# Mass Shootings in the US

# Mass Shootings Analysis

**Mass Shooting:**

4+ victims injured or killed excluding the subject/suspect/perpetrator, one location. (Gun Violence Archive)

**Key Questions:**
- Have mass shooting rates increased over the years?
- Where are mass shootings happening most often and where are they the deadliest?
- Does gun legislation have any relationship to number of mass shootings?
- Does hate group activity have any relationship with number of mass shootings?

**Data Sources:**

Mass Shooting Statistics: https://www.gunviolencearchive.org/reports

US Census API: https://github.com/datamade/census

Hate Group Data: https://www.splcenter.org/hate-map

Gun Law Data: https://lawcenter.giffords.org/scorecard/

**Data Collection Period:**

2014 - 2017

# Definitions

**Mass Shooting Definition:**
4+ victims injured or killed excluding the subject/suspect/perpetrator, one location. *(Gun Violence Archive)*

**Hate Group Definition:**
An organization that – based on its official statements or principles, the statements of its leaders, or its activities – has beliefs or practices that attack or malign an entire class of people, typically for their immutable characteristics. *(Southern Poverty Law Center)*

**Region Definitions:**
Urban - Region with a density greater than 3000 ppl / sq mi
Suburban - Region with a density greater than 1000 ppl / sq mi but less than 3000 ppl / sq mi
Rural - Region with a density less than 1000 ppl / sq mi

**State Gun Laws:**
Attorneys track and analyze gun legislation in all 50 states, evaluating bills for their relative strength or weakness. Taking note of newly enacted laws, they use an exhaustive quantitative rubric to score each state on its gun law strength, adding points for safety regulations like universal background checks and extreme risk protection orders and subtracting points for reckless policies like "Stand Your Ground" and permitless carry laws. *(Giffords Law Center)*
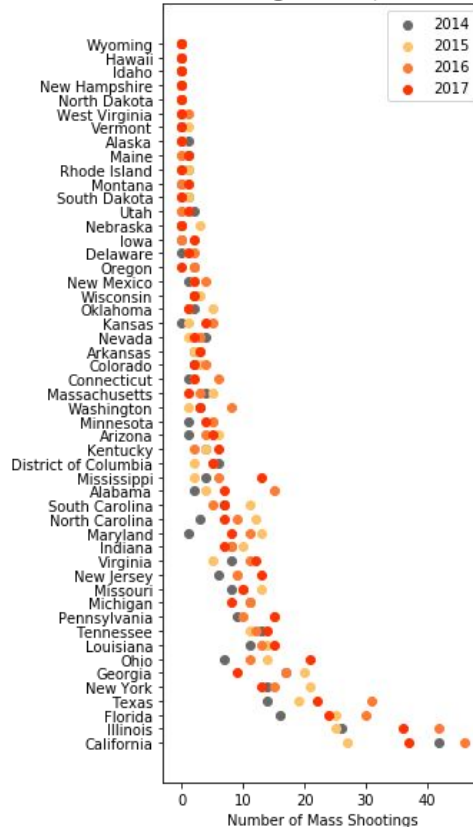
# General Overview
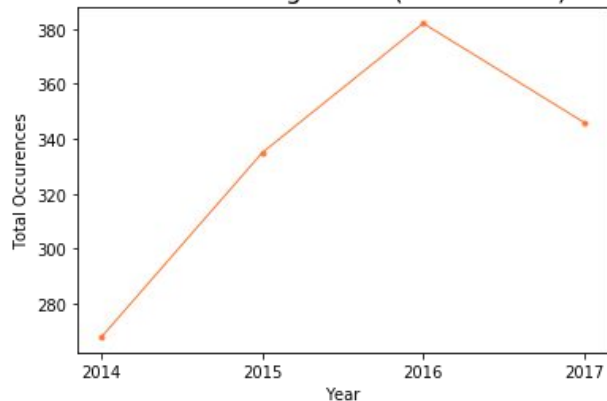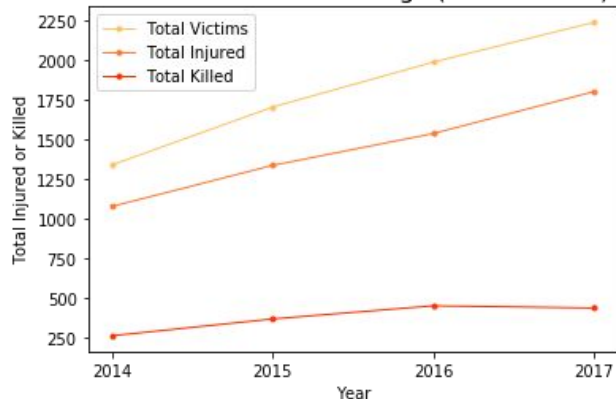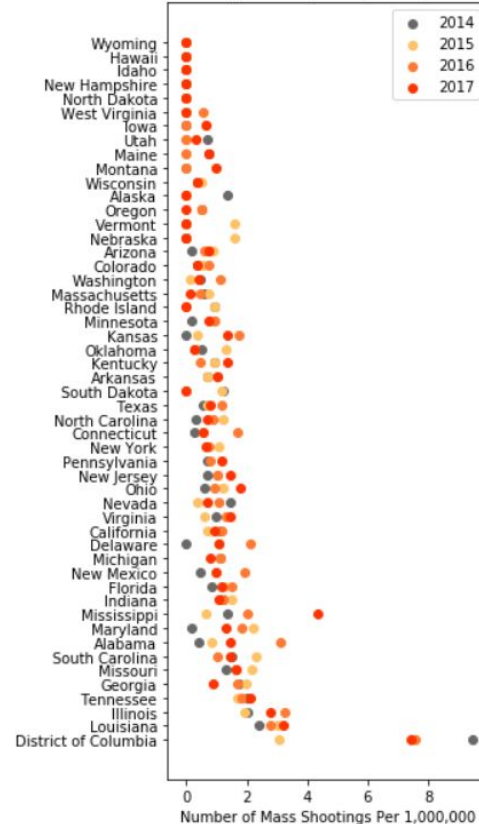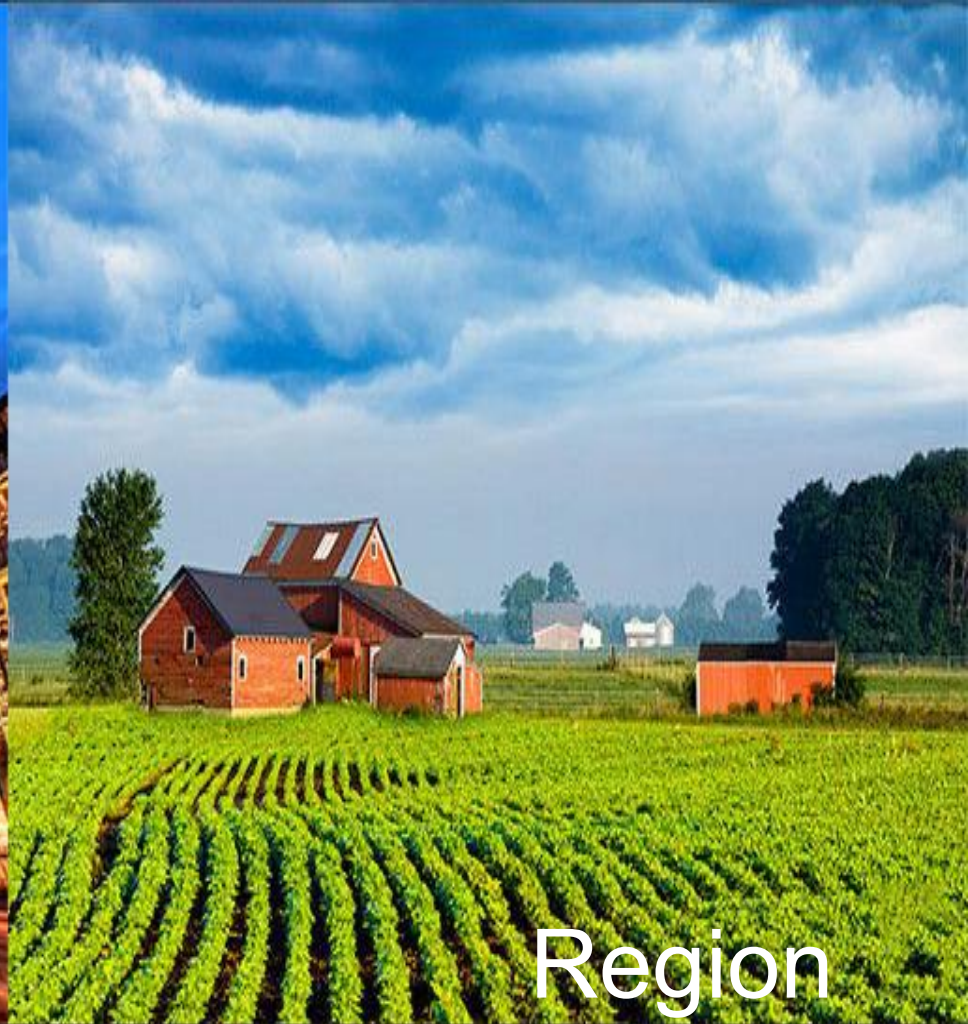
Region

