
## 436 2013    Connecticut         355.8          79.7
## 437 2010         Nevada         365.7          65.4
## 438 2000      Wisconsin         304.5         130.5
## 439 2015     New Jersey         350.6          80.9
## 440 2010    Connecticut         359.5          73.0
## 441 2004     California         344.4          85.0
## 442 2011   Rhode Island         393.9          34.2
## 443 2003      Wisconsin         327.9         103.5
## 444 2004          Texas         317.5         110.2
## 445 2008   Pennsylvania         339.3          88.9
## 446 2002      Wisconsin         312.4         116.5
## 447 2013     Washington         361.8          63.3
## 448 2005       New York         332.7          92.1
## 449 2003          Texas         312.9         111.2
## 450 2012    Connecticut         364.9          59.6
## 451 2015    Connecticut         364.9          58.1
## 452 2009   Pennsylvania         341.7          80.4
## 453 2007       Colorado         353.5          69.4
## 454 2013      Minnesota         348.4          72.0
## 455 2002         Hawaii         363.2          59.4
## 456 2004       Oklahoma         295.2         126.8
## 457 2006       Colorado         343.2          77.7
## 458 2015  Massachusetts         357.3          56.6
## 459 2009    Connecticut         344.7          72.7
## 460 2005       Virginia         303.9         111.9
## 461 2003       New York         298.2         115.5
## 462 2010         Kansas         340.6          73.9
## 463 2011           Iowa         351.4          63.0
## 464 2013         Oregon         363.7          44.3
## 465 2008   South Dakota         367.6          46.6
## 466 2014     New Jersey         336.0          74.6
## 467 2009   South Dakota         371.1          42.3
## 468 2001      Wisconsin         301.2         111.2
## 469 2012     Washington         360.1          47.4
## 470 2006   Pennsylvania         317.4          92.2
## 471 2010           Iowa         350.5          59.9
## 472 2008         Kansas         328.6          81.2
## 473 2004       Virginia         292.9         116.0
## 474 2001       Virginia         254.8         154.2
## 475 2004       New York         308.0          97.6
## 476 2004        Indiana         297.6         110.6
## 477 2003     California         330.9          73.2
## 478 2013           Iowa         356.3          47.9
## 479 2006        Florida         270.6         132.5
## 480 2005       Colorado         335.4          70.1
## 481 2010   North Dakota         371.7          31.5
## 482 2007       Virginia         318.7          81.3
## 483 2001       Missouri         247.4         154.7
## 484 2013        Montana         379.8          22.3
## 485 2006       Virginia         315.2          84.7
## 486 2012  Massachusetts         357.5          39.9
```

```
## 487 2013     New Jersey         319.6          79.1
## 488 2013  Massachusetts         349.2          46.7
## 489 2011   North Dakota         363.5          37.3
## 490 2001     New Mexico         341.6          56.8
## 491 2004   Pennsylvania         307.5          90.9
## 492 2000       Missouri         239.9         158.5
## 493 2003   Pennsylvania         301.6          96.0
## 494 2009       Kentucky         308.1          88.7
## 495 2002        Indiana         277.6         120.1
## 496 2002       Virginia         253.9         143.4
## 497 2004   Rhode Island         319.8          75.8
## 498 2012      Minnesota         337.8          57.7
## 499 2011         Oregon         356.1          38.9
## 500 2012     New Jersey         309.2          84.9
## 501 2005   South Dakota         350.4          45.5
## 502 2000       Oklahoma         270.1         122.4
## 503 2010        Wyoming         388.2           7.3
## 504 2005    Connecticut         315.1          78.5
## 505 2008       Nebraska         312.5          81.9
## 506 2007    Connecticut         327.0          66.4
## 507 2012        Montana         383.4          10.8
## 508 2008       Kentucky         284.9         106.5
## 509 2005   Pennsylvania         300.3          90.5
## 510 2011     Washington         346.2          40.7
## 511 2012         Oregon         347.5          37.8
## 512 2002       Colorado         311.3          77.9
## 513 2006    Connecticut         312.3          74.5
## 514 2006       Nebraska         307.0          81.0
## 515 2011  Massachusetts         347.7          35.9
## 516 2002     California         314.1          70.1
## 517 2003       Virginia         263.2         122.7
## 518 2006   South Dakota         336.7          46.9
## 519 2011     New Jersey         298.1          83.6
## 520 2003        Indiana         275.6         107.8
## 521 2002       New York         266.9         114.0
## 522 2002        Florida         251.6         127.7
## 523 2009       Nebraska         303.0          76.6
## 524 2015        Wyoming         348.7          30.0
## 525 2004       Colorado         311.0          67.1
## 526 2011        Wyoming         371.2           8.2
## 527 2014  Massachusetts         317.8          57.0
## 528 2001         Hawaii         328.5          49.2
## 529 2012        Wyoming         370.0           7.7
## 530 2002    Connecticut         283.4          93.7
## 531 2007         Kansas         294.7          82.2
## 532 2008     Washington         326.8          47.7
## 533 2015          Idaho         344.5          28.9
## 534 2004        Arizona         300.8          72.8
## 535 2009   Rhode Island         343.2          30.6
## 536 2009        Wyoming         360.7          13.6
## 537 2003   Rhode Island         278.8          90.4
## 538 2000       Arkansas         232.2         136.0
## 539 2001       Colorado         298.8          72.0
## 540 2014        Vermont         357.0          13.4
```

```
## 541 2003   South Dakota         341.2          29.6
## 542 2004   South Dakota         331.3          39.8
## 543 2010     New Jersey         300.2          67.4
## 544 2007       Nebraska         289.2          80.8
## 545 2005        Florida         249.3         116.3
## 546 2004         Kansas         275.1          93.3
## 547 2008           Iowa         312.1          56.6
## 548 2009           Iowa         312.7          55.1
## 549 2004       Nebraska         301.2          65.9
## 550 2010     Washington         320.3          43.0
## 551 2002       Nebraska         276.4          90.4
## 552 2005         Kansas         271.2          95.2
## 553 2003       Nebraska         272.5          93.3
## 554 2002   Pennsylvania         257.7         107.8
## 555 2014          Idaho         337.6          27.5
## 556 2001        Indiana         249.0         113.8
## 557 2002         Nevada         273.1          91.5
## 558 2011      Minnesota         318.7          43.1
## 559 2003        Florida         249.0         111.5
## 560 2001        Florida         229.8         131.5
## 561 2003         Kansas         266.2          97.2
## 562 2006         Kansas         283.2          80.0
## 563 2001     California         294.6          67.3
## 564 2004        Florida         250.0         109.2
## 565 2005     Washington         300.1          60.3
## 566 2007   South Dakota         329.1          32.8
## 567 2010   Rhode Island         330.4          27.6
## 568 2010  Massachusetts         319.7          37.7
## 569 2001       New York         243.1         116.8
## 570 2000       Virginia         216.0         143.2
## 571 2003    Connecticut         269.7          89.4
## 572 2003         Nevada         260.1          99.1
## 573 2013        Wyoming         347.8          11.5
## 574 2014        Wyoming         338.4          19.9
## 575 2005       Nebraska         291.8          66.3
## 576 2004    Connecticut         274.2          82.2
## 577 2009     Washington         320.9          34.3
## 578 2007           Iowa         289.3          64.5
## 579 2013          Idaho         340.2          13.2
## 580 2001   Rhode Island         274.8          78.3
## 581 2011        Montana         344.2           8.6
## 582 2010         Oregon         322.9          28.1
## 583 2000        Florida         208.0         141.9
## 584 2002         Kansas         249.8         101.0
## 585 2010       Nebraska         284.6          66.1
## 586 2003       Colorado         286.5          62.7
## 587 2002   Rhode Island         264.7          84.1
## 588 2000     New Mexico         285.7          63.2
## 589 2000       Colorado         277.3          71.9
## 590 2007     Washington         290.4          56.5
## 591 2015           Utah         293.3          53.1
## 592 2006           Iowa         281.3          65.9
## 593 2002        Arizona         274.4          69.6
## 594 2001        Arizona         270.3          73.9
```

```
## 595 2006     Washington         278.6          66.2
## 596 2001   Pennsylvania         230.6         115.8
## 597 2008   Rhode Island         315.7          29.2
## 598 2005   Rhode Island         302.5          40.5
## 599 2000     California         280.5          63.6
## 600 2000        Indiana         230.8         107.1
## 601 2006   Rhode Island         294.3          47.6
## 602 2007   Rhode Island         300.3          38.0
## 603 2004     Washington         287.6          45.8
## 604 2008      Minnesota         274.9          58.2
## 605 2013  West Virginia         277.0          57.3
## 606 2014           Utah         283.5          49.7
## 607 2008        Montana         320.5          12.6
## 608 2010      Minnesota         290.4          40.2
## 609 2000         Hawaii         292.5          39.8
## 610 2009     New Jersey         275.3          54.7
## 611 2015          Maine         298.1          31.4
## 612 2009         Oregon         300.5          29.1
## 613 2015        Vermont         303.4          24.7
## 614 2000         Kansas         224.9         103.8
## 615 2000        Arizona         243.7          79.9
## 616 2000   Pennsylvania         215.5         110.8
## 617 2010        Montana         316.1          10.5
## 618 2009  Massachusetts         292.9          30.0
## 619 2009   North Dakota         302.5          23.3
## 620 2007      Minnesota         258.1          66.5
## 621 2002   South Dakota         291.0          34.6
## 622 2001         Kansas         223.9          98.8
## 623 2008   North Dakota         299.5          22.3
## 624 2008     New Jersey         258.0          61.0
## 625 2007     New Jersey         247.9          70.0
## 626 2003     Washington         273.9          44.9
## 627 2008        Wyoming         296.1          23.3
## 628 2008         Oregon         283.5          32.3
## 629 2006      Minnesota         250.3          63.9
## 630 2009        Montana         306.5           8.2
## 631 2009      Minnesota         269.6          43.7
## 632 2001         Nevada         230.3          83.7
## 633 2000   Rhode Island         250.5          62.9
## 634 2015  West Virginia         268.0          41.6
## 635 2000       Nebraska         221.3          89.5
## 636 2011          Idaho         299.8          10.3
## 637 2006   North Dakota         286.2          24.1
## 638 2013        Vermont         294.2          15.5
## 639 2000    Connecticut         222.9          85.3
## 640 2005      Minnesota         239.0          68.3
## 641 2002       Kentucky         213.9          92.2
## 642 2001       Kentucky         218.3          88.2
## 643 2008  Massachusetts         269.4          32.8
## 644 2005           Iowa         250.1          54.4
## 645 2012  West Virginia         258.2          44.8
## 646 2004   North Dakota         285.6          17.4
## 647 2014  West Virginia         254.5          45.4
## 648 2006        Montana         280.5          20.5
```

```
## 649 2007        Montana         286.9          12.7
## 650 2013           Utah         263.9          33.3
## 651 2006        Wyoming         276.1          23.3
## 652 2012          Idaho         287.1          10.5
## 653 2006         Oregon         258.8          39.5
## 654 2001    Connecticut         224.7          74.1
## 655 2001     New Jersey         191.7         104.8
## 656 2007   North Dakota         279.7          18.1
## 657 2003        Arizona         229.7          64.1
## 658 2006     New Jersey         231.5          62.9
## 659 2007         Oregon         262.8          33.0
## 660 2002     Washington         246.1          48.2
## 661 2005         Oregon         250.9          43.5
## 662 2007  Massachusetts         250.3          41.8
## 663 2004        Montana         284.2           9.6
## 664 2012          Maine         257.0          34.3
## 665 2006       Kentucky         212.5          77.9
## 666 2012        Vermont         275.2          15.8
## 667 2003        Montana         277.6          13.3
## 668 2014  New Hampshire         271.0          17.1
## 669 2007       Kentucky         207.4          81.3
## 670 2012           Utah         270.3          17.0
## 671 2004      Minnesota         229.3          58.4
## 672 2008          Idaho         275.2          12.3
## 673 2000       Kentucky         199.1          86.5
## 674 2005     New Jersey         220.2          65.8
## 675 2002        Montana         272.1          13.5
## 676 2014          Maine         265.8          17.8
## 677 2005   North Dakota         262.8          20.2
## 678 2010          Idaho         272.2           9.5
## 679 2003       Kentucky         193.8          86.9
## 680 2004         Oregon         244.1          36.6
## 681 2003     New Jersey         187.2          92.0
## 682 2004     New Jersey         202.0          77.5
## 683 2000   South Dakota         242.7          36.7
## 684 2004           Iowa         236.3          42.4
## 685 2006  Massachusetts         239.1          37.7
## 686 2001   South Dakota         240.1          38.1
## 687 2001     Washington         227.4          49.9
## 688 2013          Maine         258.7          18.4
## 689 2003   North Dakota         261.1          16.3
## 690 2005        Montana         258.9          17.0
## 691 2000         Nevada         199.1          76.9
## 692 2003      Minnesota         211.8          63.3
## 693 2011  West Virginia         231.8          43.0
## 694 2003           Iowa         220.5          52.8
## 695 2005       Kentucky         201.4          70.8
## 696 2000       New York         165.8         105.9
## 697 2011           Utah         256.4          10.0
## 698 2007          Idaho         248.2          17.9
## 699 2005  Massachusetts         224.6          39.5
## 700 2002      Minnesota         201.3          60.7
## 701 2000     Washington         221.0          40.9
## 702 2002           Iowa         210.9          50.4
```

```
## 703 2002     New Jersey         164.9          91.9
## 704 2001       Nebraska         186.4          69.1
## 705 2009          Idaho         248.5           7.1
## 706 2004  Massachusetts         205.8          47.5
## 707 2015  New Hampshire         233.3          18.5
## 708 2011          Maine         232.9          20.5
## 709 2010           Utah         240.3          11.1
## 710 2000           Iowa         204.4          47.5
## 711 2005        Wyoming         231.6          17.2
## 712 2007           Utah         216.3          31.0
## 713 2001         Oregon         214.6          32.9
## 714 2013  New Hampshire         236.2           9.2
## 715 2012  New Hampshire         233.0          11.2
## 716 2011        Vermont         237.0           7.7
## 717 2003         Oregon         216.0          28.1
## 718 2007        Wyoming         228.9          15.5
## 719 2010  West Virginia         213.0          31.8
## 720 2001           Iowa         194.4          48.4
## 721 2006          Idaho         228.1          14.0
## 722 2011  New Hampshire         228.6           9.9
## 723 2008           Utah         220.0          17.4
## 724 2000         Oregon         207.1          30.3
## 725 2006           Utah         199.7          34.8
## 726 2009           Utah         220.7          12.2
## 727 2000      Minnesota         164.2          64.0
## 728 2004        Wyoming         215.9          11.8
## 729 2007  West Virginia         174.8          51.3
## 730 2002         Oregon         199.0          25.8
## 731 2004       Kentucky         157.1          67.0
## 732 2008  West Virginia         182.8          41.1
## 733 2009  West Virginia         198.0          26.1
## 734 2001        Montana         212.0          11.5
## 735 2005           Utah         192.6          30.4
## 736 2003  Massachusetts         175.7          45.1
## 737 2001      Minnesota         167.0          54.2
## 738 2002  Massachusetts         169.8          50.4
## 739 2000  Massachusetts         172.4          47.9
## 740 2000     New Jersey         128.2          85.8
## 741 2001  Massachusetts         162.5          50.2
## 742 2004          Idaho         203.8           7.5
## 743 2006  West Virginia         160.0          52.4
## 744 2010        Vermont         202.2           9.3
## 745 2010          Maine         196.2          12.3
## 746 2005          Idaho         200.9           8.5
## 747 2002   North Dakota         198.1          11.4
## 748 2008          Maine         198.1           7.3
## 749 2005  West Virginia         162.2          42.4
## 750 2006        Vermont         190.9          11.5
## 751 2007          Maine         192.9           9.0
## 752 2002        Wyoming         189.3          13.0
## 753 2004  West Virginia         152.3          49.3
## 754 2003        Wyoming         191.5           9.2
## 755 2008        Vermont         191.5           6.0
## 756 2010  New Hampshire         185.9          11.4
```

```
## 757 2009        Vermont          190.7           8.0
## 758 2004        Vermont          183.6          13.9
## 759 2009          Maine          184.4          10.8
## 760 2002          Idaho          186.6           7.0
## 761 2002  West Virginia          136.7          54.1
## 762 2004           Utah          164.0          25.6
## 763 2003  West Virginia          142.8          46.8
## 764 2003        Vermont          171.2          15.7
## 765 2001        Wyoming          169.9          15.6
## 766 2006          Maine          174.5          10.4
## 767 2003           Utah          165.6          17.5
## 768 2005          Maine          171.1          10.8
## 769 2007        Vermont          170.1          10.3
## 770 2003          Idaho          173.2           5.0
## 771 2004          Maine          161.8          16.1
## 772 2001   North Dakota          166.8           8.8
## 773 2000        Wyoming          163.3          10.7
## 774 2003          Maine          155.5          17.8
## 775 2001  West Virginia          130.3          40.6
## 776 2002        Vermont          154.7          15.9
## 777 2008  New Hampshire          160.3           7.6
## 778 2002           Utah          152.8          16.1
## 779 2000        Montana          162.6           6.6
## 780 2007  New Hampshire          156.2          10.5
## 781 2009  New Hampshire          158.7           8.5
## 782 2006  New Hampshire          151.9          13.7
## 783 2005        Vermont          154.0           9.7
## 784 2001          Idaho          153.2           5.8
## 785 2005  New Hampshire          141.7          13.6
## 786 2000  West Virginia          118.6          35.7
## 787 2000          Idaho          146.7           7.5
## 788 2000   North Dakota          141.8          11.4
## 789 2002          Maine          139.4          11.0
## 790 2004  New Hampshire          134.8          10.3
## 791 2001           Utah          131.8           9.6
## 792 2003  New Hampshire          125.5           9.7
## 793 2002  New Hampshire          122.1           9.4
## 794 2001  New Hampshire          109.8          14.0
## 795 2000          Maine          115.4           7.0
## 796 2001        Vermont          104.1          12.4
## 797 2001          Maine          104.2          11.0
## 798 2000           Utah           97.6          10.3
## 799 2000  New Hampshire           91.1           8.9
## 800 2000        Vermont           86.2          10.7
##     Primary_Secondary_Syphilis_Rate Total_Mean
## 1                               8.0  350.80000
## 2                               0.4  348.13333
## 3                               4.6  344.13333
## 4                               5.0  336.60000
## 5                               6.3  328.16667
## 6                               1.7  327.10000
## 7                               2.0  323.96667
## 8                               0.7  315.73333
## 9                               3.1  315.56667
```

```
## 10                          7.7  314.36667
## 11                         15.0  310.43333
## 12                          1.1  306.83333
## 13                          6.4  305.76667
## 14                          3.0  304.66667
## 15                          9.9  303.20000
## 16                          2.0  301.76667
## 17                          0.0  293.76667
## 18                         12.2  286.50000
## 19                         12.0  286.20000
## 20                          1.5  285.93333
## 21                          6.3  283.26667
## 22                          2.1  278.70000
## 23                          4.5  278.36667
## 24                         12.4  277.66667
## 25                         16.5  277.26667
## 26                          9.2  274.03333
## 27                          4.8  271.90000
## 28                          4.8  270.26667
## 29                          1.0  268.06667
## 30                          2.2  266.86667
## 31                          7.4  266.43333
## 32                          0.1  264.20000
## 33                          3.8  262.83333
## 34                          8.2  262.30000
## 35                          7.3  260.13333
## 36                          4.8  258.00000
## 37                          1.6  256.96667
## 38                          2.7  256.50000
## 39                          5.2  255.40000
## 40                          4.5  254.13333
## 41                          3.3  254.10000
## 42                          3.4  253.20000
## 43                          2.6  252.80000
## 44                          1.5  252.50000
## 45                          1.4  252.43333
## 46                          9.6  249.86667
## 47                          5.5  249.43333
## 48                          4.8  249.40000
## 49                          6.1  248.60000
## 50                         16.0  248.03333
## 51                         14.0  247.70000
## 52                          7.0  246.06667
## 53                          6.9  245.70000
## 54                          4.1  244.66667
## 55                          5.7  243.56667
## 56                          7.4  242.50000
## 57                          5.7  241.90000
## 58                         12.4  240.93333
## 59                          8.9  239.60000
## 60                          5.9  239.30000
## 61                          6.2  239.13333
## 62                          5.4  238.76667
## 63                          4.5  236.86667
```

```
## 64                          7.1  235.30000
## 65                          4.7  233.43333
## 66                          3.9  233.30000
## 67                          5.7  233.26667
## 68                          9.5  233.20000
## 69                          1.2  232.66667
## 70                          5.8  232.60000
## 71                          0.0  230.26667
## 72                          0.2  229.86667
## 73                          4.9  229.53333
## 74                          4.1  228.26667
## 75                          3.7  227.66667
## 76                          8.4  227.26667
## 77                          8.0  226.30000
## 78                          6.2  225.70000
## 79                          3.9  225.70000
## 80                          3.6  225.30000
## 81                          6.2  224.43333
## 82                         12.3  223.33333
## 83                          3.4  222.93333
## 84                         10.3  222.93333
## 85                          2.8  222.70000
## 86                          6.0  222.66667
## 87                          4.9  222.23333
## 88                          6.0  221.90000
## 89                         10.2  221.43333
## 90                          9.5  220.23333
## 91                          7.2  220.13333
## 92                          4.2  218.06667
## 93                          1.7  217.33333
## 94                          5.8  216.40000
## 95                          6.7  215.73333
## 96                          2.6  215.43333
## 97                          3.1  215.26667
## 98                          6.9  215.26667
## 99                          3.4  215.03333
## 100                         1.4  214.73333
## 101                         7.1  214.53333
## 102                         5.6  214.26667
## 103                         2.0  213.90000
## 104                         4.1  213.56667
## 105                        12.6  213.20000
## 106                         6.3  212.93333
## 107                         4.8  212.33333
## 108                         4.4  212.20000
## 109                         6.2  211.96667
## 110                         2.4  211.80000
## 111                         2.9  211.63333
## 112                         5.7  211.26667
## 113                         4.9  210.86667
## 114                         6.2  210.83333
## 115                         7.4  210.83333
## 116                         5.1  210.00000
## 117                         6.2  209.86667
```

```
## 118                          5.8  209.76667
## 119                          8.1  209.56667
## 120                          6.3  209.20000
## 121                          5.1  208.83333
## 122                          4.6  208.06667
## 123                          4.3  207.70000
## 124                          2.1  207.26667
## 125                          6.7  207.06667
## 126                          3.1  207.06667
## 127                          1.0  206.46667
## 128                          4.9  206.43333
## 129                          2.8  206.00000
## 130                          9.4  205.83333
## 131                          8.8  205.73333
## 132                          5.1  205.66667
## 133                          5.0  205.66667
## 134                          4.4  205.10000
## 135                          8.7  204.86667
## 136                          8.7  204.10000
## 137                          3.0  204.00000
## 138                          5.3  203.60000
## 139                          5.6  203.53333
## 140                          2.3  202.76667
## 141                          3.8  202.66667
## 142                          4.9  202.50000
## 143                          3.7  202.30000
## 144                          3.8  201.73333
## 145                          6.3  201.66667
## 146                          6.4  201.40000
## 147                          4.2  200.93333
## 148                          2.3  199.96667
## 149                          6.2  199.90000
## 150                          1.7  199.70000
## 151                          7.0  199.70000
## 152                          6.6  199.66667
## 153                          7.5  199.60000
## 154                          2.3  199.40000
## 155                          6.0  199.23333
## 156                          3.6  199.03333
## 157                          3.0  199.03333
## 158                          2.6  198.96667
## 159                          4.0  198.53333
## 160                          5.8  198.50000
## 161                         11.8  198.33333
## 162                          4.2  197.50000
## 163                          6.4  197.33333
## 164                          6.2  197.20000
## 165                          7.8  197.00000
## 166                          5.8  196.96667
## 167                          4.6  196.86667
## 168                          4.6  196.76667
## 169                          3.7  196.33333
## 170                         10.0  196.13333
## 171                          3.6  196.13333
```

```
## 172                              3.3  195.96667
## 173                             10.5  195.53333
## 174                              1.1  194.93333
## 175                              4.1  194.63333
## 176                              1.9  194.50000
## 177                              4.2  194.43333
## 178                              3.1  194.36667
## 179                              6.3  194.23333
## 180                              8.5  194.20000
## 181                              3.5  192.86667
## 182                              3.2  192.80000
## 183                              3.4  192.76667
## 184                              4.1  192.46667
## 185                              3.3  192.26667
## 186                              3.8  192.06667
## 187                              1.8  191.60000
## 188                              3.3  191.53333
## 189                              2.3  191.23333
## 190                              7.6  191.06667
## 191                              2.9  190.26667
## 192                              1.7  190.20000
## 193                              5.3  190.20000
## 194                              1.8  189.96667
## 195                              3.4  189.56667
## 196                              4.1  189.53333
## 197                              4.4  189.53333
## 198                              4.4  189.13333
## 199                              1.8  189.06667
## 200                              7.3  189.00000
## 201                              4.9  188.46667
## 202                              1.8  188.16667
## 203                              2.2  188.06667
## 204                              6.0  188.03333
## 205                              7.7  187.86667
## 206                              2.2  187.83333
## 207                              6.7  187.63333
## 208                              3.1  187.43333
## 209                              4.3  187.03333
## 210                              2.3  186.76667
## 211                              7.4  186.76667
## 212                              3.1  186.53333
## 213                              3.1  186.50000
## 214                              4.1  186.43333
## 215                              3.8  186.40000
## 216                              1.0  186.30000
## 217                              2.5  185.73333
## 218                              3.0  185.70000
## 219                              3.9  185.43333
## 220                              4.4  185.36667
## 221                              2.6  185.20000
## 222                              9.7  184.70000
## 223                              2.1  184.63333
## 224                              5.8  184.26667
## 225                              6.6  184.06667
```

```
## 226                    12.8  183.83333
## 227                     2.4  183.73333
## 228                     9.3  183.16667
## 229                     4.3  183.13333
## 230                     2.6  182.50000
## 231                     6.2  182.43333
## 232                     8.9  182.20000
## 233                     3.2  181.60000
## 234                     3.3  181.46667
## 235                     2.9  181.10000
## 236                     7.8  180.60000
## 237                     3.3  180.43333
## 238                     3.7  180.23333
## 239                     3.5  179.93333
## 240                     2.2  179.90000
## 241                     3.1  179.60000
## 242                     6.1  179.53333
## 243                     3.4  179.43333
## 244                     2.7  179.36667
## 245                     1.1  179.06667
## 246                     1.6  178.96667
## 247                     2.6  178.93333
## 248                     4.8  178.20000
## 249                     5.5  178.13333
## 250                     4.3  177.76667
## 251                     2.7  177.60000
## 252                     7.4  177.60000
## 253                     2.2  177.56667
## 254                     4.6  177.30000
## 255                     3.3  177.26667
## 256                     7.8  176.90000
## 257                     1.2  176.70000
## 258                     3.0  176.40000
## 259                     2.9  176.23333
## 260                     6.6  176.06667
## 261                     2.9  175.86667
## 262                     2.3  175.83333
## 263                     1.4  175.70000
## 264                     3.3  175.66667
## 265                     1.2  175.26667
## 266                     4.0  175.26667
## 267                     2.7  175.23333
## 268                     2.1  175.13333
## 269                     3.6  175.10000
## 270                     5.3  175.00000
## 271                     2.5  174.96667
## 272                     1.4  174.90000
## 273                     5.1  174.40000
## 274                     1.7  174.06667
## 275                     1.5  173.73333
## 276                     1.2  173.50000
## 277                     5.7  173.50000
## 278                     3.5  173.43333
## 279                     3.7  173.40000
```

```
## 280                    1.3  173.26667
## 281                    6.9  173.23333
## 282                    6.4  172.80000
## 283                    1.1  172.73333
## 284                    1.6  172.73333
## 285                    0.6  172.50000
## 286                    0.7  172.36667
## 287                    7.2  172.23333
## 288                    0.9  172.23333
## 289                    2.5  172.16667
## 290                    1.4  172.10000
## 291                    6.7  171.93333
## 292                    2.4  171.93333
## 293                    5.5  171.83333
## 294                    6.3  171.43333
## 295                    2.3  171.36667
## 296                    5.6  170.53333
## 297                    0.9  170.06667
## 298                    2.5  169.63333
## 299                    0.0  168.40000
## 300                    3.6  168.16667
## 301                    3.3  168.16667
## 302                    2.2  167.90000
## 303                    2.0  167.76667
## 304                    4.3  167.46667
## 305                    1.4  167.26667
## 306                    0.9  167.26667
## 307                    8.7  166.93333
## 308                    1.6  166.46667
## 309                    4.2  166.43333
## 310                    6.0  166.16667
## 311                    4.9  166.00000
## 312                    2.3  165.66667
## 313                    3.4  165.56667
## 314                    4.1  165.36667
## 315                    7.3  165.30000
## 316                    3.8  165.23333
## 317                    3.8  164.86667
## 318                    1.7  164.53333
## 319                    1.8  164.36667
## 320                    0.7  164.30000
## 321                    0.0  164.20000
## 322                    1.3  164.20000
## 323                    1.0  164.20000
## 324                    2.8  164.16667
## 325                    1.7  163.70000
## 326                    3.3  163.50000
## 327                    3.0  163.46667
## 328                    1.2  163.10000
## 329                    3.5  162.70000
## 330                    1.9  162.46667
## 331                    3.4  162.43333
## 332                    2.2  162.36667
## 333                    4.3  162.03333
```

```
## 334                    3.0  161.70000
## 335                    4.2  161.70000
## 336                    5.6  161.36667
## 337                    3.2  161.16667
## 338                    2.6  161.10000
## 339                    1.2  160.83333
## 340                    2.9  160.70000
## 341                    2.7  160.70000
## 342                    4.1  160.66667
## 343                    3.7  160.60000
## 344                    9.3  160.56667
## 345                    1.8  160.53333
## 346                    6.0  160.33333
## 347                    2.1  160.23333
## 348                    1.1  160.23333
## 349                    5.6  159.83333
## 350                    3.5  159.56667
## 351                    0.7  159.53333
## 352                    4.7  158.96667
## 353                    5.4  158.93333
## 354                    6.8  158.83333
## 355                    1.5  158.56667
## 356                    4.9  158.43333
## 357                    2.1  158.30000
## 358                    0.6  158.26667
## 359                    1.9  157.86667
## 360                    4.8  157.63333
## 361                    1.1  157.26667
## 362                    1.2  156.93333
## 363                    2.2  156.76667
## 364                    4.9  156.76667
## 365                    5.0  156.70000
## 366                    2.2  156.36667
## 367                    4.5  156.30000
## 368                    5.0  156.06667
## 369                    4.3  155.70000
## 370                    2.6  155.66667
## 371                    0.0  155.60000
## 372                    0.8  155.40000
## 373                    0.9  155.26667
## 374                    3.8  155.06667
## 375                    5.1  155.03333
## 376                    5.6  154.80000
## 377                    4.4  154.76667
## 378                    2.5  154.70000
## 379                    2.4  154.53333
## 380                    1.1  154.30000
## 381                    4.2  154.23333
## 382                    0.8  154.16667
## 383                    5.7  153.76667
## 384                    5.6  153.76667
## 385                    6.9  153.50000
## 386                    3.5  153.33333
## 387                    3.0  153.13333
```

```
## 388                              2.7  153.06667
## 389                              3.0  152.80000
## 390                              1.8  152.76667
## 391                              4.3  152.70000
## 392                              5.7  152.33333
## 393                              0.8  152.20000
## 394                              2.1  152.10000
## 395                              4.5  151.80000
## 396                              1.5  151.43333
## 397                              5.5  151.26667
## 398                              5.8  150.96667
## 399                              1.0  150.80000
## 400                              1.8  150.73333
## 401                              0.5  150.33333
## 402                              3.1  150.16667
## 403                              3.8  150.03333
## 404                              2.7  149.90000
## 405                              0.8  149.90000
## 406                              3.3  149.80000
## 407                              3.4  149.56667
## 408                              5.0  149.43333
## 409                              2.5  149.06667
## 410                              4.7  149.03333
## 411                              3.5  149.00000
## 412                              1.9  148.70000
## 413                              2.1  148.63333
## 414                              2.7  148.60000
## 415                              0.5  148.56667
## 416                              2.7  148.40000
## 417                              0.6  148.33333
## 418                              1.8  148.33333
## 419                              2.1  148.23333
## 420                              0.4  148.06667
## 421                              0.5  148.00000
## 422                              0.6  147.86667
## 423                              1.8  147.63333
## 424                              1.7  147.33333
## 425                              4.7  147.23333
## 426                              1.7  147.20000
## 427                              2.9  146.93333
## 428                              1.3  146.73333
## 429                              3.9  146.50000
## 430                              2.4  146.46667
## 431                              2.3  146.43333
## 432                              4.9  146.36667
## 433                              1.0  146.20000
## 434                              1.8  145.86667
## 435                              2.3  145.80000
## 436                              1.6  145.70000
## 437                              4.9  145.33333
## 438                              0.9  145.30000
## 439                              4.2  145.23333
## 440                              2.8  145.10000
## 441                              3.8  144.40000
```

```
## 442                    4.4  144.16667
## 443                    0.3  143.90000
## 444                    3.7  143.80000
## 445                    2.2  143.46667
## 446                    0.6  143.16667
## 447                    4.1  143.06667
## 448                    3.7  142.83333
## 449                    3.0  142.36667
## 450                    1.5  142.00000
## 451                    2.6  141.86667
## 452                    2.7  141.60000
## 453                    1.2  141.36667
## 454                    3.6  141.33333
## 455                    0.9  141.16667
## 456                    0.7  140.90000
## 457                    1.5  140.80000
## 458                    6.2  140.03333
## 459                    1.8  139.73333
## 460                    1.9  139.23333
## 461                    3.0  138.90000
## 462                    0.7  138.40000
## 463                    0.7  138.36667
## 464                    6.8  138.26667
## 465                    0.1  138.10000
## 466                    3.3  137.96667
## 467                    0.0  137.80000
## 468                    0.4  137.60000
## 469                    4.4  137.30000
## 470                    2.1  137.23333
## 471                    0.6  137.00000
## 472                    1.1  136.96667
## 473                    1.6  136.83333
## 474                    1.4  136.80000
## 475                    3.8  136.46667
## 476                    1.0  136.40000
## 477                    3.7  135.93333
## 478                    3.4  135.86667
## 479                    4.0  135.70000
## 480                    1.0  135.50000
## 481                    0.5  134.56667
## 482                    3.0  134.33333
## 483                    0.5  134.20000
## 484                    0.5  134.20000
## 485                    2.5  134.13333
## 486                    4.8  134.06667
## 487                    2.6  133.76667
## 488                    5.4  133.76667
## 489                    0.1  133.63333
## 490                    1.0  133.13333
## 491                    1.0  133.13333
## 492                    0.5  132.96667
## 493                    1.3  132.96667
## 494                    2.1  132.96667
## 495                    1.0  132.90000
```