# Region



Incidents
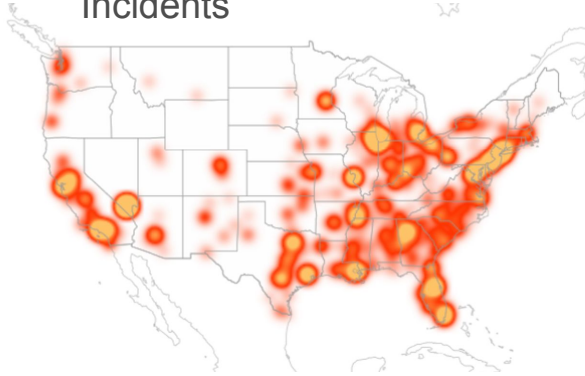
Victims Per Capita
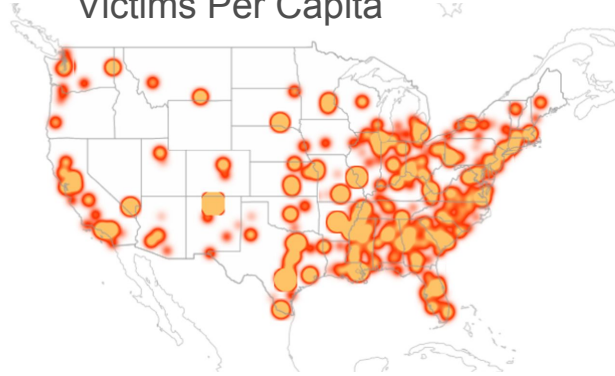
Fatalities Per Capita
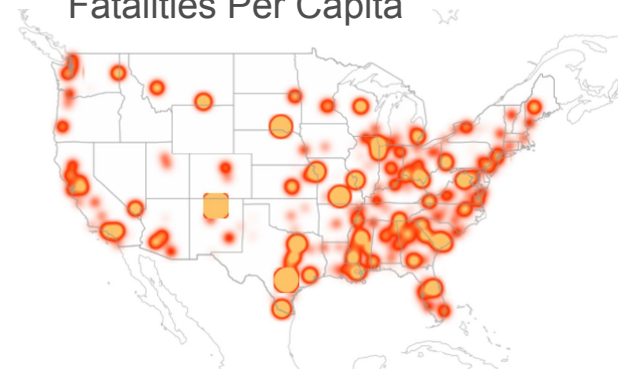
% Total Incidents by Density Type

Urban 59.7%
Rural 23.8%
Suburban 16.4%
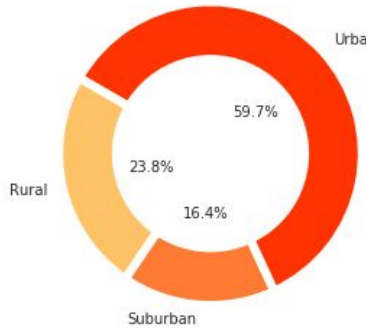
% Total Victims by Density Type

Urban 61.7%
Rural 23.2%
Suburban 15.0%
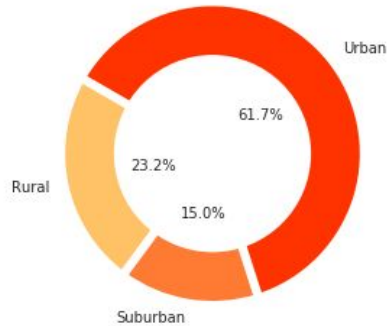
% Total Fatalities by Density Type

Urban 49.8%
al 33.2%
Suburban 16.9%
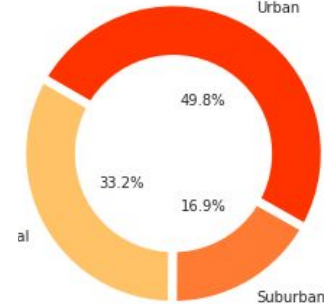
0.21 Urban
0.42 Suburban
4.02 Rural

Fatalities Per Capita

17.2% Urban
23.95% Suburban
30.47% Rural

Fatality Rate

# Region
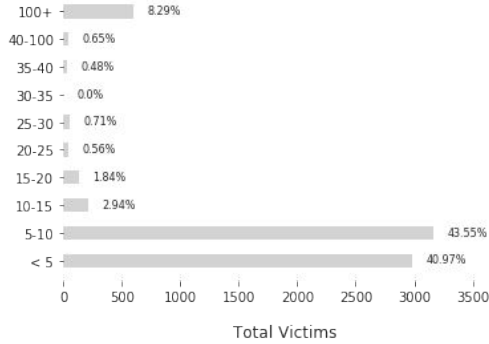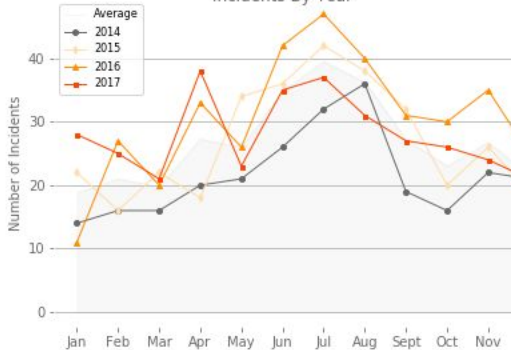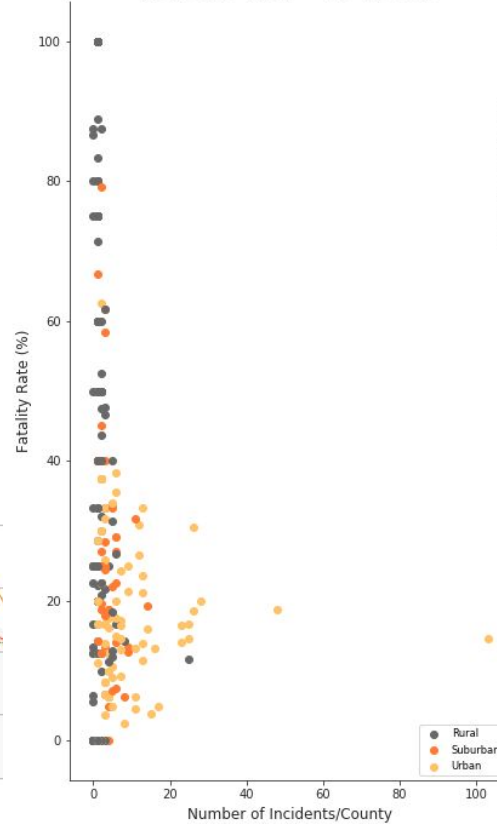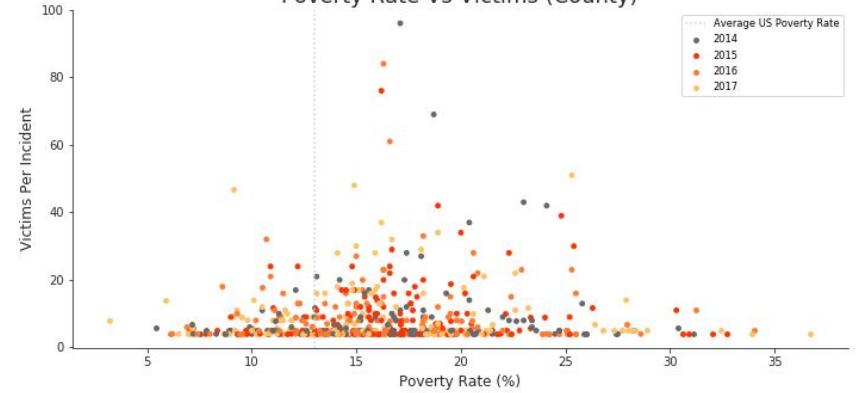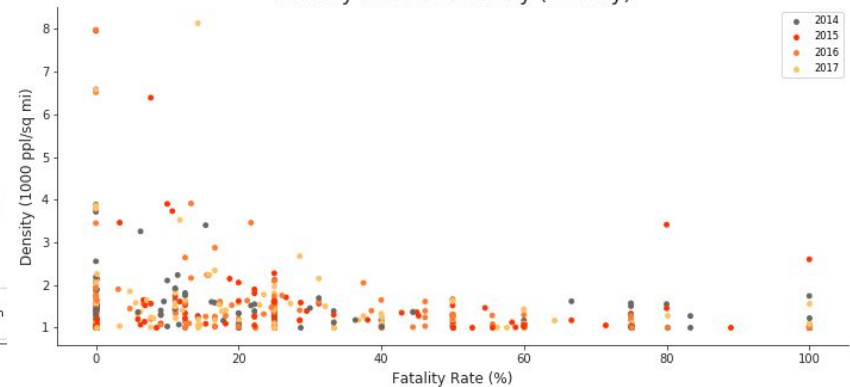
Hate Groups