```
## 496                    1.0  132.76667
## 497                    2.4  132.66667
## 498                    2.2  132.56667
## 499                    2.5  132.50000
## 500                    2.6  132.23333
## 501                    0.3  132.06667
## 502                    3.4  131.96667
## 503                    0.0  131.83333
## 504                    1.7  131.76667
## 505                    0.8  131.73333
## 506                    1.1  131.50000
## 507                    0.2  131.46667
## 508                    2.2  131.20000
## 509                    1.6  130.80000
## 510                    4.9  130.60000
## 511                    5.5  130.26667
## 512                    1.4  130.20000
## 513                    1.8  129.53333
## 514                    0.4  129.46667
## 515                    4.1  129.23333
## 516                    2.9  129.03333
## 517                    1.1  129.00000
## 518                    1.7  128.43333
## 519                    2.6  128.10000
## 520                    0.8  128.06667
## 521                    2.5  127.80000
## 522                    3.7  127.66667
## 523                    0.3  126.63333
## 524                    0.9  126.53333
## 525                    1.4  126.50000
## 526                    0.0  126.46667
## 527                    4.5  126.43333
## 528                    1.0  126.23333
## 529                    0.7  126.13333
## 530                    0.8  125.96667
## 531                    1.0  125.96667
## 532                    2.8  125.76667
## 533                    3.5  125.63333
## 534                    2.8  125.46667
## 535                    1.9  125.23333
## 536                    0.6  124.96667
## 537                    3.1  124.10000
## 538                    3.9  124.03333
## 539                    0.5  123.76667
## 540                    0.8  123.73333
## 541                    0.3  123.70000
## 542                    0.0  123.70000
## 543                    2.8  123.46667
## 544                    0.2  123.40000
## 545                    4.2  123.26667
## 546                    0.9  123.10000
## 547                    0.5  123.06667
## 548                    0.8  122.86667
## 549                    0.4  122.50000
```

```
## 550                              4.0  122.43333
## 551                              0.3  122.36667
## 552                              0.7  122.36667
## 553                              0.6  122.13333
## 554                              0.9  122.13333
## 555                              0.7  121.93333
## 556                              2.5  121.76667
## 557                              0.7  121.76667
## 558                              2.6  121.46667
## 559                              3.9  121.46667
## 560                              3.0  121.43333
## 561                              0.9  121.43333
## 562                              1.0  121.40000
## 563                              1.6  121.16667
## 564                              4.3  121.16667
## 565                              2.5  120.96667
## 566                              0.9  120.93333
## 567                              3.9  120.63333
## 568                              4.3  120.56667
## 569                              1.6  120.50000
## 570                              1.8  120.33333
## 571                              0.9  120.00000
## 572                              0.5  119.90000
## 573                              0.2  119.83333
## 574                              0.7  119.66667
## 575                              0.2  119.43333
## 576                              1.3  119.23333
## 577                              2.1  119.10000
## 578                              0.7  118.16667
## 579                              0.9  118.10000
## 580                              0.8  117.96667
## 581                              0.7  117.83333
## 582                              1.9  117.63333
## 583                              2.6  117.50000
## 584                              0.7  117.16667
## 585                              0.7  117.13333
## 586                              0.9  116.70000
## 587                              1.2  116.66667
## 588                              0.9  116.60000
## 589                              0.3  116.50000
## 590                              2.4  116.43333
## 591                              2.2  116.20000
## 592                              0.6  115.93333
## 593                              3.7  115.90000
## 594                              3.4  115.86667
## 595                              2.8  115.86667
## 596                              0.8  115.73333
## 597                              1.7  115.53333
## 598                              2.2  115.06667
## 599                              1.0  115.03333
## 600                              5.8  114.56667
## 601                              1.3  114.40000
## 602                              3.4  113.90000
## 603                              2.4  111.93333
```

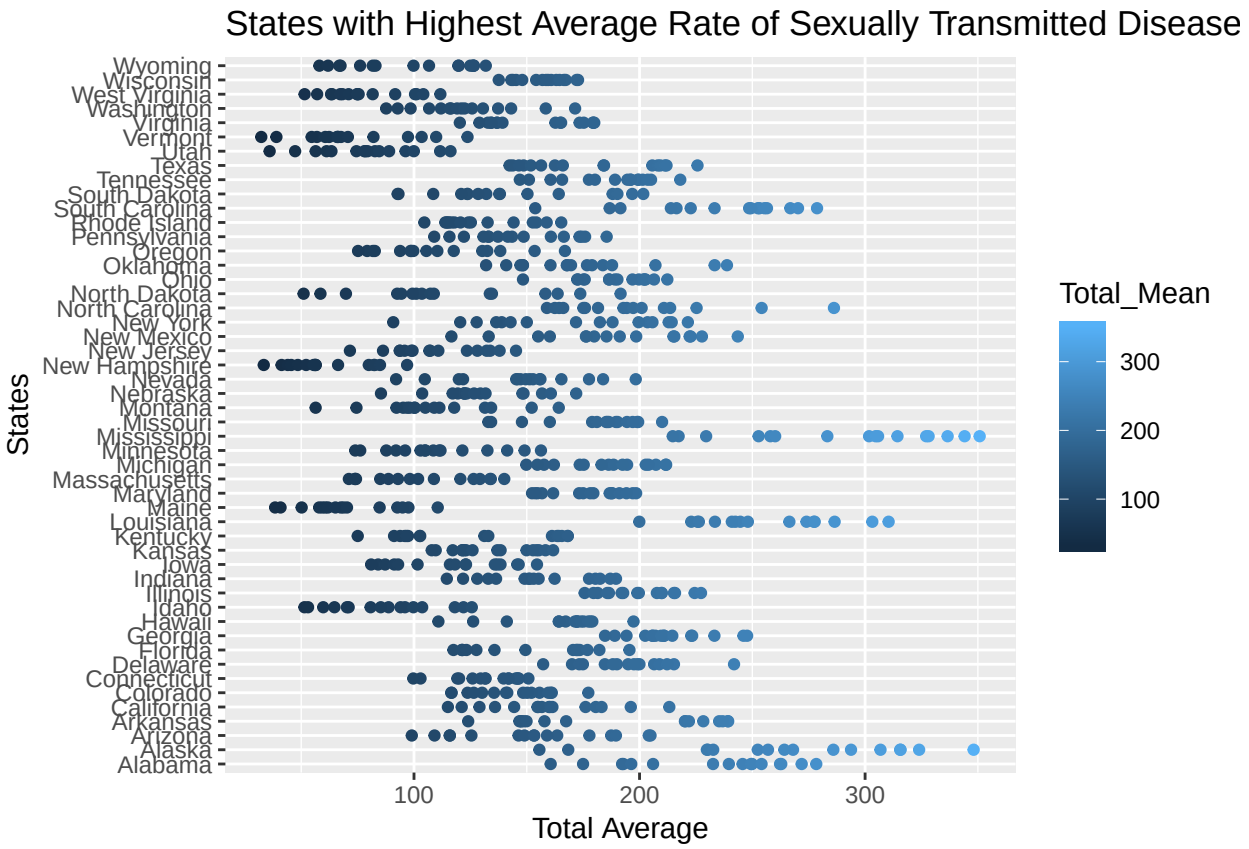
```
## 604                    2.2  111.76667
## 605                    0.8  111.70000
## 606                    1.6  111.60000
## 607                    0.7  111.26667
## 608                    2.8  111.13333
## 609                    0.2  110.83333
## 610                    2.4  110.80000
## 611                    2.1  110.53333
## 612                    1.5  110.36667
## 613                    1.4  109.83333
## 614                    0.2  109.63333
## 615                    3.7  109.10000
## 616                    0.6  108.96667
## 617                    0.3  108.96667
## 618                    3.6  108.83333
## 619                    0.6  108.80000
## 620                    1.1  108.56667
## 621                    0.0  108.53333
## 622                    0.9  107.86667
## 623                    0.0  107.26667
## 624                    2.6  107.20000
## 625                    2.6  106.83333
## 626                    1.3  106.70000
## 627                    0.6  106.66667
## 628                    0.7  105.50000
## 629                    0.9  105.03333
## 630                    0.4  105.03333
## 631                    1.3  104.86667
## 632                    0.4  104.80000
## 633                    0.4  104.60000
## 634                    2.8  104.13333
## 635                    0.1  103.63333
## 636                    0.8  103.63333
## 637                    0.2  103.50000
## 638                    0.5  103.40000
## 639                    0.5  102.90000
## 640                    1.4  102.90000
## 641                    2.2  102.76667
## 642                    1.2  102.56667
## 643                    3.3  101.83333
## 644                    0.3  101.60000
## 645                    0.4  101.13333
## 646                    0.0  101.00000
## 647                    1.5  100.46667
## 648                    0.1  100.36667
## 649                    0.8  100.13333
## 650                    2.6   99.93333
## 651                    0.0   99.80000
## 652                    1.6   99.73333
## 653                    0.8   99.70000
## 654                    0.3   99.70000
## 655                    1.6   99.36667
## 656                    0.2   99.33333
## 657                    3.3   99.03333
```

```
## 658                    2.0   98.80000
## 659                    0.5   98.76667
## 660                    1.2   98.50000
## 661                    1.1   98.50000
## 662                    2.4   98.16667
## 663                    0.4   98.06667
## 664                    1.3   97.53333
## 665                    1.7   97.36667
## 666                    1.0   97.33333
## 667                    0.0   96.96667
## 668                    2.7   96.93333
## 669                    1.3   96.66667
## 670                    1.5   96.26667
## 671                    0.5   96.06667
## 672                    0.5   96.00000
## 673                    2.1   95.90000
## 674                    1.5   95.83333
## 675                    0.0   95.20000
## 676                    1.2   94.93333
## 677                    0.2   94.40000
## 678                    0.4   94.03333
## 679                    0.8   93.83333
## 680                    0.8   93.83333
## 681                    2.0   93.73333
## 682                    1.7   93.73333
## 683                    0.0   93.13333
## 684                    0.2   92.96667
## 685                    1.9   92.90000
## 686                    0.1   92.76667
## 687                    1.0   92.76667
## 688                    0.8   92.63333
## 689                    0.3   92.56667
## 690                    0.8   92.23333
## 691                    0.2   92.06667
## 692                    0.9   92.00000
## 693                    0.2   91.66667
## 694                    0.4   91.23333
## 695                    1.3   91.16667
## 696                    0.7   90.80000
## 697                    0.5   88.96667
## 698                    0.1   88.73333
## 699                    1.9   88.66667
## 700                    1.2   87.73333
## 701                    1.1   87.66667
## 702                    0.3   87.20000
## 703                    2.0   86.26667
## 704                    0.6   85.36667
## 705                    0.2   85.26667
## 706                    1.8   85.03333
## 707                    3.0   84.93333
## 708                    0.9   84.76667
## 709                    2.3   84.56667
## 710                    0.4   84.10000
## 711                    0.0   82.93333
```

```
## 712                    0.8   82.70000
## 713                    0.4   82.63333
## 714                    2.1   82.50000
## 715                    2.7   82.30000
## 716                    1.4   82.03333
## 717                    1.3   81.80000
## 718                    0.8   81.73333
## 719                    0.3   81.70000
## 720                    0.2   81.00000
## 721                    0.2   80.76667
## 722                    1.4   79.96667
## 723                    0.9   79.43333
## 724                    0.3   79.23333
## 725                    0.8   78.43333
## 726                    1.1   78.00000
## 727                    0.3   76.16667
## 728                    0.6   76.10000
## 729                    0.3   75.46667
## 730                    0.8   75.20000
## 731                    1.1   75.06667
## 732                    0.7   74.86667
## 733                    0.4   74.83333
## 734                    0.0   74.50000
## 735                    0.4   74.46667
## 736                    2.1   74.30000
## 737                    0.7   73.96667
## 738                    1.5   73.90000
## 739                    1.1   73.80000
## 740                    0.8   71.60000
## 741                    0.7   71.13333
## 742                    1.8   71.03333
## 743                    0.6   71.00000
## 744                    0.6   70.70000
## 745                    2.4   70.30000
## 746                    1.4   70.26667
## 747                    0.0   69.83333
## 748                    0.8   68.73333
## 749                    0.2   68.26667
## 750                    0.5   67.63333
## 751                    0.7   67.53333
## 752                    0.0   67.43333
## 753                    0.2   67.26667
## 754                    0.0   66.90000
## 755                    1.8   66.43333
## 756                    1.7   66.33333
## 757                    0.0   66.23333
## 758                    0.2   65.90000
## 759                    0.3   65.16667
## 760                    0.6   64.73333
## 761                    0.1   63.63333
## 762                    0.6   63.40000
## 763                    0.1   63.23333
## 764                    0.2   62.36667
## 765                    0.2   61.90000
```

```
## 766                          0.7   61.86667
## 767                          0.6   61.23333
## 768                          0.1   60.66667
## 769                          1.6   60.66667
## 770                          1.1   59.76667
## 771                          0.2   59.36667
## 772                          0.0   58.53333
## 773                          0.2   58.06667
## 774                          0.6   57.96667
## 775                          0.3   57.06667
## 776                          0.3   56.96667
## 777                          1.5   56.46667
## 778                          0.3   56.40000
## 779                          0.0   56.40000
## 780                          2.3   56.33333
## 781                          1.1   56.10000
## 782                          1.0   55.53333
## 783                          0.2   54.63333
## 784                          0.1   53.03333
## 785                          1.2   52.16667
## 786                          0.2   51.50000
## 787                          0.1   51.43333
## 788                          0.0   51.06667
## 789                          0.2   50.20000
## 790                          0.4   48.50000
## 791                          0.5   47.30000
## 792                          1.5   45.56667
## 793                          0.6   44.03333
## 794                          0.1   41.30000
## 795                          0.1   40.83333
## 796                          0.5   39.00000
## 797                          0.1   38.43333
## 798                          0.1   36.00000
## 799                          0.2   33.40000
## 800                          0.0   32.30000
```

```
# Visualize the model

ggplot(model3_std_data, aes(x=Total_Mean, y=State)) + geom_point(aes(color=Total_Mean)) + labs(x= "Tota
```




```
summary(model3_std_data)
```

```
##       Year             State     Chlamydia_Rate  Gonorrhea_Rate
##  Min.   :2000   Alabama   : 16   Min.   : 86.2   Min.   :  5.00
##  1st Qu.:2004   Alaska    : 16   1st Qu.:272.2   1st Qu.: 49.30
##  Median :2008   Arizona   : 16   Median :350.6   Median : 90.40
##  Mean   :2008   Arkansas  : 16   Mean   :360.0   Mean   : 97.13
##  3rd Qu.:2011   California: 16   3rd Qu.:433.6   3rd Qu.:138.05
##  Max.   :2015   Colorado  : 16   Max.   :861.7   Max.   :323.50
##                 (Other)   :704
##  Primary_Secondary_Syphilis_Rate   Total_Mean
##  Min.   : 0.000                  Min.   : 32.3
##  1st Qu.: 0.900                  1st Qu.:114.5
##  Median : 2.300                  Median :150.5
##  Mean   : 2.919                  Mean   :153.4
##  3rd Qu.: 4.200                  3rd Qu.:188.6
##  Max.   :16.500                  Max.   :350.8
##
```

```
# Reduce data to states with the very highest rates of sexually transmitted diseases, eliminating rates

highest_states <- select (model3_std_data, "State", "Total_Mean", "Year")

# Correlation between Total_Mean and year

highest_states %>%
  summarize(correlation = cor(Year, Total_Mean))
```

```
##   correlation
## 1   0.3898846
```

```
# Arrange highest states of STDs

arrange (highest_states, desc(Total_Mean))
```

```
##              State Total_Mean Year
## 1      Mississippi  350.80000 2009
## 2           Alaska  348.13333 2010
## 3      Mississippi  344.13333 2007
## 4      Mississippi  336.60000 2012
## 5      Mississippi  328.16667 2008
## 6      Mississippi  327.10000 2005
## 7           Alaska  323.96667 2014
## 8           Alaska  315.73333 2011
## 9           Alaska  315.56667 2013
## 10     Mississippi  314.36667 2010
## 11       Louisiana  310.43333 2015
## 12          Alaska  306.83333 2015
## 13     Mississippi  305.76667 2011
## 14     Mississippi  304.66667 2006
## 15       Louisiana  303.20000 2011
## 16     Mississippi  301.76667 2004
## 17          Alaska  293.76667 2009
## 18       Louisiana  286.50000 2010
## 19  North Carolina  286.20000 2015
## 20          Alaska  285.93333 2012
## 21     Mississippi  283.26667 2014
## 22  South Carolina  278.70000 2007
## 23         Alabama  278.36667 2012
## 24       Louisiana  277.66667 2014
## 25       Louisiana  277.26667 2009
## 26       Louisiana  274.03333 2013
## 27         Alabama  271.90000 2011
## 28  South Carolina  270.26667 2011
## 29          Alaska  268.06667 2007
## 30  South Carolina  266.86667 2008
## 31       Louisiana  266.43333 2012
## 32          Alaska  264.20000 2008
## 33         Alabama  262.83333 2013
## 34         Alabama  262.30000 2007
## 35     Mississippi  260.13333 2015
## 36     Mississippi  258.00000 2000
## 37          Alaska  256.96667 2006
## 38  South Carolina  256.50000 2009
## 39  South Carolina  255.40000 2014
## 40  North Carolina  254.13333 2011
## 41         Alabama  254.10000 2014
## 42  South Carolina  253.20000 2010
## 43     Mississippi  252.80000 2013
## 44  South Carolina  252.50000 2006
## 45          Alaska  252.43333 2005
## 46         Alabama  249.86667 2008
## 47         Alabama  249.43333 2010
```

```
## 48  South Carolina  249.40000 2012
## 49  South Carolina  248.60000 2015
## 50       Louisiana  248.03333 2008
## 51         Georgia  247.70000 2015
## 52         Georgia  246.06667 2011
## 53         Alabama  245.70000 2006
## 54       Louisiana  244.66667 2003
## 55      New Mexico  243.56667 2015
## 56       Louisiana  242.50000 2004
## 57        Delaware  241.90000 2013
## 58       Louisiana  240.93333 2007
## 59         Alabama  239.60000 2009
## 60        Arkansas  239.30000 2012
## 61        Arkansas  239.13333 2011
## 62        Oklahoma  238.76667 2015
## 63        Arkansas  236.86667 2015
## 64        Arkansas  235.30000 2010
## 65       Louisiana  233.43333 2000
## 66        Oklahoma  233.30000 2014
## 67  South Carolina  233.26667 2013
## 68         Georgia  233.20000 2012
## 69          Alaska  232.66667 2004
## 70         Alabama  232.60000 2015
## 71          Alaska  230.26667 2002
## 72          Alaska  229.86667 2003
## 73     Mississippi  229.53333 2001
## 74        Arkansas  228.26667 2014
## 75      New Mexico  227.66667 2013
## 76        Illinois  227.26667 2015
## 77       Louisiana  226.30000 2006
## 78           Texas  225.70000 2015
## 79       Louisiana  225.70000 2001
## 80  North Carolina  225.30000 2012
## 81        Illinois  224.43333 2012
## 82         Georgia  223.33333 2014
## 83       Louisiana  222.93333 2002
## 84         Georgia  222.93333 2013
## 85  South Carolina  222.70000 2004
## 86      New Mexico  222.66667 2014
## 87      New Mexico  222.23333 2012
## 88        Arkansas  221.90000 2013
## 89        New York  221.43333 2015
## 90        Arkansas  220.23333 2009
## 91        Arkansas  220.13333 2008
## 92       Tennessee  218.06667 2012
## 93     Mississippi  217.33333 2002
## 94  South Carolina  216.40000 2001
## 95        Illinois  215.73333 2014
## 96      New Mexico  215.43333 2010
## 97        Delaware  215.26667 2009
## 98        Illinois  215.26667 2011
## 99      New Mexico  215.03333 2011
## 100    Mississippi  214.73333 2003
## 101        Georgia  214.53333 2007
```

```
## 102       New York  214.26667 2011
## 103 South Carolina  213.90000 2005
## 104 North Carolina  213.56667 2013
## 105     California  213.20000 2015
## 106       New York  212.93333 2012
## 107           Ohio  212.33333 2015
## 108       Delaware  212.20000 2015
## 109          Texas  211.96667 2014
## 110       Michigan  211.80000 2010
## 111       Michigan  211.63333 2011
## 112          Texas  211.26667 2013
## 113        Georgia  210.86667 2001
## 114        Georgia  210.83333 2006
## 115 North Carolina  210.83333 2014
## 116       Missouri  210.00000 2015
## 117       Illinois  209.86667 2013
## 118       Illinois  209.76667 2009
## 119        Georgia  209.56667 2010
## 120          Texas  209.20000 2012
## 121       Delaware  208.83333 2014
## 122          Texas  208.06667 2011
## 123       Illinois  207.70000 2008
## 124       Michigan  207.26667 2008
## 125        Georgia  207.06667 2003
## 126       Oklahoma  207.06667 2013
## 127       Delaware  206.46667 2010
## 128           Ohio  206.43333 2014
## 129        Alabama  206.00000 2000
## 130        Georgia  205.83333 2008
## 131       New York  205.73333 2014
## 132        Georgia  205.66667 2002
## 133          Texas  205.66667 2010
## 134      Tennessee  205.10000 2011
## 135        Arizona  204.86667 2014
## 136        Arizona  204.10000 2015
## 137       Michigan  204.00000 2012
## 138      Tennessee  203.60000 2015
## 139       New York  203.53333 2010
## 140       Michigan  202.76667 2009
## 141           Ohio  202.66667 2013
## 142        Georgia  202.50000 2000
## 143           Ohio  202.30000 2012
## 144           Ohio  201.73333 2011
## 145   South Dakota  201.66667 2014
## 146      Tennessee  201.40000 2009
## 147 North Carolina  200.93333 2010
## 148       Delaware  199.96667 2006
## 149      Louisiana  199.90000 2005
## 150           Ohio  199.70000 2007
## 151       Illinois  199.70000 2010
## 152      Tennessee  199.66667 2008
## 153       New York  199.60000 2013
## 154       Missouri  199.40000 2011
## 155      Tennessee  199.23333 2007
```

```
## 156       Illinois  199.03333 2007
## 157       Delaware  199.03333 2011
## 158       Missouri  198.96667 2012
## 159     New Mexico  198.53333 2006
## 160       Maryland  198.50000 2010
## 161         Nevada  198.33333 2015
## 162       Delaware  197.50000 2012
## 163         Hawaii  197.33333 2015
## 164 North Carolina  197.20000 2009
## 165       Maryland  197.00000 2011
## 166       Missouri  196.96667 2014
## 167           Ohio  196.86667 2010
## 168   South Dakota  196.76667 2015
## 169        Alabama  196.33333 2005
## 170     California  196.13333 2014
## 171      Tennessee  196.13333 2014
## 172      Tennessee  195.96667 2013
## 173        Florida  195.53333 2015
## 174       Delaware  194.93333 2000
## 175      Tennessee  194.63333 2006
## 176       Michigan  194.50000 2004
## 177       Missouri  194.43333 2013
## 178 North Carolina  194.36667 2008
## 179        Georgia  194.23333 2004
## 180       Maryland  194.20000 2015
## 181 North Carolina  192.86667 2006
## 182        Alabama  192.80000 2001
## 183       Illinois  192.76667 2006
## 184       Michigan  192.46667 2015
## 185        Alabama  192.26667 2002
## 186       Illinois  192.06667 2002
## 187   North Dakota  191.60000 2014
## 188 South Carolina  191.53333 2002
## 189     New Mexico  191.23333 2007
## 190       Maryland  191.06667 2014
## 191       Missouri  190.26667 2006
## 192           Ohio  190.20000 2003
## 193   South Dakota  190.20000 2013
## 194       Delaware  189.96667 2001
## 195        Indiana  189.56667 2012
## 196       Missouri  189.53333 2007
## 197        Arizona  189.53333 2013
## 198      Tennessee  189.13333 2010
## 199           Ohio  189.06667 2005
## 200        Georgia  189.00000 2005
## 201       Michigan  188.46667 2013
## 202       Delaware  188.16667 2008
## 203   South Dakota  188.06667 2012
## 204       New York  188.03333 2009
## 205       Maryland  187.86667 2013
## 206       Oklahoma  187.83333 2012
## 207       Maryland  187.63333 2008
## 208        Arizona  187.43333 2012
## 209        Indiana  187.03333 2015
```

```
## 210 South Carolina  186.76667 2003
## 211       Maryland  186.76667 2012
## 212           Ohio  186.53333 2008
## 213           Ohio  186.50000 2009
## 214       Illinois  186.43333 2005
## 215       Missouri  186.40000 2008
## 216       Michigan  186.30000 2005
## 217       Missouri  185.73333 2010
## 218       Illinois  185.70000 2003
## 219   Pennsylvania  185.43333 2012
## 220     New Mexico  185.36667 2004
## 221       Missouri  185.20000 2005
## 222        Georgia  184.70000 2009
## 223       Delaware  184.63333 2007
## 224          Texas  184.26667 2008
## 225          Texas  184.06667 2009
## 226         Nevada  183.83333 2014
## 227       Oklahoma  183.73333 2008
## 228     California  183.16667 2013
## 229       Michigan  183.13333 2014
## 230        Indiana  182.50000 2014
## 231       New York  182.43333 2008
## 232        Florida  182.20000 2014
## 233 North Carolina  181.60000 2005
## 234       Illinois  181.46667 2001
## 235       Missouri  181.10000 2009
## 236     California  180.60000 2012
## 237        Indiana  180.43333 2013
## 238      Tennessee  180.23333 2005
## 239       Virginia  179.93333 2014
## 240     New Mexico  179.90000 2008
## 241       Illinois  179.60000 2004
## 242       Maryland  179.53333 2007
## 243       Virginia  179.43333 2008
## 244       Virginia  179.36667 2011
## 245         Hawaii  179.06667 2003
## 246       Missouri  178.96667 2004
## 247       Oklahoma  178.93333 2009
## 248         Hawaii  178.20000 2014
## 249       Maryland  178.13333 2009
## 250        Arizona  177.76667 2011
## 251        Indiana  177.60000 2011
## 252         Nevada  177.60000 2013
## 253      Tennessee  177.56667 2004
## 254       Colorado  177.30000 2015
## 255         Hawaii  177.26667 2013
## 256        Florida  176.90000 2013
## 257       Oklahoma  176.70000 2005
## 258     New Mexico  176.40000 2009
## 259     New Mexico  176.23333 2005
## 260     California  176.06667 2011
## 261   Pennsylvania  175.86667 2011
## 262 North Carolina  175.83333 2004
## 263           Ohio  175.70000 2002
```

```
## 264       Illinois  175.66667 2000
## 265       Michigan  175.26667 2007
## 266       Virginia  175.26667 2015
## 267         Hawaii  175.23333 2010
## 268           Ohio  175.13333 2004
## 269 North Carolina  175.10000 2007
## 270       Maryland  175.00000 2006
## 271        Alabama  174.96667 2003
## 272       Delaware  174.90000 2002
## 273   Pennsylvania  174.40000 2015
## 274         Hawaii  174.06667 2012
## 275   North Dakota  173.73333 2015
## 276       Michigan  173.50000 2006
## 277        Florida  173.50000 2008
## 278       Virginia  173.43333 2012
## 279   Pennsylvania  173.40000 2013
## 280       Delaware  173.26667 2005
## 281       Maryland  173.23333 2004
## 282        Florida  172.80000 2010
## 283      Wisconsin  172.73333 2011
## 284           Ohio  172.73333 2006
## 285         Hawaii  172.50000 2004
## 286           Ohio  172.36667 2001
## 287        Florida  172.23333 2012
## 288         Hawaii  172.23333 2005
## 289         Hawaii  172.16667 2009
## 290      Wisconsin  172.10000 2015
## 291        Florida  171.93333 2011
## 292       Nebraska  171.93333 2015
## 293       New York  171.83333 2007
## 294     Washington  171.43333 2015
## 295         Hawaii  171.36667 2008
## 296        Florida  170.53333 2009
## 297       Delaware  170.06667 2003
## 298       Oklahoma  169.63333 2010
## 299         Alaska  168.40000 2001
## 300       Kentucky  168.16667 2014
## 301       Kentucky  168.16667 2015
## 302       Oklahoma  167.90000 2011
## 303       Oklahoma  167.76667 2006
## 304       Arkansas  167.46667 2007
## 305         Hawaii  167.26667 2006
## 306      Wisconsin  167.26667 2010
## 307         Oregon  166.93333 2015
## 308      Wisconsin  166.46667 2012
## 309   Pennsylvania  166.43333 2014
## 310 North Carolina  166.16667 2000
## 311          Texas  166.00000 2007
## 312      Tennessee  165.66667 2003
## 313       Kentucky  165.56667 2012
## 314         Nevada  165.36667 2012
## 315   Rhode Island  165.30000 2015
## 316       Virginia  165.23333 2013
## 317       Virginia  164.86667 2009
```

```
## 318      Wisconsin  164.53333 2013
## 319 North Carolina  164.36667 2003
## 320         Hawaii  164.30000 2007
## 321   South Dakota  164.20000 2011
## 322        Montana  164.20000 2015
## 323         Hawaii  164.20000 2011
## 324       Kentucky  164.16667 2013
## 325   North Dakota  163.70000 2013
## 326        Arizona  163.50000 2006
## 327       Kentucky  163.46667 2011
## 328      Wisconsin  163.10000 2006
## 329       Virginia  162.70000 2010
## 330          Texas  162.46667 2000
## 331 North Carolina  162.43333 2002
## 332        Indiana  162.36667 2008
## 333       Michigan  162.03333 2001
## 334         Kansas  161.70000 2015
## 335       Maryland  161.70000 2002
## 336     California  161.36667 2010
## 337       Kentucky  161.16667 2010
## 338       Colorado  161.10000 2011
## 339      Wisconsin  160.83333 2008
## 340   Pennsylvania  160.70000 2010
## 341       Nebraska  160.70000 2014
## 342       Colorado  160.66667 2012
## 343        Alabama  160.60000 2004
## 344      Tennessee  160.56667 2000
## 345       Oklahoma  160.53333 2007
## 346     California  160.33333 2008
## 347     New Mexico  160.23333 2002
## 348       Missouri  160.23333 2003
## 349     California  159.83333 2007
## 350       Colorado  159.56667 2014
## 351      Wisconsin  159.53333 2005
## 352        Arizona  158.96667 2007
## 353 North Carolina  158.93333 2001
## 354   Rhode Island  158.83333 2014
## 355      Wisconsin  158.56667 2014
## 356     Washington  158.43333 2014
## 357         Kansas  158.30000 2014
## 358   North Dakota  158.26667 2012
## 359       Arkansas  157.86667 2005
## 360       Michigan  157.63333 2002
## 361       Delaware  157.26667 2004
## 362      Wisconsin  156.93333 2007
## 363       Nebraska  156.76667 2013
## 364       Maryland  156.76667 2001
## 365     California  156.70000 2006
## 366          Texas  156.36667 2001
## 367      Minnesota  156.30000 2015
## 368         Nevada  156.06667 2011
## 369         Nevada  155.70000 2007
## 370       Colorado  155.66667 2008
## 371         Alaska  155.60000 2000
```

```
## 372         Kansas  155.40000 2012
## 373        Indiana  155.26667 2007
## 374     New Mexico  155.06667 2003
## 375     California  155.03333 2009
## 376       Maryland  154.80000 2000
## 377     California  154.76667 2005
## 378       Michigan  154.70000 2003
## 379           Iowa  154.53333 2015
## 380         Kansas  154.30000 2009
## 381   Rhode Island  154.23333 2012
## 382      Wisconsin  154.16667 2009
## 383 South Carolina  153.76667 2000
## 384       Maryland  153.76667 2005
## 385         Oregon  153.50000 2014
## 386        Arizona  153.33333 2010
## 387        Arizona  153.13333 2005
## 388        Indiana  153.06667 2010
## 389         Nevada  152.80000 2008
## 390         Kansas  152.76667 2013
## 391   Rhode Island  152.70000 2013
## 392       Maryland  152.33333 2003
## 393        Montana  152.20000 2014
## 394       Colorado  152.10000 2009
## 395          Texas  151.80000 2006
## 396        Indiana  151.43333 2006
## 397         Nevada  151.26667 2006
## 398      Tennessee  150.96667 2001
## 399        Indiana  150.80000 2005
## 400    Connecticut  150.73333 2011
## 401   South Dakota  150.33333 2010
## 402       Colorado  150.16667 2013
## 403       New York  150.03333 2006
## 404       Arkansas  149.90000 2006
## 405         Kansas  149.90000 2011
## 406       Michigan  149.80000 2000
## 407         Nevada  149.56667 2009
## 408        Florida  149.43333 2007
## 409        Indiana  149.06667 2009
## 410      Minnesota  149.03333 2014
## 411        Arizona  149.00000 2009
## 412       Arkansas  148.70000 2003
## 413   Pennsylvania  148.63333 2007
## 414          Texas  148.60000 2002
## 415       Nebraska  148.56667 2011
## 416       Colorado  148.40000 2010
## 417           Ohio  148.33333 2000
## 418       Oklahoma  148.33333 2003
## 419       Oklahoma  148.23333 2002
## 420       Nebraska  148.06667 2012
## 421      Wisconsin  148.00000 2004
## 422       Missouri  147.86667 2002
## 423       Arkansas  147.63333 2001
## 424       Arkansas  147.33333 2004
## 425         Nevada  147.23333 2005
```

```
## 426       Oklahoma  147.20000 2001
## 427      Tennessee  146.93333 2002
## 428       Arkansas  146.73333 2002
## 429          Texas  146.50000 2005
## 430    Connecticut  146.46667 2014
## 431           Iowa  146.43333 2012
## 432        Arizona  146.36667 2008
## 433    Connecticut  146.20000 2008
## 434         Nevada  145.86667 2004
## 435           Iowa  145.80000 2014
## 436    Connecticut  145.70000 2013
## 437         Nevada  145.33333 2010
## 438      Wisconsin  145.30000 2000
## 439     New Jersey  145.23333 2015
## 440    Connecticut  145.10000 2010
## 441     California  144.40000 2004
## 442   Rhode Island  144.16667 2011
## 443      Wisconsin  143.90000 2003
## 444          Texas  143.80000 2004
## 445   Pennsylvania  143.46667 2008
## 446      Wisconsin  143.16667 2002
## 447     Washington  143.06667 2013
## 448       New York  142.83333 2005
## 449          Texas  142.36667 2003
## 450    Connecticut  142.00000 2012
## 451    Connecticut  141.86667 2015
## 452   Pennsylvania  141.60000 2009
## 453       Colorado  141.36667 2007
## 454      Minnesota  141.33333 2013
## 455         Hawaii  141.16667 2002
## 456       Oklahoma  140.90000 2004
## 457       Colorado  140.80000 2006
## 458  Massachusetts  140.03333 2015
## 459    Connecticut  139.73333 2009
## 460       Virginia  139.23333 2005
## 461       New York  138.90000 2003
## 462         Kansas  138.40000 2010
## 463           Iowa  138.36667 2011
## 464         Oregon  138.26667 2013
## 465   South Dakota  138.10000 2008
## 466     New Jersey  137.96667 2014
## 467   South Dakota  137.80000 2009
## 468      Wisconsin  137.60000 2001
## 469     Washington  137.30000 2012
## 470   Pennsylvania  137.23333 2006
## 471           Iowa  137.00000 2010
## 472         Kansas  136.96667 2008
## 473       Virginia  136.83333 2004
## 474       Virginia  136.80000 2001
## 475       New York  136.46667 2004
## 476        Indiana  136.40000 2004
## 477     California  135.93333 2003
## 478           Iowa  135.86667 2013
## 479        Florida  135.70000 2006
```