# Hate Groups

There is a consistent positive, linear correlation between number of hate groups in a state and the number of mass shooting occurrences



Hate Group Count 2014-2017



Hate Group Count vs. Number of Mass Shootings (2014)



Hate Group Count vs. Number of Mass Shootings (2015)



Hate Group Count vs. Number of Mass Shootings (2016)



Hate Group Count vs. Number of Mass Shootings (2017)
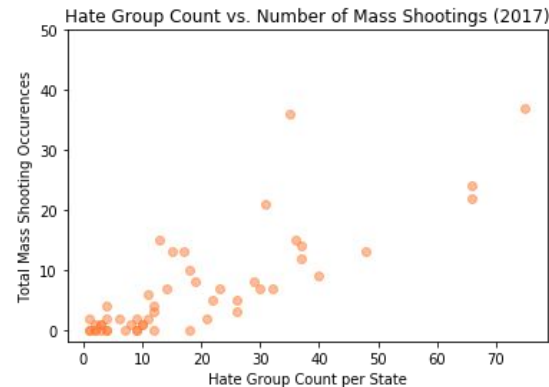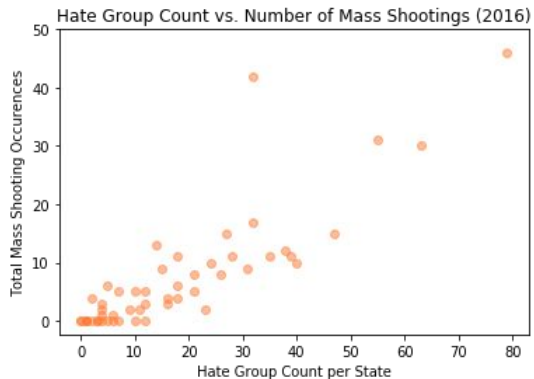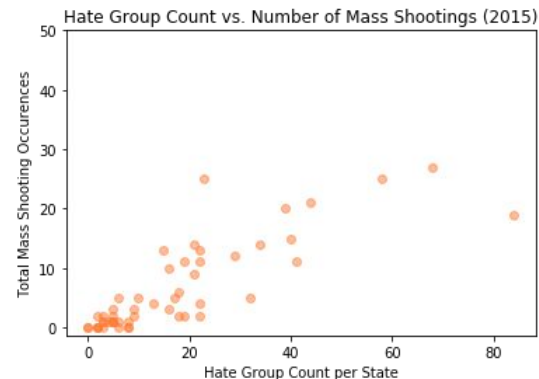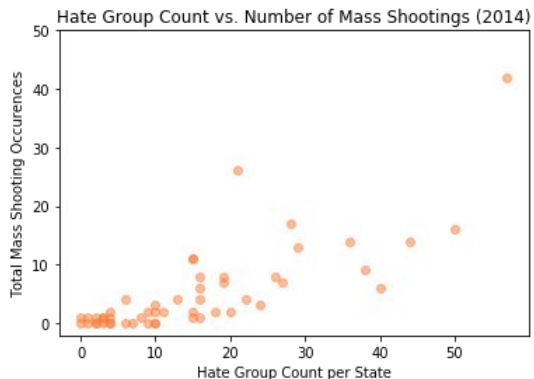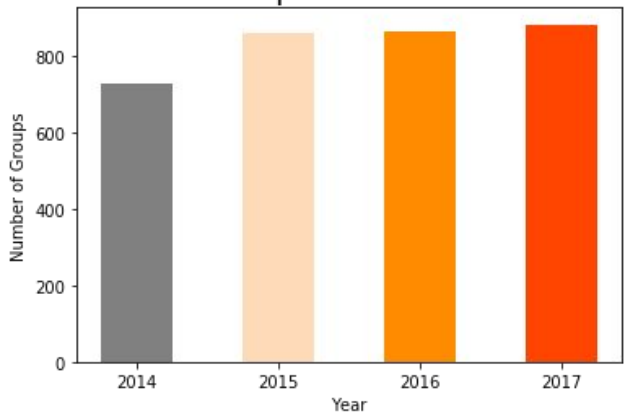
Gun Laws

# Gun Laws



2014-2017 data vs. Gun Law Grade
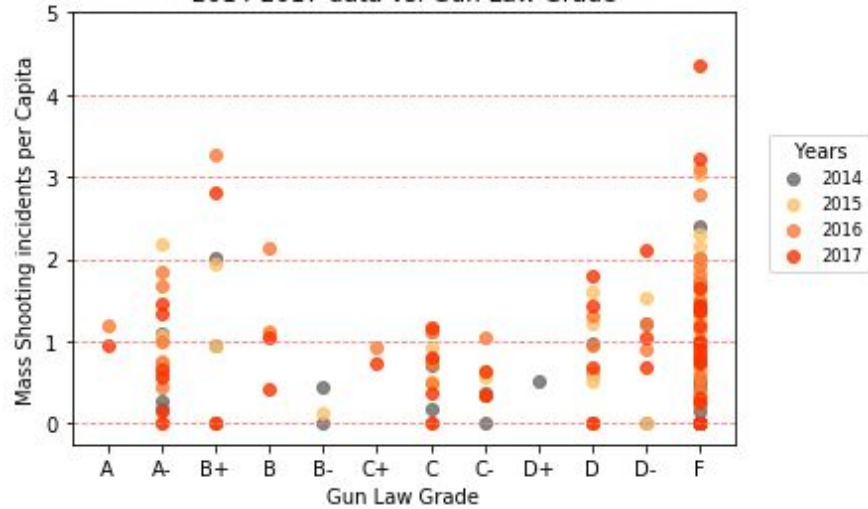
2014-2017 data vs. Gun Law Ranked

*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)

$$\int_{-\infty}^{\infty} e^{-x^2} dx = \sqrt{n}$$

$$f(x) = a_0 + \sum_{n=1}^{\infty} \left( a_n \cos \frac{n\pi x}{L} + b_n \ldots \right)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$R = \frac{\sum_{i=1}^{n} (x_1 - \bar{x})(y_1 - \bar{y})}{\sum^{n} \ldots}$$

Quantitative Analysis

$R$

$\dfrac{R}{\cos x}$

# Regression Exploration

```
                      OLS Regression Results
==============================================================================
Dep. Variable:     Per Capita Mass Shooting   R-squared:               0.193
Model:                              OLS        Adj. R-squared:          0.177
Method:                   Least Squares        F-statistic:             11.70
Date:                Sat, 30 Mar 2019          Prob (F-statistic):    1.56e-08
Time:                        17:05:54          Log-Likelihood:        -210.06
No. Observations:                 200          AIC:                     430.1
Df Residuals:                     195          BIC:                     446.6
Df Model:                           4
Covariance Type:            nonrobust
==============================================================================
                          coef    std err        t      P>|t|    [0.025    0.975]
------------------------------------------------------------------------------
const                  -0.4976      0.327   -1.522      0.130   -1.142     0.147
Poverty Rates           0.1207      0.019    6.501      0.000    0.084     0.157
Per Capita Hate Group   0.1938      0.300    0.646      0.519   -0.397     0.785
GRADE_number           -0.0978      0.037   -2.618      0.010   -0.171    -0.024
Election_Result_B      -0.0491      0.143   -0.344      0.731   -0.330     0.232
==============================================================================
Omnibus:                32.374     Durbin-Watson:            2.066
Prob(Omnibus):           0.000     Jarque-Bera (JB):        43.967
Skew:                    0.992     Prob(JB):              2.84e-10
Kurtosis:                4.158     Cond. No.                 109.
==============================================================================
```

**'Election_Result_B' (indicating BLUE or RED States)**
*Dummy variables* (0, 1)

The p-value for 'Election_Result_B' (0.731) is greater than the significance level (0.05), we cannot conclude that there is a statistically significant association between the mass shooting incidents Per Capita and the Election results.

Regarding Regression Model reduction, this p-value is also the highest p-value that is greater than 0.05, so we reduce the model by removing this term. We, then, repeat the regression.

*For regression, Mass Shooting incidents of each State per 1,000,000 people
**A significance level of 0.05 indicates a 5% risk of concluding that an association exists when there is no actual association.

# Regression Exploration

```
                            OLS Regression Results
================================================================================
Dep. Variable:     Per Capita Mass Shooting   R-squared:               0.193
Model:                                 OLS    Adj. R-squared:          0.181
Method:                      Least Squares    F-statistic:             15.63
Date:                     Sat, 30 Mar 2019    Prob (F-statistic):    3.76e-09
Time:                             16:55:08    Log-Likelihood:         -210.12
No. Observations:                      200    AIC:                     428.2
Df Residuals:                          196    BIC:                     441.4
Df Model:                                3
Covariance Type:                 nonrobust
================================================================================
                        coef     std err         t      P>|t|    [0.025    0.975]
--------------------------------------------------------------------------------
const                -0.5747       0.238    -2.419      0.016    -1.043    -0.106
Poverty Rates         0.1218       0.018     6.676      0.000     0.086     0.158
Per Capita Hate Group 0.2113       0.295     0.717      0.474    -0.370     0.793
GRADE number         -0.0902       0.030    -2.996      0.003    -0.150    -0.031
================================================================================
Omnibus:                  33.037    Durbin-Watson:                   2.072
Prob(Omnibus):             0.000    Jarque-Bera (JB):               45.242
Skew:                      1.004    Prob(JB):                     1.50e-10
Kurtosis:                  4.181    Cond. No.                         90.9
================================================================================
```

**Variables with a p value > 0.05**

**Per Capita Hate Group**
The p-value for 'Per Capita Hate Group' (0.474) is greater than the significance level (0.05), we cannot conclude that there is a statistically significant association between the mass shooting incidents Per Capita and Hate group count Per Capita.