```
## 480       Colorado  135.50000 2005
## 481   North Dakota  134.56667 2010
## 482       Virginia  134.33333 2007
## 483       Missouri  134.20000 2001
## 484        Montana  134.20000 2013
## 485       Virginia  134.13333 2006
## 486  Massachusetts  134.06667 2012
## 487     New Jersey  133.76667 2013
## 488  Massachusetts  133.76667 2013
## 489   North Dakota  133.63333 2011
## 490     New Mexico  133.13333 2001
## 491   Pennsylvania  133.13333 2004
## 492       Missouri  132.96667 2000
## 493   Pennsylvania  132.96667 2003
## 494       Kentucky  132.96667 2009
## 495        Indiana  132.90000 2002
## 496       Virginia  132.76667 2002
## 497   Rhode Island  132.66667 2004
## 498      Minnesota  132.56667 2012
## 499         Oregon  132.50000 2011
## 500     New Jersey  132.23333 2012
## 501   South Dakota  132.06667 2005
## 502       Oklahoma  131.96667 2000
## 503        Wyoming  131.83333 2010
## 504    Connecticut  131.76667 2005
## 505       Nebraska  131.73333 2008
## 506    Connecticut  131.50000 2007
## 507        Montana  131.46667 2012
## 508       Kentucky  131.20000 2008
## 509   Pennsylvania  130.80000 2005
## 510     Washington  130.60000 2011
## 511         Oregon  130.26667 2012
## 512       Colorado  130.20000 2002
## 513    Connecticut  129.53333 2006
## 514       Nebraska  129.46667 2006
## 515  Massachusetts  129.23333 2011
## 516     California  129.03333 2002
## 517       Virginia  129.00000 2003
## 518   South Dakota  128.43333 2006
## 519     New Jersey  128.10000 2011
## 520        Indiana  128.06667 2003
## 521       New York  127.80000 2002
## 522        Florida  127.66667 2002
## 523       Nebraska  126.63333 2009
## 524        Wyoming  126.53333 2015
## 525       Colorado  126.50000 2004
## 526        Wyoming  126.46667 2011
## 527  Massachusetts  126.43333 2014
## 528         Hawaii  126.23333 2001
## 529        Wyoming  126.13333 2012
## 530    Connecticut  125.96667 2002
## 531         Kansas  125.96667 2007
## 532     Washington  125.76667 2008
## 533          Idaho  125.63333 2015
```

```
## 534        Arizona  125.46667 2004
## 535   Rhode Island  125.23333 2009
## 536        Wyoming  124.96667 2009
## 537   Rhode Island  124.10000 2003
## 538       Arkansas  124.03333 2000
## 539       Colorado  123.76667 2001
## 540        Vermont  123.73333 2014
## 541   South Dakota  123.70000 2003
## 542   South Dakota  123.70000 2004
## 543     New Jersey  123.46667 2010
## 544       Nebraska  123.40000 2007
## 545        Florida  123.26667 2005
## 546         Kansas  123.10000 2004
## 547           Iowa  123.06667 2008
## 548           Iowa  122.86667 2009
## 549       Nebraska  122.50000 2004
## 550     Washington  122.43333 2010
## 551       Nebraska  122.36667 2002
## 552         Kansas  122.36667 2005
## 553       Nebraska  122.13333 2003
## 554   Pennsylvania  122.13333 2002
## 555          Idaho  121.93333 2014
## 556        Indiana  121.76667 2001
## 557         Nevada  121.76667 2002
## 558      Minnesota  121.46667 2011
## 559        Florida  121.46667 2003
## 560        Florida  121.43333 2001
## 561         Kansas  121.43333 2003
## 562         Kansas  121.40000 2006
## 563     California  121.16667 2001
## 564        Florida  121.16667 2004
## 565     Washington  120.96667 2005
## 566   South Dakota  120.93333 2007
## 567   Rhode Island  120.63333 2010
## 568  Massachusetts  120.56667 2010
## 569       New York  120.50000 2001
## 570       Virginia  120.33333 2000
## 571    Connecticut  120.00000 2003
## 572         Nevada  119.90000 2003
## 573        Wyoming  119.83333 2013
## 574        Wyoming  119.66667 2014
## 575       Nebraska  119.43333 2005
## 576    Connecticut  119.23333 2004
## 577     Washington  119.10000 2009
## 578           Iowa  118.16667 2007
## 579          Idaho  118.10000 2013
## 580   Rhode Island  117.96667 2001
## 581        Montana  117.83333 2011
## 582         Oregon  117.63333 2010
## 583        Florida  117.50000 2000
## 584         Kansas  117.16667 2002
## 585       Nebraska  117.13333 2010
## 586       Colorado  116.70000 2003
## 587   Rhode Island  116.66667 2002
```

```
## 588     New Mexico  116.60000 2000
## 589       Colorado  116.50000 2000
## 590     Washington  116.43333 2007
## 591           Utah  116.20000 2015
## 592           Iowa  115.93333 2006
## 593        Arizona  115.90000 2002
## 594        Arizona  115.86667 2001
## 595     Washington  115.86667 2006
## 596   Pennsylvania  115.73333 2001
## 597   Rhode Island  115.53333 2008
## 598   Rhode Island  115.06667 2005
## 599     California  115.03333 2000
## 600        Indiana  114.56667 2000
## 601   Rhode Island  114.40000 2006
## 602   Rhode Island  113.90000 2007
## 603     Washington  111.93333 2004
## 604      Minnesota  111.76667 2008
## 605  West Virginia  111.70000 2013
## 606           Utah  111.60000 2014
## 607        Montana  111.26667 2008
## 608      Minnesota  111.13333 2010
## 609         Hawaii  110.83333 2000
## 610     New Jersey  110.80000 2009
## 611          Maine  110.53333 2015
## 612         Oregon  110.36667 2009
## 613        Vermont  109.83333 2015
## 614         Kansas  109.63333 2000
## 615        Arizona  109.10000 2000
## 616   Pennsylvania  108.96667 2000
## 617        Montana  108.96667 2010
## 618  Massachusetts  108.83333 2009
## 619   North Dakota  108.80000 2009
## 620      Minnesota  108.56667 2007
## 621   South Dakota  108.53333 2002
## 622         Kansas  107.86667 2001
## 623   North Dakota  107.26667 2008
## 624     New Jersey  107.20000 2008
## 625     New Jersey  106.83333 2007
## 626     Washington  106.70000 2003
## 627        Wyoming  106.66667 2008
## 628         Oregon  105.50000 2008
## 629      Minnesota  105.03333 2006
## 630        Montana  105.03333 2009
## 631      Minnesota  104.86667 2009
## 632         Nevada  104.80000 2001
## 633   Rhode Island  104.60000 2000
## 634  West Virginia  104.13333 2015
## 635       Nebraska  103.63333 2000
## 636          Idaho  103.63333 2011
## 637   North Dakota  103.50000 2006
## 638        Vermont  103.40000 2013
## 639    Connecticut  102.90000 2000
## 640      Minnesota  102.90000 2005
## 641       Kentucky  102.76667 2002
```

```
## 642       Kentucky  102.56667 2001
## 643  Massachusetts  101.83333 2008
## 644           Iowa  101.60000 2005
## 645  West Virginia  101.13333 2012
## 646   North Dakota  101.00000 2004
## 647  West Virginia  100.46667 2014
## 648        Montana  100.36667 2006
## 649        Montana  100.13333 2007
## 650           Utah   99.93333 2013
## 651        Wyoming   99.80000 2006
## 652          Idaho   99.73333 2012
## 653         Oregon   99.70000 2006
## 654    Connecticut   99.70000 2001
## 655     New Jersey   99.36667 2001
## 656   North Dakota   99.33333 2007
## 657        Arizona   99.03333 2003
## 658     New Jersey   98.80000 2006
## 659         Oregon   98.76667 2007
## 660     Washington   98.50000 2002
## 661         Oregon   98.50000 2005
## 662  Massachusetts   98.16667 2007
## 663        Montana   98.06667 2004
## 664          Maine   97.53333 2012
## 665       Kentucky   97.36667 2006
## 666        Vermont   97.33333 2012
## 667        Montana   96.96667 2003
## 668  New Hampshire   96.93333 2014
## 669       Kentucky   96.66667 2007
## 670           Utah   96.26667 2012
## 671      Minnesota   96.06667 2004
## 672          Idaho   96.00000 2008
## 673       Kentucky   95.90000 2000
## 674     New Jersey   95.83333 2005
## 675        Montana   95.20000 2002
## 676          Maine   94.93333 2014
## 677   North Dakota   94.40000 2005
## 678          Idaho   94.03333 2010
## 679       Kentucky   93.83333 2003
## 680         Oregon   93.83333 2004
## 681     New Jersey   93.73333 2003
## 682     New Jersey   93.73333 2004
## 683   South Dakota   93.13333 2000
## 684           Iowa   92.96667 2004
## 685  Massachusetts   92.90000 2006
## 686   South Dakota   92.76667 2001
## 687     Washington   92.76667 2001
## 688          Maine   92.63333 2013
## 689   North Dakota   92.56667 2003
## 690        Montana   92.23333 2005
## 691         Nevada   92.06667 2000
## 692      Minnesota   92.00000 2003
## 693  West Virginia   91.66667 2011
## 694           Iowa   91.23333 2003
## 695       Kentucky   91.16667 2005
```

```
## 696       New York   90.80000 2000
## 697           Utah   88.96667 2011
## 698          Idaho   88.73333 2007
## 699  Massachusetts   88.66667 2005
## 700      Minnesota   87.73333 2002
## 701     Washington   87.66667 2000
## 702           Iowa   87.20000 2002
## 703     New Jersey   86.26667 2002
## 704       Nebraska   85.36667 2001
## 705          Idaho   85.26667 2009
## 706  Massachusetts   85.03333 2004
## 707  New Hampshire   84.93333 2015
## 708          Maine   84.76667 2011
## 709           Utah   84.56667 2010
## 710           Iowa   84.10000 2000
## 711        Wyoming   82.93333 2005
## 712           Utah   82.70000 2007
## 713         Oregon   82.63333 2001
## 714  New Hampshire   82.50000 2013
## 715  New Hampshire   82.30000 2012
## 716        Vermont   82.03333 2011
## 717         Oregon   81.80000 2003
## 718        Wyoming   81.73333 2007
## 719  West Virginia   81.70000 2010
## 720           Iowa   81.00000 2001
## 721          Idaho   80.76667 2006
## 722  New Hampshire   79.96667 2011
## 723           Utah   79.43333 2008
## 724         Oregon   79.23333 2000
## 725           Utah   78.43333 2006
## 726           Utah   78.00000 2009
## 727      Minnesota   76.16667 2000
## 728        Wyoming   76.10000 2004
## 729  West Virginia   75.46667 2007
## 730         Oregon   75.20000 2002
## 731       Kentucky   75.06667 2004
## 732  West Virginia   74.86667 2008
## 733  West Virginia   74.83333 2009
## 734        Montana   74.50000 2001
## 735           Utah   74.46667 2005
## 736  Massachusetts   74.30000 2003
## 737      Minnesota   73.96667 2001
## 738  Massachusetts   73.90000 2002
## 739  Massachusetts   73.80000 2000
## 740     New Jersey   71.60000 2000
## 741  Massachusetts   71.13333 2001
## 742          Idaho   71.03333 2004
## 743  West Virginia   71.00000 2006
## 744        Vermont   70.70000 2010
## 745          Maine   70.30000 2010
## 746          Idaho   70.26667 2005
## 747   North Dakota   69.83333 2002
## 748          Maine   68.73333 2008
## 749  West Virginia   68.26667 2005
```

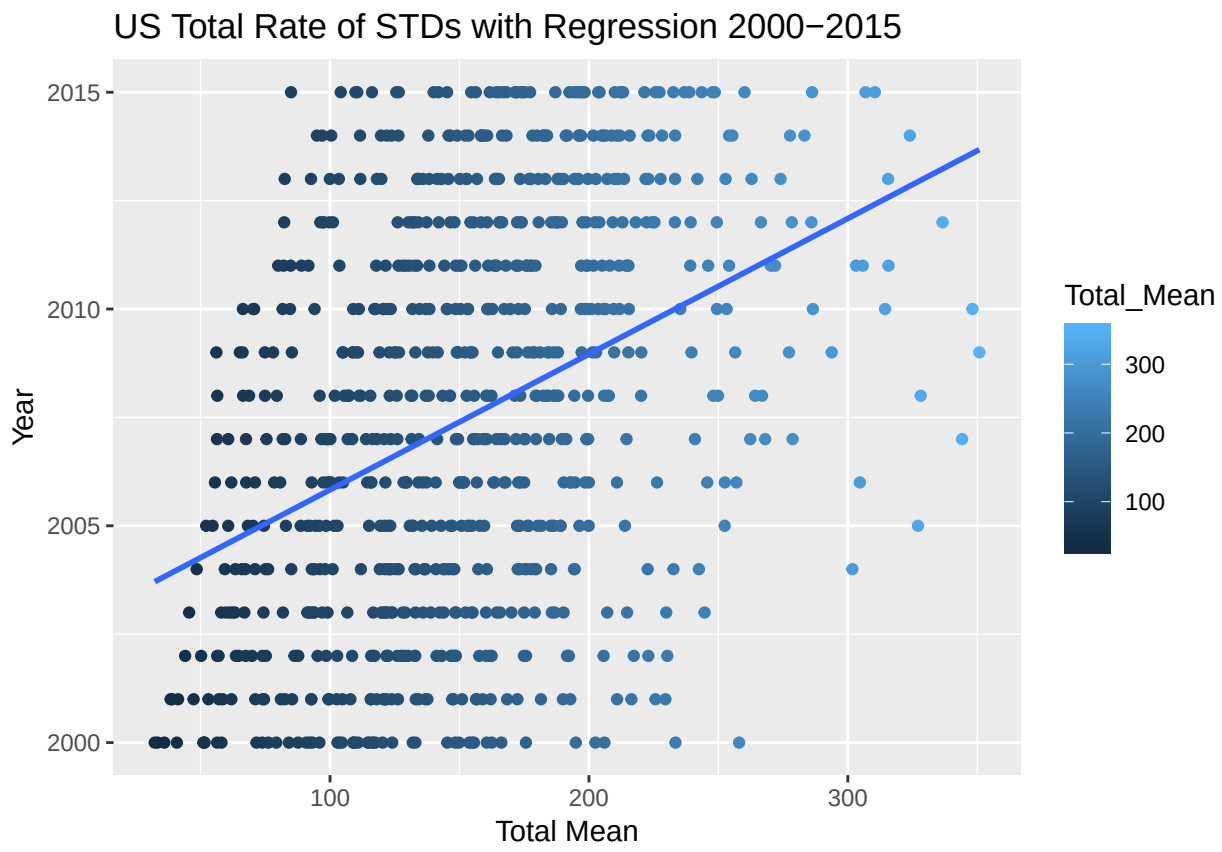
```
## 750        Vermont   67.63333 2006
## 751          Maine   67.53333 2007
## 752        Wyoming   67.43333 2002
## 753  West Virginia   67.26667 2004
## 754        Wyoming   66.90000 2003
## 755        Vermont   66.43333 2008
## 756  New Hampshire   66.33333 2010
## 757        Vermont   66.23333 2009
## 758        Vermont   65.90000 2004
## 759          Maine   65.16667 2009
## 760          Idaho   64.73333 2002
## 761  West Virginia   63.63333 2002
## 762           Utah   63.40000 2004
## 763  West Virginia   63.23333 2003
## 764        Vermont   62.36667 2003
## 765        Wyoming   61.90000 2001
## 766          Maine   61.86667 2006
## 767           Utah   61.23333 2003
## 768          Maine   60.66667 2005
## 769        Vermont   60.66667 2007
## 770          Idaho   59.76667 2003
## 771          Maine   59.36667 2004
## 772   North Dakota   58.53333 2001
## 773        Wyoming   58.06667 2000
## 774          Maine   57.96667 2003
## 775  West Virginia   57.06667 2001
## 776        Vermont   56.96667 2002
## 777  New Hampshire   56.46667 2008
## 778           Utah   56.40000 2002
## 779        Montana   56.40000 2000
## 780  New Hampshire   56.33333 2007
## 781  New Hampshire   56.10000 2009
## 782  New Hampshire   55.53333 2006
## 783        Vermont   54.63333 2005
## 784          Idaho   53.03333 2001
## 785  New Hampshire   52.16667 2005
## 786  West Virginia   51.50000 2000
## 787          Idaho   51.43333 2000
## 788   North Dakota   51.06667 2000
## 789          Maine   50.20000 2002
## 790  New Hampshire   48.50000 2004
## 791           Utah   47.30000 2001
## 792  New Hampshire   45.56667 2003
## 793  New Hampshire   44.03333 2002
## 794  New Hampshire   41.30000 2001
## 795          Maine   40.83333 2000
## 796        Vermont   39.00000 2001
## 797          Maine   38.43333 2001
## 798           Utah   36.00000 2000
## 799  New Hampshire   33.40000 2000
## 800        Vermont   32.30000 2000
```