**Variables with a p value < 0.05**

**Poverty Rates**
= (Poverty counts per State) / (Population of that State)

**GRADE number (Gun Law Strength)**
*where*
scale: 0 = more legislation, 5.5 = less legislation

| Gun Law Strength | |
|---|---|
| GRADE letter | GRADE number |
| A | 0.0 |
| A- | 0.5 |
| B+ | 1.0 |
| B | 1.5 |
| B- | 2.0 |
| C+ | 2.5 |
| C | 3.0 |
| C- | 3.5 |
| D+ | 4.0 |
| D | 4.5 |
| D- | 5.0 |
| F | 5.5 |

*For regression, Mass Shooting incidents of each State per 1,000,000 people

**A significance level of 0.05 indicates a 5% risk of concluding that an association exists when there is no actual association.

# Regression Exploration

```
                    OLS Regression Results
========================================================================
Dep. Variable:    Per Capita Mass Shooting   R-squared:           0.156
Model:                             OLS        Adj. R-squared:      0.152
Method:                  Least Squares        F-statistic:         36.58
Date:              Sat, 30 Mar 2019          Prob (F-statistic):  7.20e-09
Time:                       16:55:21         Log-Likelihood:     -214.61
No. Observations:                200         AIC:                 433.2
Df Residuals:                    198         BIC:                 439.8
Df Model:                          1
Covariance Type:           nonrobust
========================================================================
                 coef    std err      t      P>|t|    [0.025    0.975]
------------------------------------------------------------------------
const          -0.5716     0.240   -2.378    0.018    -1.046    -0.098
Poverty Rates   0.1004     0.017    6.048    0.000     0.068     0.133
========================================================================
Omnibus:                      37.281   Durbin-Watson:             2.129
Prob(Omnibus):                 0.000   Jarque-Bera (JB):         54.814
Skew:                          1.066   Prob(JB):               1.25e-12
Kurtosis:                      4.425   Cond. No.                   69.5
========================================================================
```
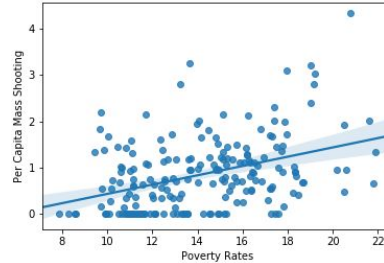
( Y = m*X + const )
Mass Shooting Per Capita = 0.1004*Poverty Rates - 0.5716



```
                    OLS Regression Results
========================================================================
Dep. Variable:    Per Capita Mass Shooting   R-squared:           0.000
Model:                             OLS        Adj. R-squared:     -0.005
Method:                  Least Squares        F-statistic:       0.001593
Date:              Sat, 30 Mar 2019          Prob (F-statistic):  0.968
Time:                       16:57:49         Log-Likelihood:     -231.56
No. Observations:                200         AIC:                 467.1
Df Residuals:                    198         BIC:                 473.7
Df Model:                          1
Covariance Type:           nonrobust
========================================================================
                 coef    std err      t      P>|t|    [0.025    0.975]
------------------------------------------------------------------------
const           0.8453     0.128    6.593    0.000     0.592     1.098
GRADE number    0.0011     0.029    0.040    0.968    -0.055     0.058
========================================================================
Omnibus:                      47.385   Durbin-Watson:             2.115
Prob(Omnibus):                 0.000   Jarque-Bera (JB):         84.939
Skew:                          1.196   Prob(JB):               3.59e-19
Kurtosis:                      5.116   Cond. No.                   10.9
========================================================================
```



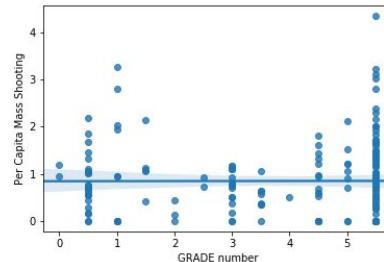**Poverty Rates (p value < 0.05)**

We conclude that there is a statistically significant association between the mass shooting incidents Per Capita and Poverty rates.

The coefficient (0.1004) of the term represents the change in the mean response for one unit of change in Poverty Rates.

Also, the coefficient is positive, as Poverty Rates increases, the mean value of the Mass Shooting incidents Per Capita increases.

The R-squared of this regression is the fraction (0.156) of the variation in Mass Shooting Per Capita that is accounted for (or predicted by) Poverty rates.

*A high or low R-square isn't necessarily good or bad. You can get a low R-squared for a good model, or a high R-square for a poorly fitted model, and vice versa.*

Conclusion

# Conclusion

**Key Questions:**

Have mass shooting rates increased over the years?
*From 2014 - 2016 mass shootings increased, in 2017 the number of mass shootings decreased but the number of victims increased.*

Where are mass shootings happening most often and where are they the deadliest?
*There is a relationship between higher poverty rates and a higher amount of people affected by a mass shooting. The incidents occur the most in dense population centers, however, fatality rates are highest in the rural areas.*

Does gun legislation have any relationship to number of mass shootings?
*There does not seem to be a noticeable linear correlation between gun law strength and mass shootings.*
*Note, this study disregards gun crime.*

Does hate group activity have any correlation with number of mass shootings?
*Hate group activity does not have any significant effect on the number of mass shootings overall. However, in states which experience at least one mass shooting there is a positive linear correlation between number of hate groups and mass shootings.*
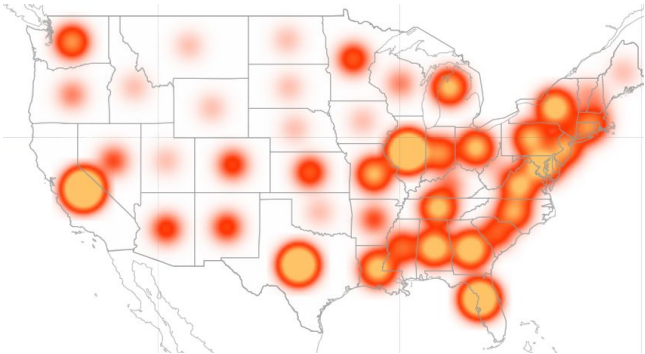
Appendix

# Mass Shootings Analysis: Total Count by State
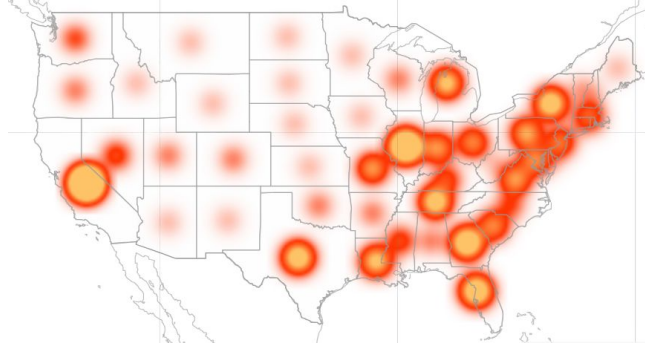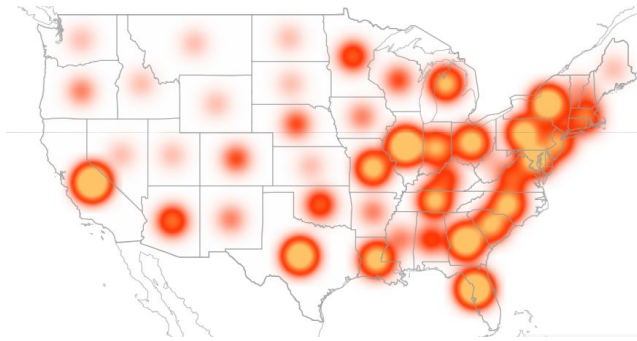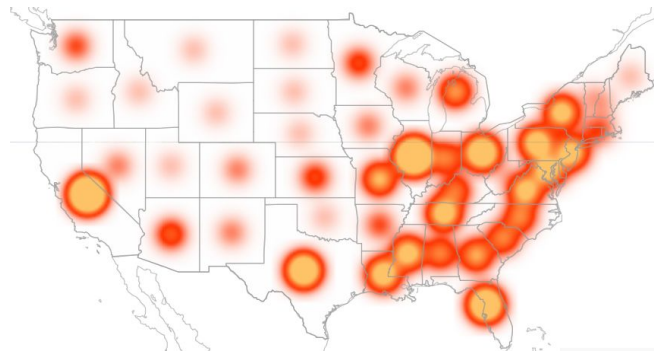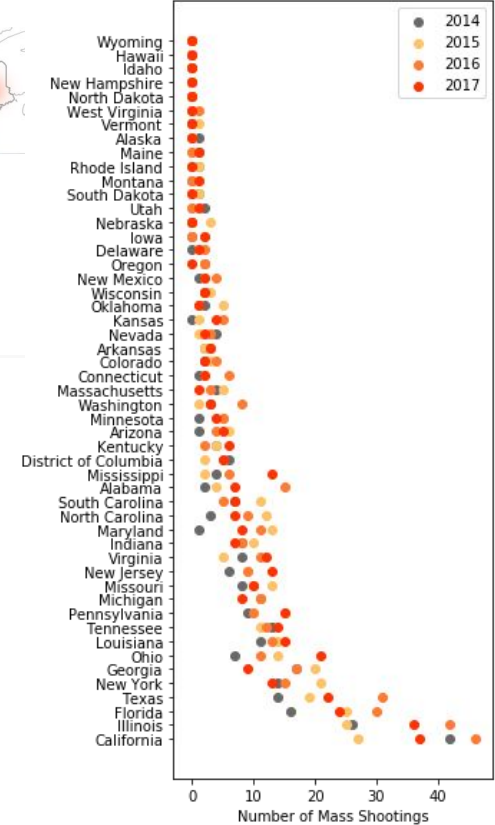
# Mass Shootings Analysis: Per 100,000,000 people
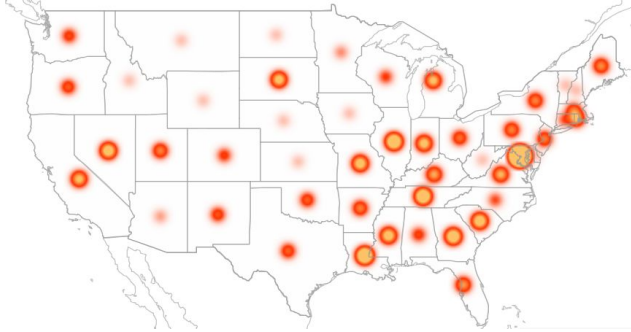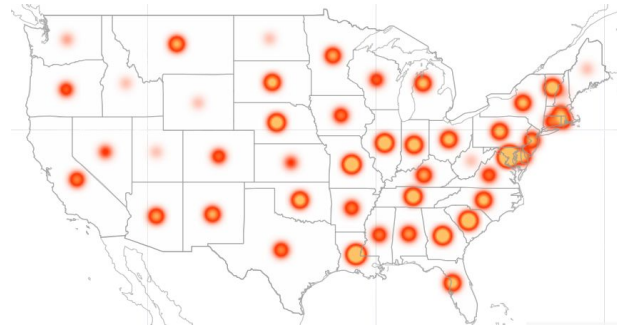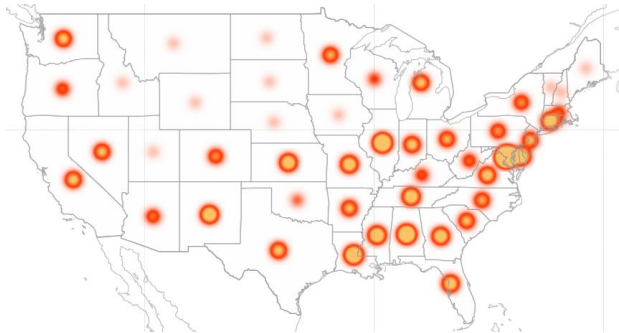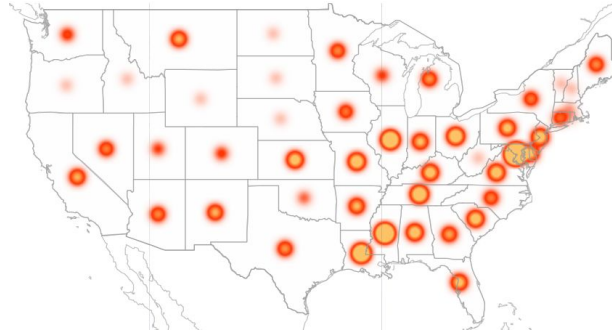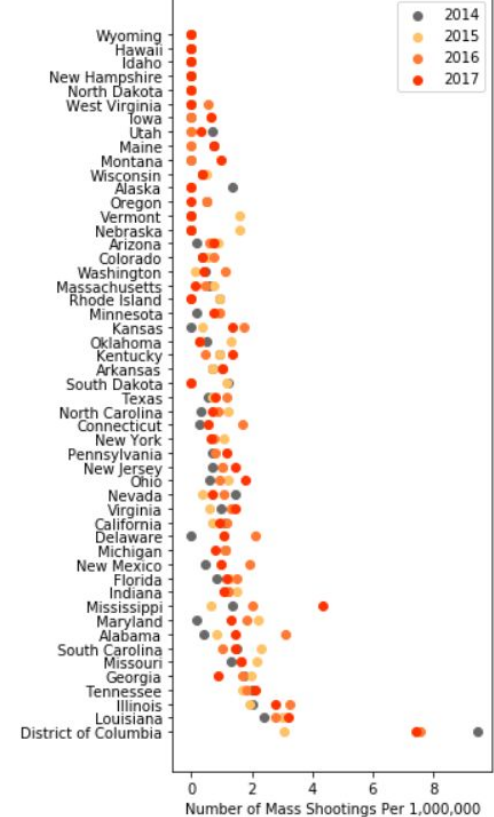
# Hate Groups 2017

| Ideology | |
|---|---|
| Black Nationalist | 233 |
| Neo-Nazi | 121 |
| Anti-Muslim | 114 |
| White Nationalist | 100 |
| Ku Klux Klan | 72 |
| Racist Skinhead | 71 |
| General Hate | 55 |
| Anti-LGBT | 51 |
| Neo-Confederate | 31 |
| Neo-Volkisch | 28 |
| Anti-Immigrant | 22 |
| Christian Identity | 20 |
| Hate Music | 15 |
| Radical Traditional Catholicism | 11 |
| Holocaust Denial | 10 |
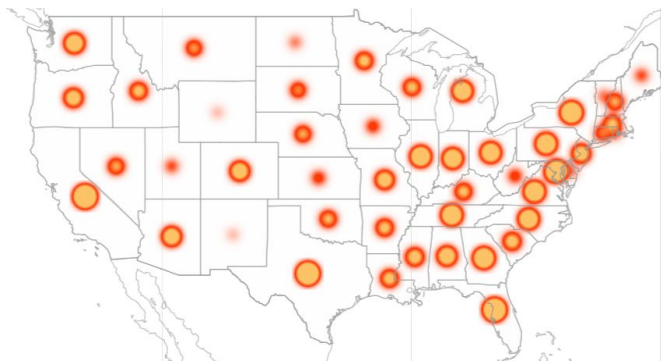


Total Count 2017
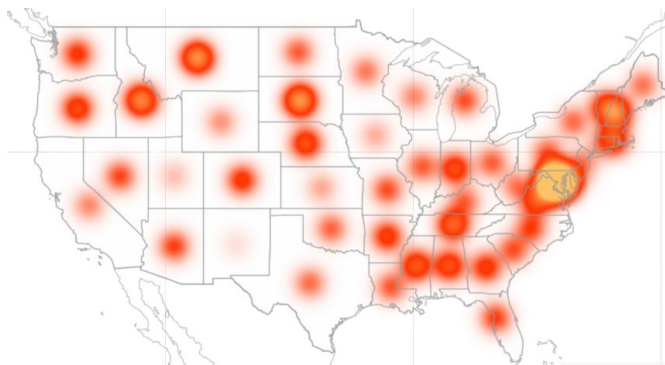


Per Capita 2017

# 2017 Census Data

# Mass Shootings Analysis: US Census Overview



State Poverty Rate vs. Number of Mass Shootings (2017)