```
# Summarize new data set
```

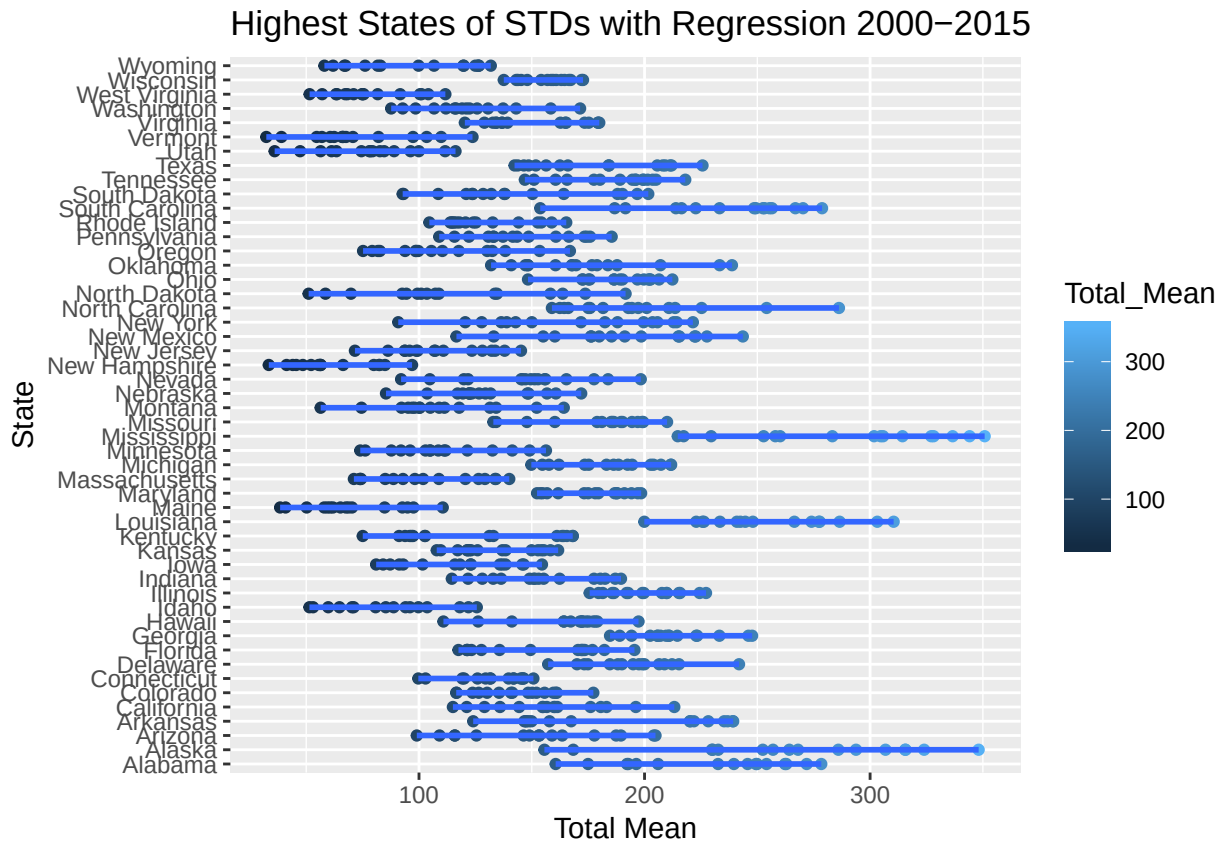
```
summary (highest_states)
```

```
##         State       Total_Mean         Year
##  Alabama   : 16   Min.   : 32.3   Min.   :2000
##  Alaska    : 16   1st Qu.:114.5   1st Qu.:2004
##  Arizona   : 16   Median :150.5   Median :2008
##  Arkansas  : 16   Mean   :153.4   Mean   :2008
##  California: 16   3rd Qu.:188.6   3rd Qu.:2011
##  Colorado  : 16   Max.   :350.8   Max.   :2015
##  (Other)   :704
```

```
# Plot US STDs 2000-2015 with regression line
ggplot(highest_states, aes(x=Total_Mean, y=Year)) +
geom_point(aes(color=Total_Mean)) +
labs(x= "Total Mean", y="Year", title = "US Total Rate of STDs with Regression 2000-2015") +
geom_smooth (method = "lm", se=FALSE)
```



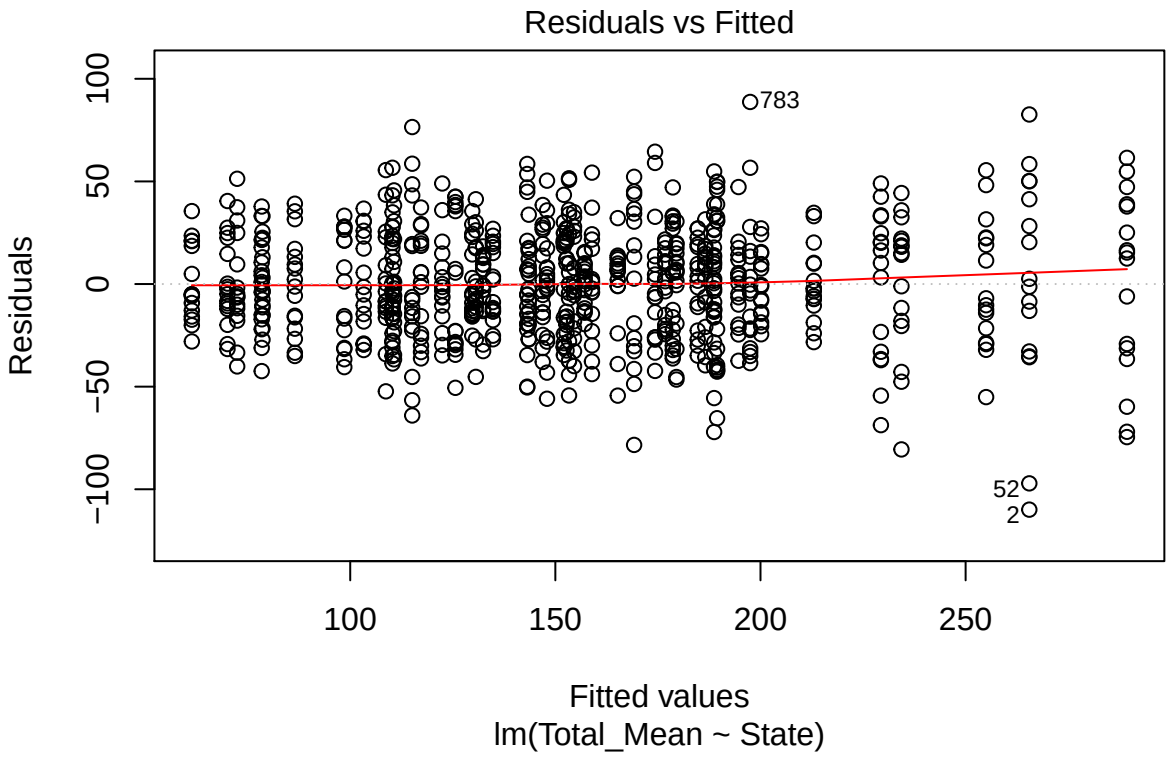

```
# Plot states with highest rates of STDs 2000-2015 with regression line
ggplot(highest_states, aes(x=Total_Mean, y=State)) +
geom_point(aes(color=Total_Mean)) +
labs(x= "Total Mean", y="State", title = "Highest States of STDs with Regression 2000-2015") +
geom_smooth (method = "lm", se=FALSE)
```

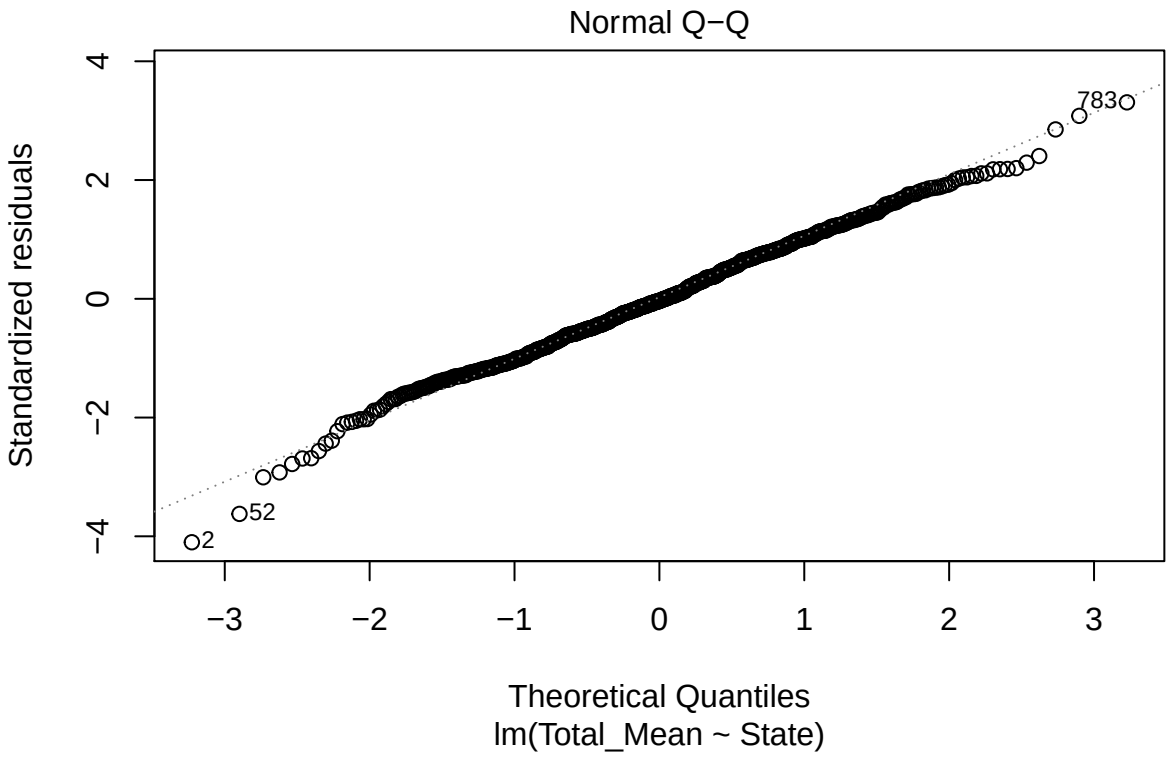


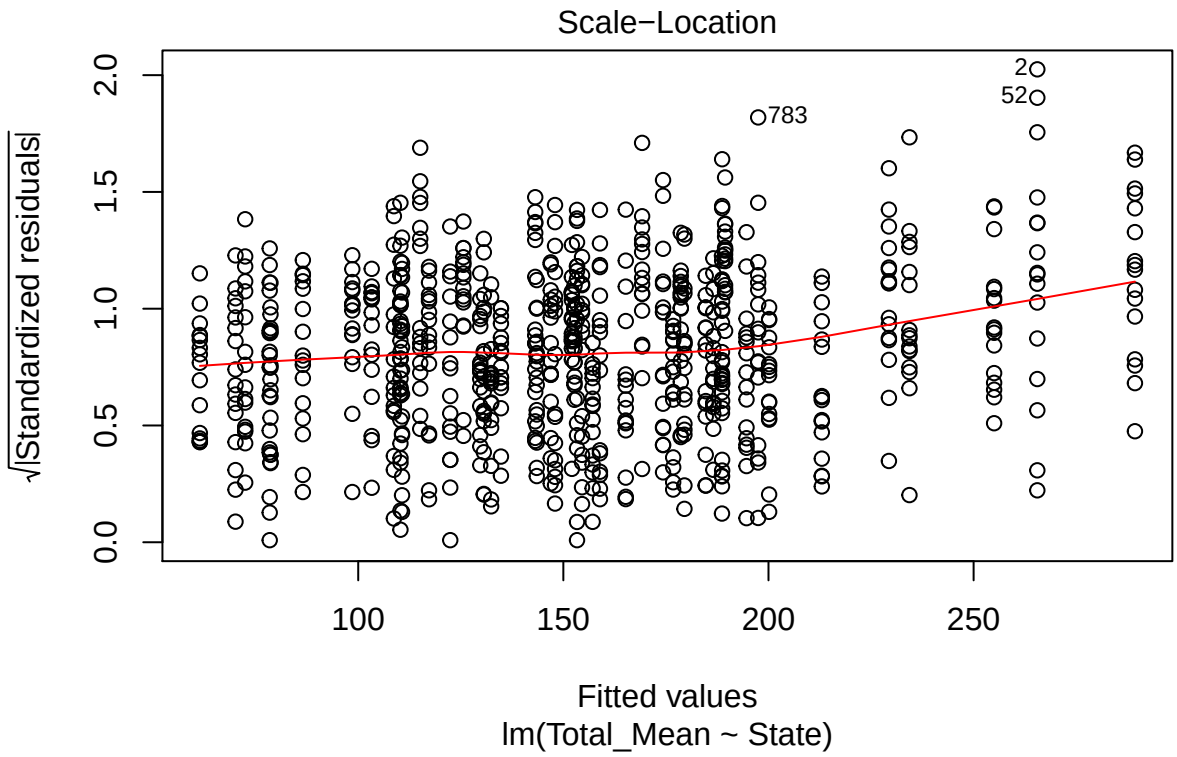

```
# Computing slope and intercept of regression model using formula of form y~x

highest_states <- lm(Total_Mean ~ State, highest_states)


# Regression table of states with highest rates of STDs 2000-2015

get_regression_table(highest_states)
```

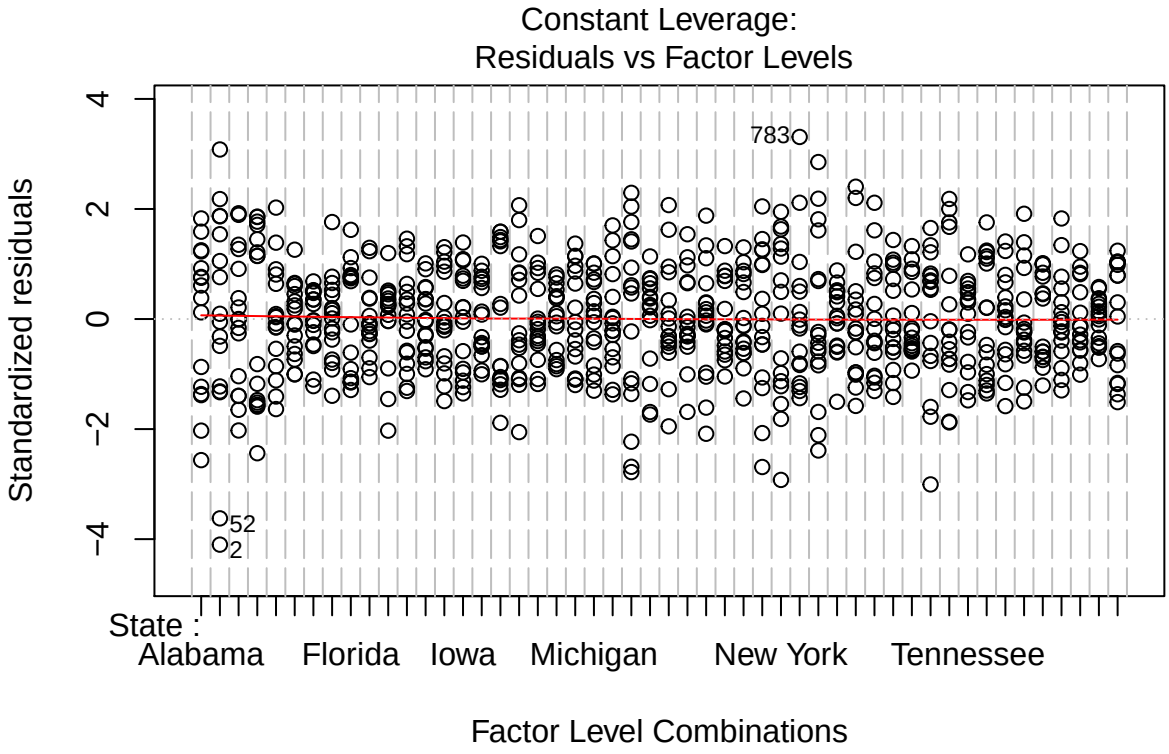
```
## # A tibble: 50 x 7
##    term             estimate std_error statistic p_value lower_ci upper_ci
##    <chr>               <dbl>     <dbl>     <dbl>   <dbl>    <dbl>    <dbl>
##  1 intercept           229.       6.92     33.1    0        216.    243.
##  2 StateAlaska          36.2      9.79      3.70   0         17.0    55.4
##  3 StateArizona        -76.0      9.79     -7.76   0        -95.2   -56.8
##  4 StateArkansas       -39.9      9.79     -4.08   0        -59.1   -20.7
##  5 StateCalifornia     -70.4      9.79     -7.19   0        -89.7   -51.2
##  6 StateColorado       -85.8      9.79     -8.77   0       -105.    -66.6
##  7 StateConnecticut    -97.0      9.79     -9.90   0       -116.    -77.7
##  8 StateDelaware       -34.7      9.79     -3.54   0        -53.9   -15.5
##  9 StateFlorida        -77.3      9.79     -7.89   0        -96.5   -58.1
## 10 StateGeorgia        -16.4      9.79     -1.67   0.095    -35.6     2.87
## # ... with 40 more rows
```