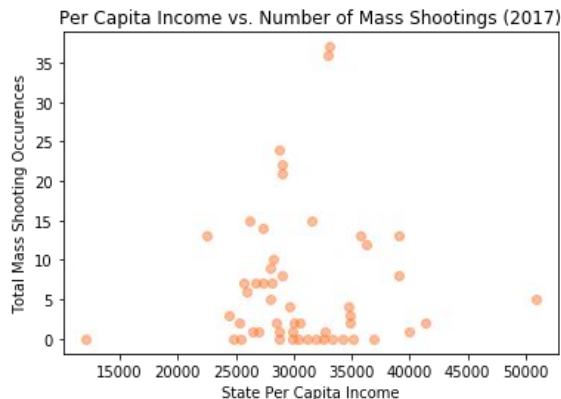Household Income vs. Number of Mass Shootings (2017)
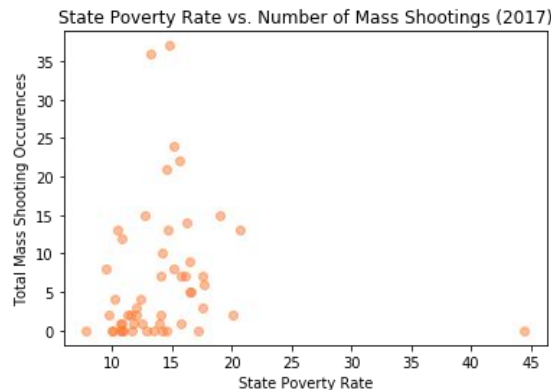
- There appears to be no strong correlation between state poverty rate and mass shootings
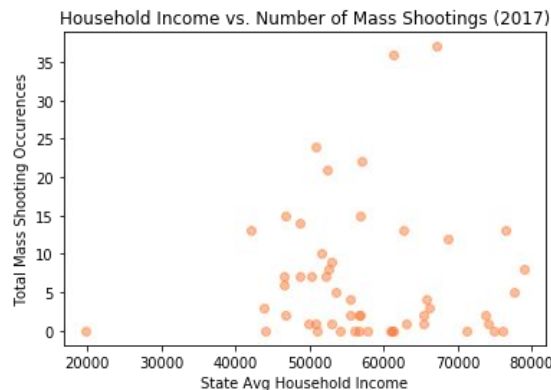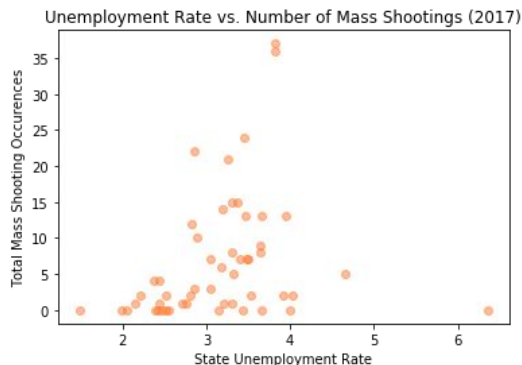
- There does not appear to be a strong correlation between state household income and mass shootings

- States with an average household income of over $70k did not experience more than 15 mass shootings in 2017

# Mass Shootings Analysis: US Census Overview



Per Capita Income vs. Number of Mass Shootings (2017)

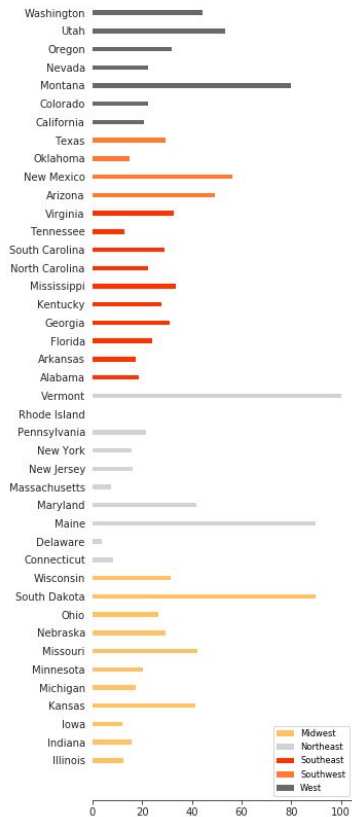- There does not appear to be a strong linear correlation between per capita income and mass shootings

- States with a per capita income of $35k or less experience a higher number of mass shootings



Unemployment Rate vs. Number of Mass Shootings (2017)

- There does not appear to be a strong correlation between per unemployment and mass shootings

Regional Studies - Census Data
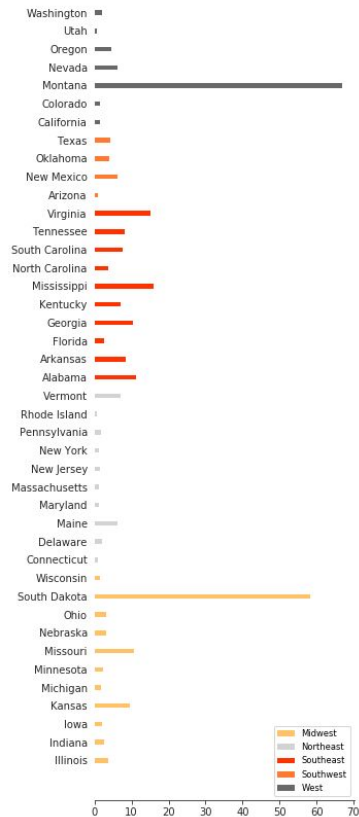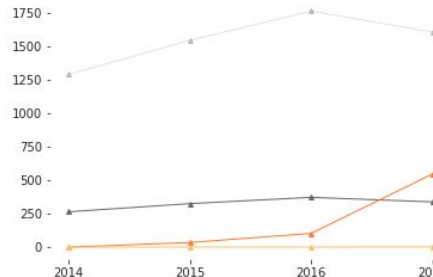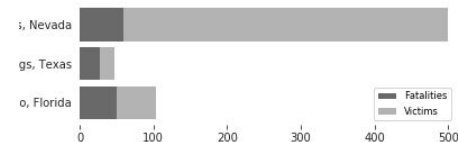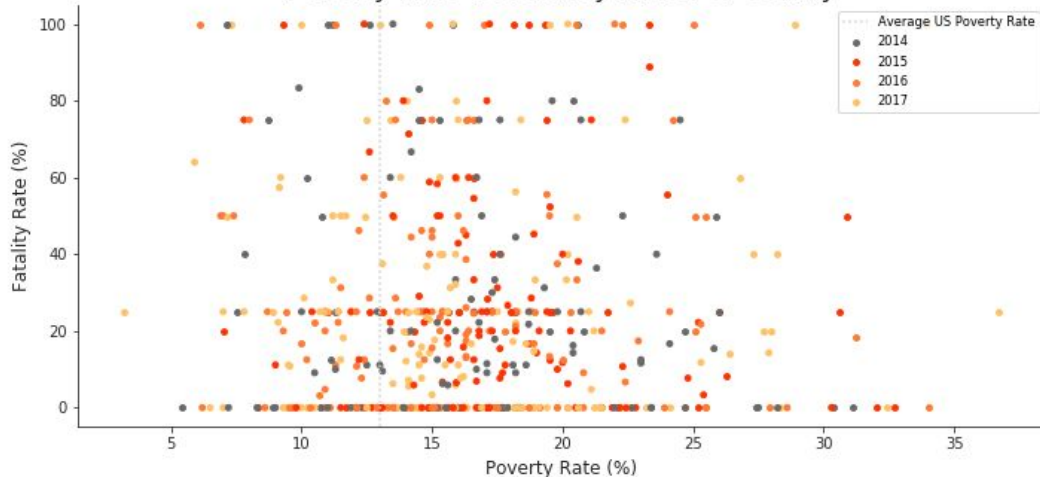
# Regional Studies - Census Data

# Gun Laws
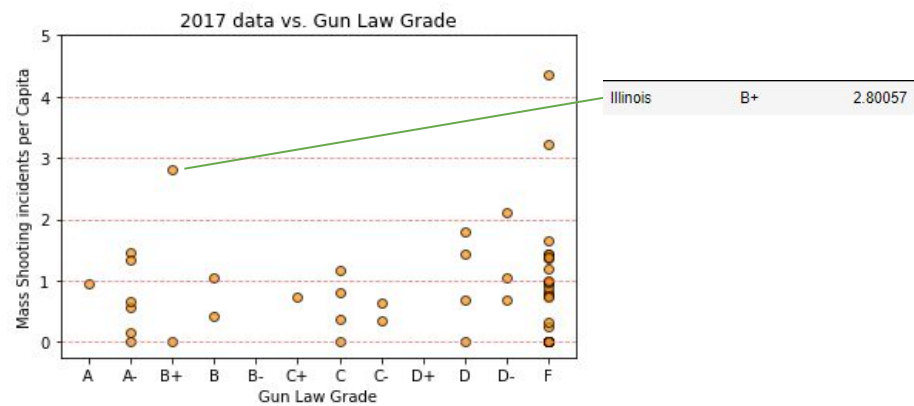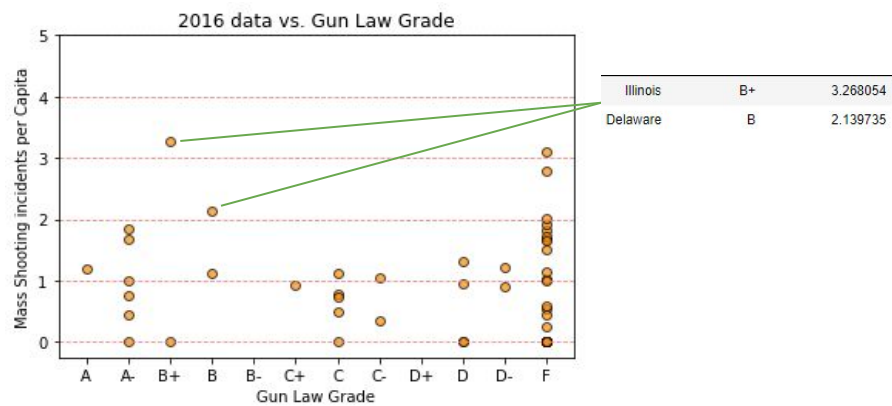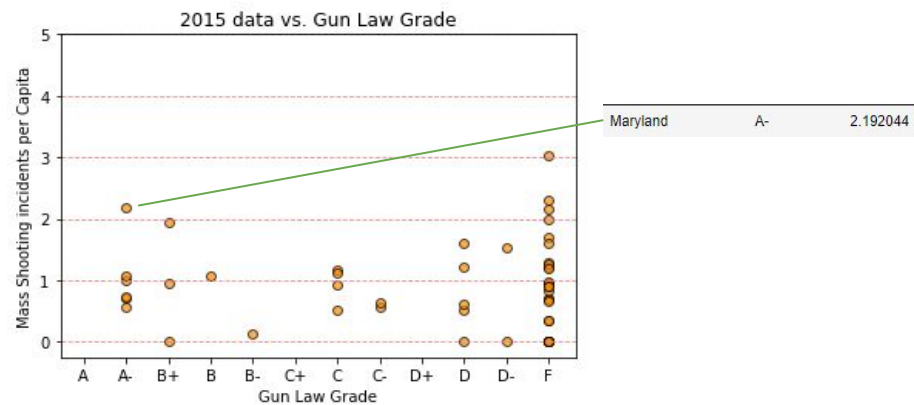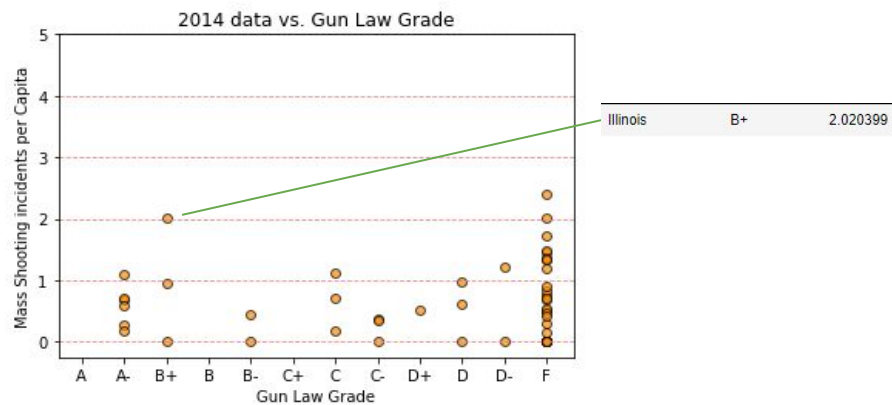
2014 data vs. Gun Law Grade

| Illinois | B+ | 2.020399 |

2015 data vs. Gun Law Grade

| Maryland | A- | 2.192044 |

2016 data vs. Gun Law Grade

| Illinois | B+ | 3.268054 |
| Delaware | B | 2.139735 |

2017 data vs. Gun Law Grade

| Illinois | B+ | 2.80057 |

*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)

2014 data vs. Gun Law Ranked

| Illinois | B+ | 2.020399 |

2015 data vs. Gun Law Ranked

| Maryland | A- | 2.192044 |

2016 data vs. Gun Law Ranked

| Illinois | B+ | 3.268054 |
| Delaware | B | 2.139735 |

2017 data vs. Gun Law Ranked

| Illinois | B+ | 2.80057 |
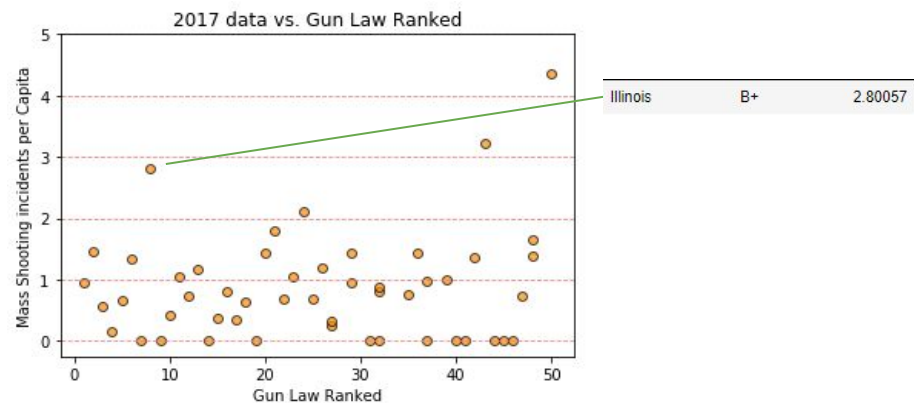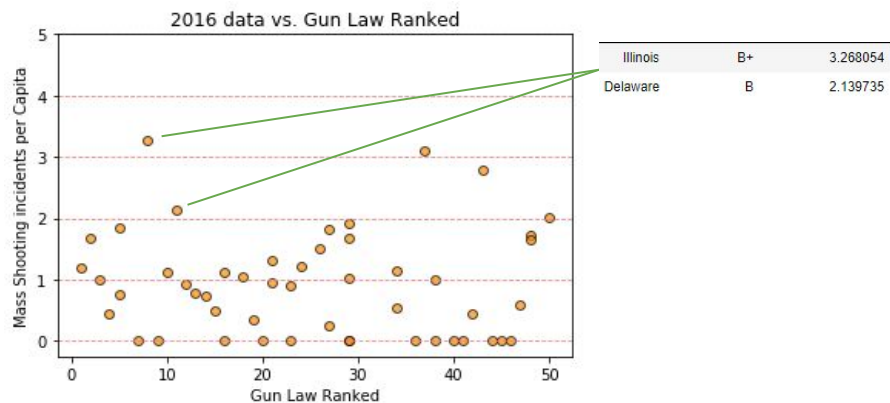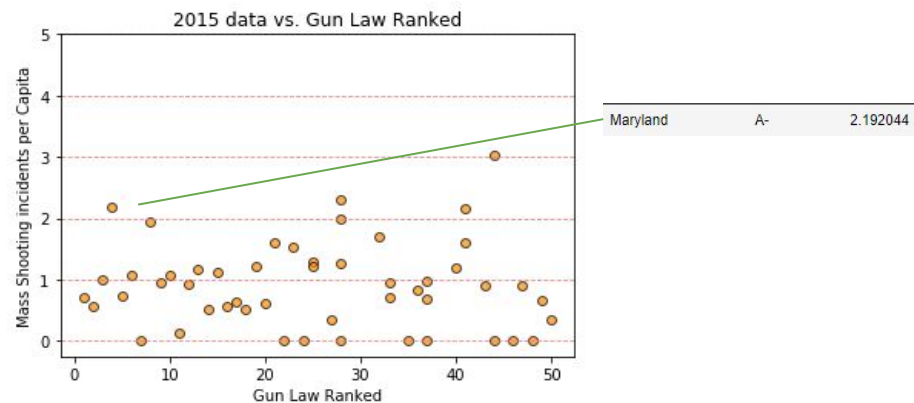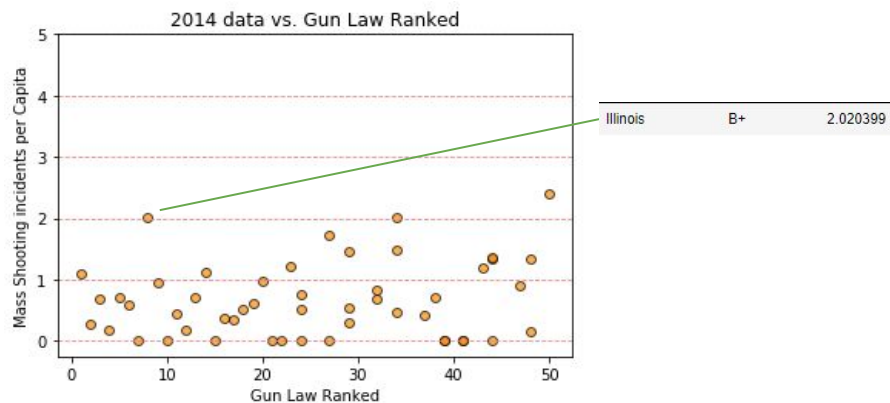
*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)