```
# Plot

plot(highest_states)
```


Residuals vs Fitted
Residuals
100
50
0
−50
−100
783
52
2
100
150
200
250
Fitted values
lm(Total_Mean ~ State)


Normal Q−Q
Standardized residuals
Theoretical Quantiles
lm(Total_Mean ~ State)
783
52
2
−4
−2
0
2
4
−3
−2
−1
0
1
2
3


Scale−Location
√|Standardized residuals|
0.0
0.5
1.0
1.5
2.0
100
150
200
250
783
52
2
Fitted values
lm(Total_Mean ~ State)




```
# Get all fitted/predicted values/residuals

get_regression_points(highest_states)
```

```
## # A tibble: 800 x 5
##       ID Total_Mean State       Total_Mean_hat residual
##    <int>      <dbl> <fct>                <dbl>    <dbl>
##  1     1        206  Alabama               229.  -23.4
##  2     2        156. Alaska                266. -110.
##  3     3        109. Arizona               153.  -44.2
##  4     4        124. Arkansas              189.  -65.4
##  5     5        115. California            159.  -43.9
##  6     6        116. Colorado              144.  -27.0
##  7     7        103. Connecticut           132.  -29.5
##  8     8        195. Delaware              195.    0.285
##  9     9        118. Florida               152.  -34.6
## 10    10        202. Georgia               213.  -10.5
## # ... with 790 more rows
```

```
# Prepare data to be plotted

model_highest_states <- get_regression_points(highest_states)

# Calculate sum of squared residuals

get_regression_points(highest_states) %>%
  mutate(sq_residuals = residual^2) %>%
```

```
  summarize(sum_sq_residuals = sum(sq_residuals))
```

```
## # A tibble: 1 x 1
##   sum_sq_residuals
##              <dbl>
## 1          575090.
```

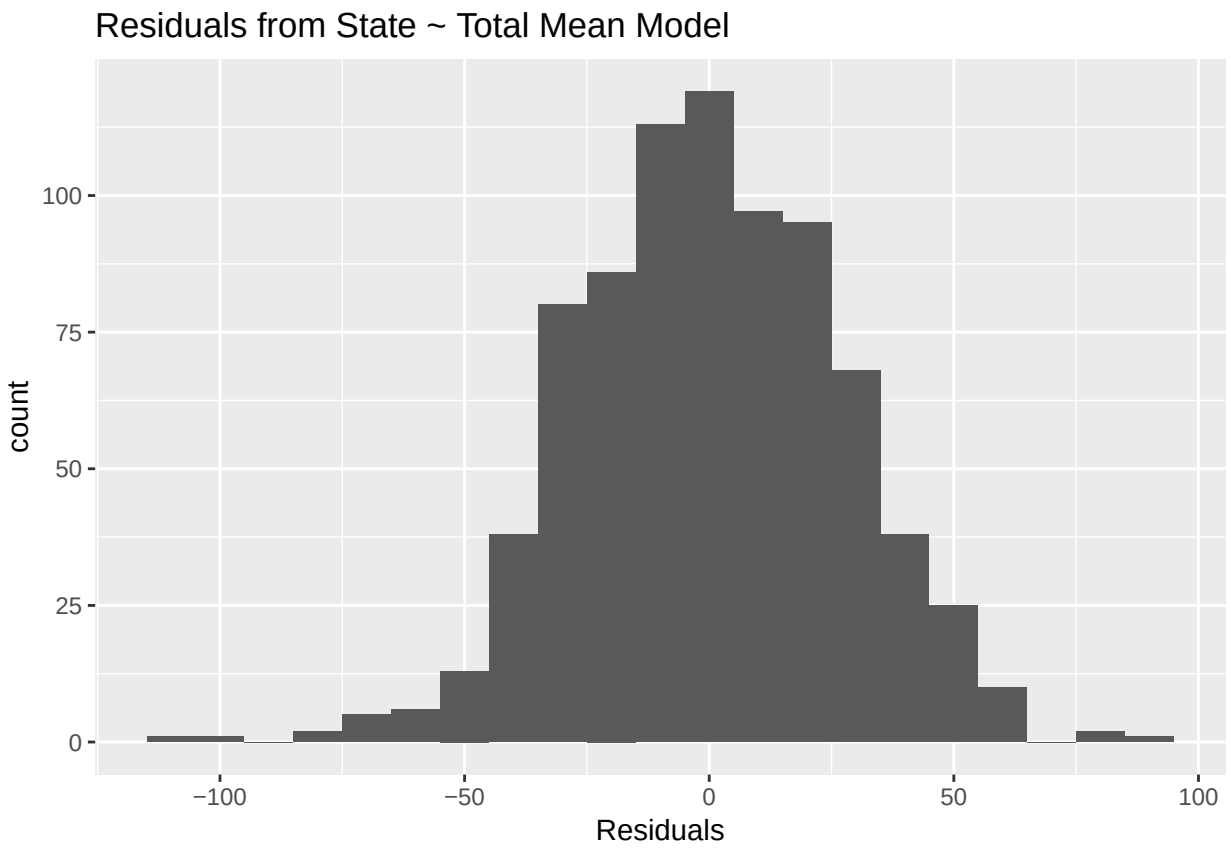
```
# Calculate mean squared error: use mean() instead of sum()

get_regression_points(highest_states) %>%
  mutate(sq_residuals = residual^2) %>%
  summarize(mse = mean (sq_residuals))
```

```
## # A tibble: 1 x 1
##     mse
##   <dbl>
## 1  719.
```

```
# Calculate root mean squared error

get_regression_points(highest_states) %>%
  mutate(sq_residuals = residual^2) %>%
  summarize(mse = mean (sq_residuals))  %>%
  mutate(rmse = sqrt(mse))
```

```
## # A tibble: 1 x 2
##     mse  rmse
##   <dbl> <dbl>
## 1  719.  26.8
```

```
# Plot residuals

ggplot(model_highest_states, aes(x = residual)) +
  geom_histogram(binwidth=10) +
  labs(x = "Residuals", title = "Residuals from State ~ Total Mean Model")
```



Cross validation of set prediction framework

```
set.seed(2)

# Randomly shuffle order of rows:
stds_shuffled <- model3_std_data %>%
  sample_frac(size = 1, replace = FALSE)
# Split into train and test:
train <- stds_shuffled %>%
  slice(1:400)
test <- stds_shuffled %>%
  slice(401:800)

# Training models on training data
train_stds_shuffled <- lm(Total_Mean ~ State + Chlamydia_Rate,
data = train)

get_regression_table(train_stds_shuffled)
```

```
## # A tibble: 51 x 7
##    term             estimate std_error statistic p_value lower_ci upper_ci
##    <chr>               <dbl>     <dbl>     <dbl>   <dbl>    <dbl>    <dbl>
##  1 intercept           70.0       3.42     20.5    0         63.3    76.7
##  2 StateAlaska        -24.3       3.88     -6.25   0        -31.9   -16.6
##  3 StateArizona       -42.1       4.03    -10.5    0        -50.0   -34.2
##  4 StateArkansas      -14.7       3.31     -4.45   0        -21.2    -8.22
##  5 StateCalifornia    -34.8       3.37    -10.3    0        -41.5   -28.2
```

```
##  6 StateColorado      -45.6       3.41    -13.4    0        -52.3   -38.9
##  7 StateConnecticut   -43.1       4.33     -9.94   0        -51.6   -34.6
##  8 StateDelaware      -18.6       3.42     -5.45   0        -25.4   -11.9
##  9 StateFlorida       -26.7       3.32     -8.04   0        -33.2   -20.1
## 10 StateGeorgia        -6.00      3.43     -1.75   0.081    -12.7     0.75
## # ... with 41 more rows
```

```
## Making predictions on test data

# Train model on train:

train_stds_shuffled <- lm(Total_Mean ~ State + Chlamydia_Rate,
data = train)

# Get predictions on test:

get_regression_points(train_stds_shuffled, newdata = test)
```

```
## # A tibble: 400 x 6
##       ID Total_Mean State      Chlamydia_Rate Total_Mean_hat residual
##    <int>      <dbl> <fct>               <dbl>          <dbl>    <dbl>
##  1     1      112.  Washington          288.           117.     -5.16
##  2     2      146.  Nevada              298.           131.     14.8
##  3     3       53.0 Idaho               153.            54.4    -1.38
##  4     4      180.  New Mexico          467.           182.     -1.78
##  5     5      194.  Missouri            454.           200.     -5.98
##  6     6      199.  New Mexico          503.           194.      4.95
##  7     7      143.  Washington          362.           142.      1.52
##  8     8      152.  Montana             413            145.      7.60
##  9     9      205.  Arizona             489.           189.     15.8
## 10    10      121.  Kansas              283.           126.     -4.60
## # ... with 390 more rows
```

```
## Assessing predictions with RMSE
# Train model:
train_stds_shuffled <- lm(Total_Mean ~ State + Chlamydia_Rate, data = train)

# Get predictions and compute RMSE:
get_regression_points(train_stds_shuffled, newdata = test) %>%
  mutate(sq_residuals = residual^2) %>%
  summarize(rmse = sqrt(mean(sq_residuals)))
```

```
## # A tibble: 1 x 1
##    rmse
##   <dbl>
## 1  7.55
```

```
# Comparing RMSE
# Train model:
train_stds_shuffled_2 <- lm(Total_Mean ~ State + Gonorrhea_Rate, data = train)

# Get predictions and compute RMSE:
get_regression_points(train_stds_shuffled_2, newdata = test) %>%
  mutate(sq_residuals = residual^2) %>%
  summarize(rmse = sqrt(mean(sq_residuals)))
```

```
## # A tibble: 1 x 1
##    rmse
##   <dbl>
## 1  29.0
```

```
# Additional models
# k-NN

set.seed(2)

mod <- train(Total_Mean ~ ., data =stds_shuffled, method = "knn",tuneLength = 12)

# Observing the structure of the model

str(mod)
```

```
## List of 24
##  $ method      : chr "knn"
##  $ modelInfo   :List of 13
##   ..$ label     : chr "k-Nearest Neighbors"
##   ..$ library   : NULL
##   ..$ loop      : NULL
##   ..$ type      : chr [1:2] "Classification" "Regression"
##   ..$ parameters:'data.frame':   1 obs. of  3 variables:
##   .. ..$ parameter: Factor w/ 1 level "k": 1
##   .. ..$ class    : Factor w/ 1 level "numeric": 1
##   .. ..$ label    : Factor w/ 1 level "#Neighbors": 1
##   ..$ grid      :function (x, y, len = NULL, search = "grid")
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 8 26 16 19 26 19 8 16
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ fit       :function (x, y, wts, param, lev, last, classProbs, ...)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 17 25 24 19 25 19 17 24
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ predict   :function (modelFit, newdata, submodels = NULL)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 25 29 33 19 29 19 25 33
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ predictors:function (x, ...)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 34 32 34 67 32 67 34 34
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ tags      : chr "Prototype Models"
##   ..$ prob      :function (modelFit, newdata, submodels = NULL)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 36 26 37 61 26 61 36 37
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ levels    :function (x)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 38 28 38 56 28 56 38 38
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##   ..$ sort      :function (x)
##   .. ..- attr(*, "srcref")= 'srcref' int [1:8] 39 26 39 54 26 54 39 39
##   .. .. ..- attr(*, "srcfile")=Classes 'srcfilecopy', 'srcfile' <environment: 0x00000000088b44a8>
##  $ modelType   : chr "Regression"
##  $ results     :'data.frame':    12 obs. of  7 variables:
##   ..$ k         : int [1:12] 5 7 9 11 13 15 17 19 21 23 ...
##   ..$ RMSE      : num [1:12] 3.43 3.48 3.56 3.7 3.87 ...
##   ..$ Rsquared  : num [1:12] 0.997 0.997 0.997 0.996 0.996 ...
##   ..$ MAE       : num [1:12] 2.21 2.21 2.23 2.27 2.32 ...
```

```
##   ..$ RMSESD    : num [1:12] 0.451 0.514 0.607 0.636 0.715 ...
##   ..$ RsquaredSD: num [1:12] 0.000693 0.000781 0.000964 0.001005 0.001203 ...
##   ..$ MAESD     : num [1:12] 0.185 0.198 0.225 0.227 0.249 ...
##  $ pred        : NULL
##  $ bestTune    :'data.frame':    1 obs. of  1 variable:
##   ..$ k: int 5
##  $ call        : language train.formula(form = Total_Mean ~ ., data = stds_shuffled, method = "knn",
##  $ dots        : list()
##  $ metric      : chr "RMSE"
##  $ control     :List of 28
##   ..$ method           : chr "boot"
##   ..$ number           : num 25
##   ..$ repeats          : logi NA
##   ..$ search           : chr "grid"
##   ..$ p                : num 0.75
##   ..$ initialWindow    : NULL
##   ..$ horizon          : num 1
##   ..$ fixedWindow      : logi TRUE
##   ..$ skip             : num 0
##   ..$ verboseIter      : logi FALSE
##   ..$ returnData       : logi TRUE
##   ..$ returnResamp     : chr "final"
##   ..$ savePredictions  : chr "none"
##   ..$ classProbs       : logi FALSE
##   ..$ summaryFunction  :function (data, lev = NULL, model = NULL)
##   ..$ selectionFunction: chr "best"
##   ..$ preProcOptions   :List of 6
##   .. ..$ thresh   : num 0.95
##   .. ..$ ICAcomp  : num 3
##   .. ..$ k        : num 5
##   .. ..$ freqCut  : num 19
##   .. ..$ uniqueCut: num 10
##   .. ..$ cutoff   : num 0.9
##   ..$ sampling         : NULL
##   ..$ index            :List of 25
##   .. ..$ Resample01: int [1:800] 1 6 6 7 8 9 11 11 11 11 ...
##   .. ..$ Resample02: int [1:800] 2 3 4 4 6 6 6 7 8 10 ...
##   .. ..$ Resample03: int [1:800] 1 2 4 6 7 7 7 8 9 12 ...
##   .. ..$ Resample04: int [1:800] 1 1 1 5 6 6 8 9 10 10 ...
##   .. ..$ Resample05: int [1:800] 1 2 2 3 4 5 5 6 7 7 ...
##   .. ..$ Resample06: int [1:800] 1 1 3 3 4 7 7 11 11 11 ...
##   .. ..$ Resample07: int [1:800] 3 4 4 6 6 6 7 7 8 9 ...
##   .. ..$ Resample08: int [1:800] 3 5 7 8 11 13 14 17 19 19 ...
##   .. ..$ Resample09: int [1:800] 1 1 1 1 7 7 8 8 12 13 ...
##   .. ..$ Resample10: int [1:800] 4 4 4 5 6 8 8 9 9 10 ...
##   .. ..$ Resample11: int [1:800] 1 4 5 5 5 6 7 8 9 10 ...
##   .. ..$ Resample12: int [1:800] 2 3 4 4 4 4 4 5 5 7 ...
##   .. ..$ Resample13: int [1:800] 1 3 3 4 4 4 5 6 7 9 ...
##   .. ..$ Resample14: int [1:800] 2 3 3 3 5 5 7 8 8 9 ...
##   .. ..$ Resample15: int [1:800] 2 4 5 5 7 8 9 9 10 11 ...
##   .. ..$ Resample16: int [1:800] 2 2 3 3 3 4 4 5 6 7 ...
##   .. ..$ Resample17: int [1:800] 2 2 3 4 4 7 8 10 10 10 ...
##   .. ..$ Resample18: int [1:800] 1 1 2 3 3 6 8 9 9 9 ...
##   .. ..$ Resample19: int [1:800] 1 2 3 4 4 5 6 7 8 8 ...
```

```
##   .. ..$ Resample20: int [1:800] 1 1 2 3 3 3 5 5 7 7 ...
##   .. ..$ Resample21: int [1:800] 2 3 3 6 6 9 9 9 12 13 ...
##   .. ..$ Resample22: int [1:800] 1 3 3 5 5 6 6 7 8 9 ...
##   .. ..$ Resample23: int [1:800] 2 3 3 3 4 4 4 5 5 5 ...
##   .. ..$ Resample24: int [1:800] 1 1 1 2 4 4 4 6 8 8 ...
##   .. ..$ Resample25: int [1:800] 1 3 6 6 7 7 7 10 11 11 ...
##   ..$ indexOut         :List of 25
##   .. ..$ Resample01: int [1:296] 2 3 4 5 10 14 16 20 22 27 ...
##   .. ..$ Resample02: int [1:288] 1 5 9 11 15 21 22 24 25 26 ...
##   .. ..$ Resample03: int [1:292] 3 5 10 11 13 14 15 17 23 24 ...
##   .. ..$ Resample04: int [1:306] 2 3 4 7 12 20 21 22 28 36 ...
##   .. ..$ Resample05: int [1:280] 8 10 11 12 13 14 22 25 26 27 ...
##   .. ..$ Resample06: int [1:288] 2 5 6 8 9 10 12 13 16 17 ...
##   .. ..$ Resample07: int [1:305] 1 2 5 10 18 21 25 27 33 38 ...
##   .. ..$ Resample08: int [1:283] 1 2 4 6 9 10 12 15 16 18 ...
##   .. ..$ Resample09: int [1:309] 2 3 4 5 6 9 10 11 14 17 ...
##   .. ..$ Resample10: int [1:291] 1 2 3 7 13 14 15 20 21 23 ...
##   .. ..$ Resample11: int [1:287] 2 3 12 19 20 22 23 25 26 27 ...
##   .. ..$ Resample12: int [1:295] 1 6 14 19 20 21 23 28 30 32 ...
##   .. ..$ Resample13: int [1:299] 2 8 12 15 18 23 29 32 35 37 ...
##   .. ..$ Resample14: int [1:290] 1 4 6 10 12 16 20 25 28 30 ...
##   .. ..$ Resample15: int [1:287] 1 3 6 15 16 23 24 27 30 31 ...
##   .. ..$ Resample16: int [1:293] 1 10 12 14 15 16 17 19 23 26 ...
##   .. ..$ Resample17: int [1:295] 1 5 6 9 13 15 17 20 22 23 ...
##   .. ..$ Resample18: int [1:294] 4 5 7 10 12 13 16 20 22 23 ...
##   .. ..$ Resample19: int [1:298] 10 11 12 14 15 18 21 23 25 29 ...
##   .. ..$ Resample20: int [1:296] 4 6 8 9 10 13 14 21 23 26 ...
##   .. ..$ Resample21: int [1:283] 1 4 5 7 8 10 11 14 17 19 ...
##   .. ..$ Resample22: int [1:292] 2 4 10 16 20 25 30 33 39 42 ...
##   .. ..$ Resample23: int [1:301] 1 6 9 10 12 13 16 21 23 24 ...
##   .. ..$ Resample24: int [1:303] 3 5 7 9 10 12 14 15 20 21 ...
##   .. ..$ Resample25: int [1:309] 2 4 5 8 9 13 20 21 23 26 ...
##   ..$ indexFinal       : NULL
##   ..$ timingSamps      : num 0
##   ..$ predictionBounds : logi [1:2] FALSE FALSE
##   ..$ seeds            :List of 26
##   .. ..$ : int [1:12] 702375 573326 168052 943837 943472 129159 833444 468016 549980 552670 ...
##   .. ..$ : int [1:12] 180818 405277 853537 976384 225822 444802 74979 661887 387542 836872 ...
##   .. ..$ : int [1:12] 488762 149244 357054 962619 132369 10415 164638 810168 868834 514265 ...
##   .. ..$ : int [1:12] 284861 667201 150465 981690 296999 115080 163195 944002 794829 974645 ...
##   .. ..$ : int [1:12] 810359 7109 14694 683369 929672 275387 811816 785836 988847 613918 ...
##   .. ..$ : int [1:12] 886931 625084 260284 859019 437461 388120 461471 218661 65932 275683 ...
##   .. ..$ : int [1:12] 184661 183360 755407 288039 867779 402612 572641 350615 671946 25049 ...
##   .. ..$ : int [1:12] 856454 971433 323695 733128 340039 976669 396981 379965 560337 463766 ...
##   .. ..$ : int [1:12] 93017 115298 439989 200915 427597 980501 828838 286945 595855 898878 ...
##   .. ..$ : int [1:12] 128664 24654 736231 373318 574313 825235 813603 872596 110543 952589 ...
##   .. ..$ : int [1:12] 245262 978767 885630 240954 757118 562767 305065 693566 335903 206083 ...
##   .. ..$ : int [1:12] 963633 315824 665520 533472 817686 185239 399463 178429 285395 629382 ...
##   .. ..$ : int [1:12] 730096 668067 311612 478508 291368 182148 360709 903664 393988 779762 ...
##   .. ..$ : int [1:12] 172216 79252 292019 840238 945117 44958 758261 296840 650948 84976 ...
##   .. ..$ : int [1:12] 538779 965619 101057 256708 894994 387878 794148 349336 138720 650394 ...
##   .. ..$ : int [1:12] 571643 953461 780111 118263 836958 87144 748461 65170 77681 105064 ...
##   .. ..$ : int [1:12] 164802 502954 201516 199683 178101 273813 130595 858521 645032 602678 ...
##   .. ..$ : int [1:12] 818948 226693 206466 194249 240519 979518 524141 826197 670744 977507 ...
```

```
##   .. ..$ : int [1:12] 12605 362778 209649 152088 935607 401005 485729 681335 853845 912712 ...
##   .. ..$ : int [1:12] 829565 675644 339624 890625 528707 874134 258597 542319 215951 216670 ...
##   .. ..$ : int [1:12] 301645 555086 755034 956194 954079 333284 516558 148153 356732 704391 ...
##   .. ..$ : int [1:12] 51423 738339 13756 42345 281748 40707 632118 754646 50934 629500 ...
##   .. ..$ : int [1:12] 671487 21882 689356 887118 537066 884789 913928 848750 293430 783973 ...
##   .. ..$ : int [1:12] 243134 72980 231593 279834 970689 658811 669924 209780 990342 533936 ...
##   .. ..$ : int [1:12] 356987 256588 316355 744227 499521 708602 414775 209850 80839 159243 ...
##   .. ..$ : int 487304
##   ..$ adaptive         :List of 4
##   .. ..$ min     : num 5
##   .. ..$ alpha   : num 0.05
##   .. ..$ method  : chr "gls"
##   .. ..$ complete: logi TRUE
##   ..$ trim             : logi FALSE
##   ..$ allowParallel    : logi TRUE
##   ..$ yLimits          : num [1:2] 16.4 366.7
##  $ finalModel  :List of 8
##   ..$ learn      :List of 2
##   .. ..$ y: Named num [1:800] 63.6 103.6 215.3 69.8 306.8 ...
##   .. .. ..- attr(*, "names")= chr [1:800] "148" "562" "458" "134" ...
##   .. ..$ X: num [1:800, 1:53] 2002 2011 2009 2002 2015 ...
##   .. .. ..- attr(*, "dimnames")=List of 2
##   .. .. .. ..$ : chr [1:800] "X148" "X562" "X458" "X134" ...
##   .. .. .. ..$ : chr [1:53] "Year" "StateAlaska" "StateArizona" "StateArkansas" ...
##   ..$ k          : int 5
##   ..$ theDots    : list()
##   ..$ xNames     : chr [1:53] "Year" "StateAlaska" "StateArizona" "StateArkansas" ...
##   ..$ problemType: chr "Regression"
##   ..$ tuneValue  :'data.frame':  1 obs. of  1 variable:
##   .. ..$ k: int 5
##   ..$ obsLevels  : logi NA
##   ..$ param      : list()
##   ..- attr(*, "class")= chr "knnreg"
##  $ preProcess  : NULL
##  $ trainingData:'data.frame':    800 obs. of  6 variables:
##   ..$ .outcome                       : num [1:800] 63.6 103.6 215.3 69.8 306.8 ...
##   ..$ Year                           : int [1:800] 2002 2011 2009 2002 2015 2015 2002 2013 2007 2008
##   ..$ State                          : Factor w/ 50 levels "Alabama","Alaska",..: 48 12 8 34 2 1 3 1
##   ..$ Chlamydia_Rate                 : num [1:800] 137 300 533 198 768 ...
##   ..$ Gonorrhea_Rate                 : num [1:800] 54.1 10.3 109.7 11.4 151.1 ...
##   ..$ Primary_Secondary_Syphilis_Rate: num [1:800] 0.1 0.8 3.1 0 1.1 5.8 3.7 3.3 2.4 2.4 ...
##  $ resample    :'data.frame':    25 obs. of  4 variables:
##   ..$ RMSE    : num [1:25] 2.95 3.99 3.2 4.11 3.48 ...
##   ..$ Rsquared: num [1:25] 0.997 0.996 0.997 0.995 0.996 ...
##   ..$ MAE     : num [1:25] 2.1 2.24 2.08 2.35 2.38 ...
##   ..$ Resample: chr [1:25] "Resample03" "Resample14" "Resample13" "Resample04" ...
##  $ resampledCM : NULL
##  $ perfNames   : chr [1:3] "RMSE" "Rsquared" "MAE"
##  $ maximize    : logi FALSE
##  $ yLimits     : num [1:2] 16.4 366.7
##  $ times       :List of 3
##   ..$ everything: 'proc_time' Named num [1:5] 7.34 0.14 7.48 NA NA
##   .. ..- attr(*, "names")= chr [1:5] "user.self" "sys.self" "elapsed" "user.child" ...
##   ..$ final     : 'proc_time' Named num [1:5] 0 0 0 NA NA
```

```
##   .. ..- attr(*, "names")= chr [1:5] "user.self" "sys.self" "elapsed" "user.child" ...
##   ..$ prediction: logi [1:3] NA NA NA
##  $ levels      : logi NA
##  $ terms       :Classes 'terms', 'formula'  language Total_Mean ~ Year + State + Chlamydia_Rate + Gon
##   .. ..- attr(*, "variables")= language list(Total_Mean, Year, State, Chlamydia_Rate, Gonorrhea_Rate
##   .. ..- attr(*, "factors")= int [1:6, 1:5] 0 1 0 0 0 0 0 0 1 0 ...
##   .. .. ..- attr(*, "dimnames")=List of 2
##   .. .. .. ..$ : chr [1:6] "Total_Mean" "Year" "State" "Chlamydia_Rate" ...
##   .. .. .. ..$ : chr [1:5] "Year" "State" "Chlamydia_Rate" "Gonorrhea_Rate" ...
##   .. ..- attr(*, "term.labels")= chr [1:5] "Year" "State" "Chlamydia_Rate" "Gonorrhea_Rate" ...
##   .. ..- attr(*, "order")= int [1:5] 1 1 1 1 1
##   .. ..- attr(*, "intercept")= int 1
##   .. ..- attr(*, "response")= int 1
##   .. ..- attr(*, ".Environment")=<environment: R_GlobalEnv>
##   .. ..- attr(*, "predvars")= language list(Total_Mean, Year, State, Chlamydia_Rate, Gonorrhea_Rate,
##   .. ..- attr(*, "dataClasses")= Named chr [1:6] "numeric" "numeric" "factor" "numeric" ...
##   .. .. ..- attr(*, "names")= chr [1:6] "Total_Mean" "Year" "State" "Chlamydia_Rate" ...
##  $ coefnames   : chr [1:53] "Year" "StateAlaska" "StateArizona" "StateArkansas" ...
##  $ contrasts   :List of 1
##   ..$ State: chr "contr.treatment"
##  $ xlevels     :List of 1
##   ..$ State: chr [1:50] "Alabama" "Alaska" "Arizona" "Arkansas" ...
##  - attr(*, "class")= chr [1:2] "train" "train.formula"
```

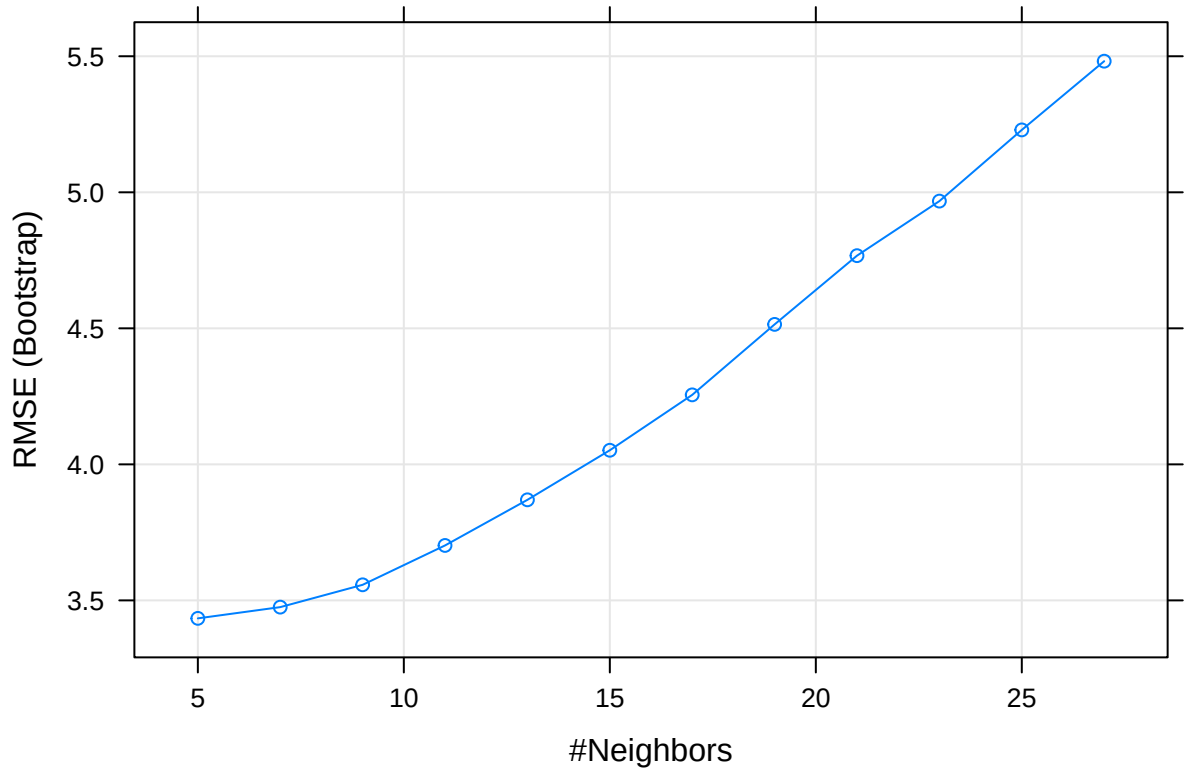
```
head(mod)
```

```
## $method
## [1] "knn"
##
## $modelInfo
## $modelInfo$label
## [1] "k-Nearest Neighbors"
##
## $modelInfo$library
## NULL
##
## $modelInfo$loop
## NULL
##
## $modelInfo$type
## [1] "Classification" "Regression"
##
## $modelInfo$parameters
##   parameter   class      label
## 1         k numeric #Neighbors
##
## $modelInfo$grid
## function (x, y, len = NULL, search = "grid")
## {
##     if (search == "grid") {
##         out <- data.frame(k = (5:((2 * len) + 4))[(5:((2 * len) +
##             4))%%2 > 0])
##     }
##     else {
##         by_val <- if (is.factor(y))
```

```
##             length(levels(y))
##         else 1
##         out <- data.frame(k = sample(seq(1, floor(nrow(x)/3),
##             by = by_val), size = len, replace = TRUE))
##     }
##     out
## }
##
## $modelInfo$fit
## function (x, y, wts, param, lev, last, classProbs, ...)
## {
##     if (is.factor(y)) {
##         knn3(as.matrix(x), y, k = param$k, ...)
##     }
##     else {
##         knnreg(as.matrix(x), y, k = param$k, ...)
##     }
## }
## <bytecode: 0x000000000d2d1668>
##
## $modelInfo$predict
## function (modelFit, newdata, submodels = NULL)
## {
##     if (modelFit$problemType == "Classification") {
##         out <- predict(modelFit, newdata, type = "class")
##     }
##     else {
##         out <- predict(modelFit, newdata)
##     }
##     out
## }
## <bytecode: 0x000000000d029428>
##
## $modelInfo$predictors
## function (x, ...)
## colnames(x$learn$X)
##
## $modelInfo$tags
## [1] "Prototype Models"
##
## $modelInfo$prob
## function (modelFit, newdata, submodels = NULL)
## predict(modelFit, newdata, type = "prob")
##
## $modelInfo$levels
## function (x)
## levels(x$learn$y)
##
## $modelInfo$sort
## function (x)
## x[order(-x[, 1]), ]
##
##
## $modelType
```

```
## [1] "Regression"
##
## $results
##     k     RMSE  Rsquared      MAE    RMSESD   RsquaredSD     MAESD
## 1   5 3.433977 0.9966231 2.208244 0.4508894 0.0006925192 0.1848140
## 2   7 3.475209 0.9965810 2.208240 0.5135383 0.0007811869 0.1983893
## 3   9 3.557308 0.9965076 2.231170 0.6067285 0.0009644110 0.2252785
## 4  11 3.701988 0.9963253 2.271066 0.6360126 0.0010050970 0.2273057
## 5  13 3.869659 0.9960695 2.324403 0.7145156 0.0012025372 0.2489469
## 6  15 4.051853 0.9957996 2.384881 0.7545490 0.0013415214 0.2603417
## 7  17 4.255444 0.9954712 2.458884 0.7826171 0.0014085282 0.2570646
## 8  19 4.514547 0.9949843 2.552225 0.8467470 0.0015752135 0.2910720
## 9  21 4.767083 0.9945090 2.647824 0.9174902 0.0017437909 0.3003202
## 10 23 4.967647 0.9941682 2.732480 0.9552496 0.0018526805 0.3026309
## 11 25 5.229283 0.9936533 2.832467 1.0050042 0.0019883946 0.3214087
## 12 27 5.481879 0.9931492 2.925253 1.0670859 0.0021698759 0.3378823
##
## $pred
## NULL
##
## $bestTune
##   k
## 1 5
```

```r
# Visulaizing the k-NN model

plot(mod)
```



Results

Intial analysis of the data showed an increase in all sexually transmitted diseases studied between 2000-2015. Of the models utilized in this project, the k-NN model yielded a RMSE value of 3.43 versus 7.55 for standard regression with rate of chlamydia as a predictor.

Conclusion

Initial data analysis clearly indicated that rates of chlamydia, gonorrhea and syphilis, increased considerably from 2000-2015.

By calculating the total average of the rates of chlamydia, gonorrhea and syphilis, from 2000-2015 and observing the outcome, this project was able to identify that Alaska, Mississippi, Louisiana, North Carolina, and South Carolina had the highest average rates, from the highest rate of 350.80 cases/100,000 in 2009 for Mississippi to 248.03/100,000 cases/100,000 in 2008 for Louisiana. Visitors to these states are advised to be cautious!

These 6 states captured the 50 highest rates of chlamydia, gonorrhea and syphilis, from 2000-2015.

Regression modeling and calculating the RMSE (root means squared) outcomes, indicated that chlamydia rates were better at predicting total mean rates versus gonorrhea rates.

k-NN modeling provided lower RMSE values than standard regression.