# Regressions

# Regressions 1
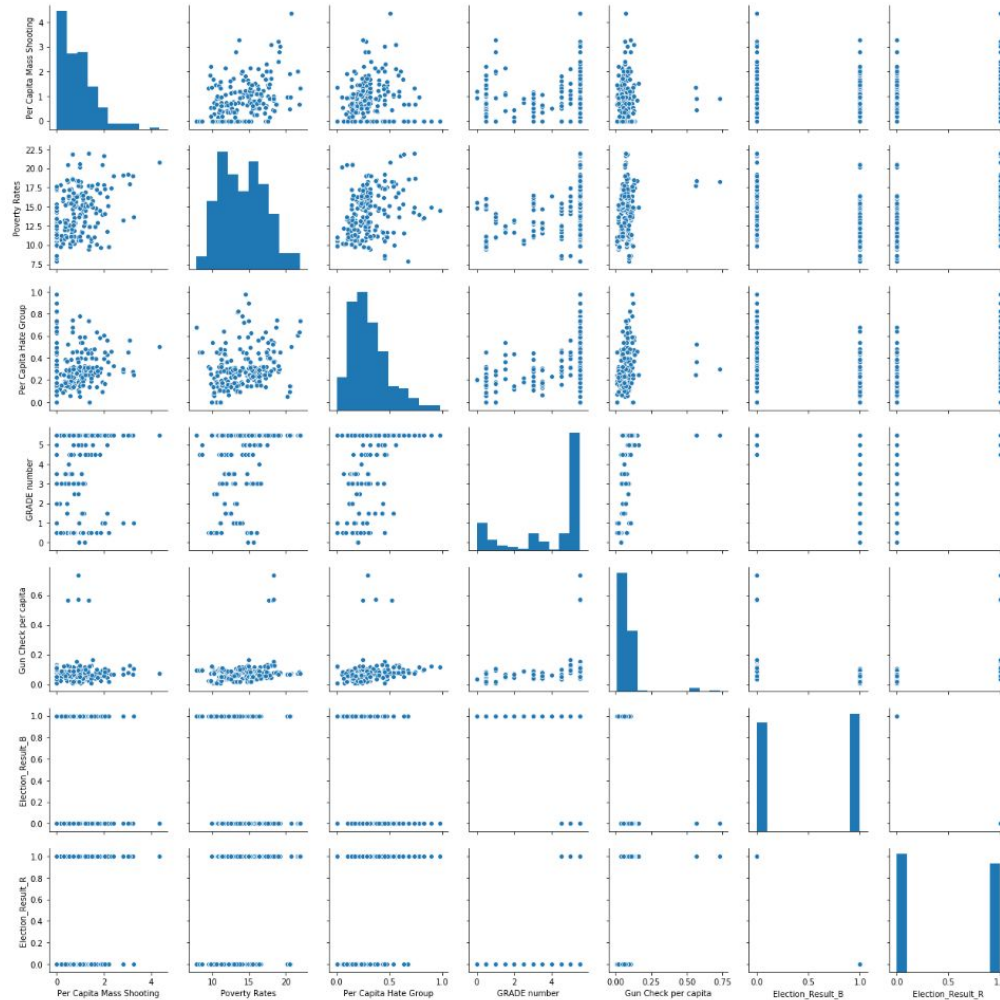
OLS Regression Results

| | | | |
|---|---|---|---|
| Dep. Variable: | Per Capita Mass Shooting | R-squared: | 0.196 |
| Model: | OLS | Adj. R-squared: | 0.175 |
| Method: | Least Squares | F-statistic: | 9.438 |
| Date: | Sun, 31 Mar 2019 | Prob (F-statistic): | 4.54e-08 |
| Time: | 14:19:12 | Log-Likelihood: | -209.79 |
| No. Observations: | 200 | AIC: | 431.6 |
| Df Residuals: | 194 | BIC: | 451.4 |
| Df Model: | 5 | | |
| Covariance Type: | nonrobust | | |

| | coef | std err | t | P>|t| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| const | -0.3400 | 0.189 | -1.798 | 0.074 | -0.713 | 0.033 |
| Poverty Rates | 0.1218 | 0.019 | 6.531 | 0.000 | 0.085 | 0.159 |
| Per Capita Hate Group | 0.1963 | 0.300 | 0.654 | 0.514 | -0.396 | 0.788 |
| GRADE number | -0.0955 | 0.038 | -2.546 | 0.012 | -0.169 | -0.022 |
| Gun Check per capita | -0.4684 | 0.648 | -0.723 | 0.470 | -1.746 | 0.809 |
| Election_Result_B | -0.2029 | 0.082 | -2.467 | 0.014 | -0.365 | -0.041 |
| Election_Result_R | -0.1371 | 0.147 | -0.933 | 0.352 | -0.427 | 0.153 |

| | | | |
|---|---|---|---|
| Omnibus: | 31.774 | Durbin-Watson: | 2.030 |
| Prob(Omnibus): | 0.000 | Jarque-Bera (JB): | 42.881 |
| Skew: | 0.979 | Prob(JB): | 4.88e-10 |
| Kurtosis: | 4.145 | Cond. No. | 1.56e+17 |

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
[2] The smallest eigenvalue is 1.87e-30. This might indicate that there are strong multicollinearity problems or that the design matrix is singular.

# Regressions 2

OLS Regression Results

| | | | |
|---|---|---|---|
| Dep. Variable: | Per Capita Mass Shooting | R-squared: | 0.193 |
| Model: | OLS | Adj. R-squared: | 0.177 |
| Method: | Least Squares | F-statistic: | 11.70 |
| Date: | Sat, 30 Mar 2019 | Prob (F-statistic): | 1.56e-08 |
| Time: | 17:05:54 | Log-Likelihood: | -210.06 |
| No. Observations: | 200 | AIC: | 430.1 |
| Df Residuals: | 195 | BIC: | 446.6 |
| Df Model: | 4 | | |
| Covariance Type: | nonrobust | | |

| | coef | std err | t | P>|t| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| const | -0.4976 | 0.327 | -1.522 | 0.130 | -1.142 | 0.147 |
| Poverty Rates | 0.1207 | 0.019 | 6.501 | 0.000 | 0.084 | 0.157 |
| Per Capita Hate Group | 0.1938 | 0.300 | 0.646 | 0.519 | -0.397 | 0.785 |
| GRADE number | -0.0978 | 0.037 | -2.618 | 0.010 | -0.171 | -0.024 |
| Election_Result_B | -0.0491 | 0.143 | -0.344 | 0.731 | -0.330 | 0.232 |

| | | | |
|---|---|---|---|
| Omnibus: | 32.374 | Durbin-Watson: | 2.066 |
| Prob(Omnibus): | 0.000 | Jarque-Bera (JB): | 43.967 |
| Skew: | 0.992 | Prob(JB): | 2.84e-10 |
| Kurtosis: | 4.158 | Cond. No. | 109. |

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Regressions 3

OLS Regression Results

| | | | | |
|---|---|---|---|---|
| Dep. Variable: | Per Capita Mass Shooting | R-squared: | | 0.193 |
| Model: | OLS | Adj. R-squared: | | 0.181 |
| Method: | Least Squares | F-statistic: | | 15.63 |
| Date: | Sat, 30 Mar 2019 | Prob (F-statistic): | | 3.76e-09 |
| Time: | 16:55:08 | Log-Likelihood: | | -210.12 |
| No. Observations: | 200 | AIC: | | 428.2 |
| Df Residuals: | 196 | BIC: | | 441.4 |
| Df Model: | 3 | | | |
| Covariance Type: | nonrobust | | | |

| | coef | std err | t | P>|t| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| const | -0.5747 | 0.238 | -2.419 | 0.016 | -1.043 | -0.106 |
| Poverty Rates | 0.1218 | 0.018 | 6.676 | 0.000 | 0.086 | 0.158 |
| Per Capita Hate Group | 0.2113 | 0.295 | 0.717 | 0.474 | -0.370 | 0.793 |
| GRADE number | -0.0902 | 0.030 | -2.996 | 0.003 | -0.150 | -0.031 |

| | | | |
|---|---|---|---|
| Omnibus: | 33.037 | Durbin-Watson: | 2.072 |
| Prob(Omnibus): | 0.000 | Jarque-Bera (JB): | 45.242 |
| Skew: | 1.004 | Prob(JB): | 1.50e-10 |
| Kurtosis: | 4.181 | Cond. No. | 90.9 |

# Regression Exploration

```
                          OLS Regression Results
================================================================================
Dep. Variable:      Incidents Per Capita   R-squared:                   0.308
Model:                             OLS     Adj. R-squared:              0.304
Method:                  Least Squares     F-statistic:                 73.73
Date:                Mon, 01 Apr 2019     Prob (F-statistic):       3.28e-27
Time:                        04:50:07     Log-Likelihood:            -682.36
No. Observations:                 334     AIC:                         1371.
Df Residuals:                     331     BIC:                         1382.
Df Model:                           2
Covariance Type:            nonrobust
================================================================================
                 coef     std err          t      P>|t|      [0.025      0.975]
--------------------------------------------------------------------------------
const         -1.5440       0.306     -5.052      0.000      -2.145      -0.943
Rural          1.2697       0.217      5.852      0.000       0.843       1.696
Poverty Rate   0.1574       0.019      8.173      0.000       0.120       0.195
================================================================================
Omnibus:                      283.953   Durbin-Watson:                 1.575
Prob(Omnibus):                  0.000   Jarque-Bera (JB):           6895.172
Skew:                           3.393   Prob(JB):                       0.00
Kurtosis:                      24.199   Cond. No.                       50.1
================================================================================

Warnings:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
```
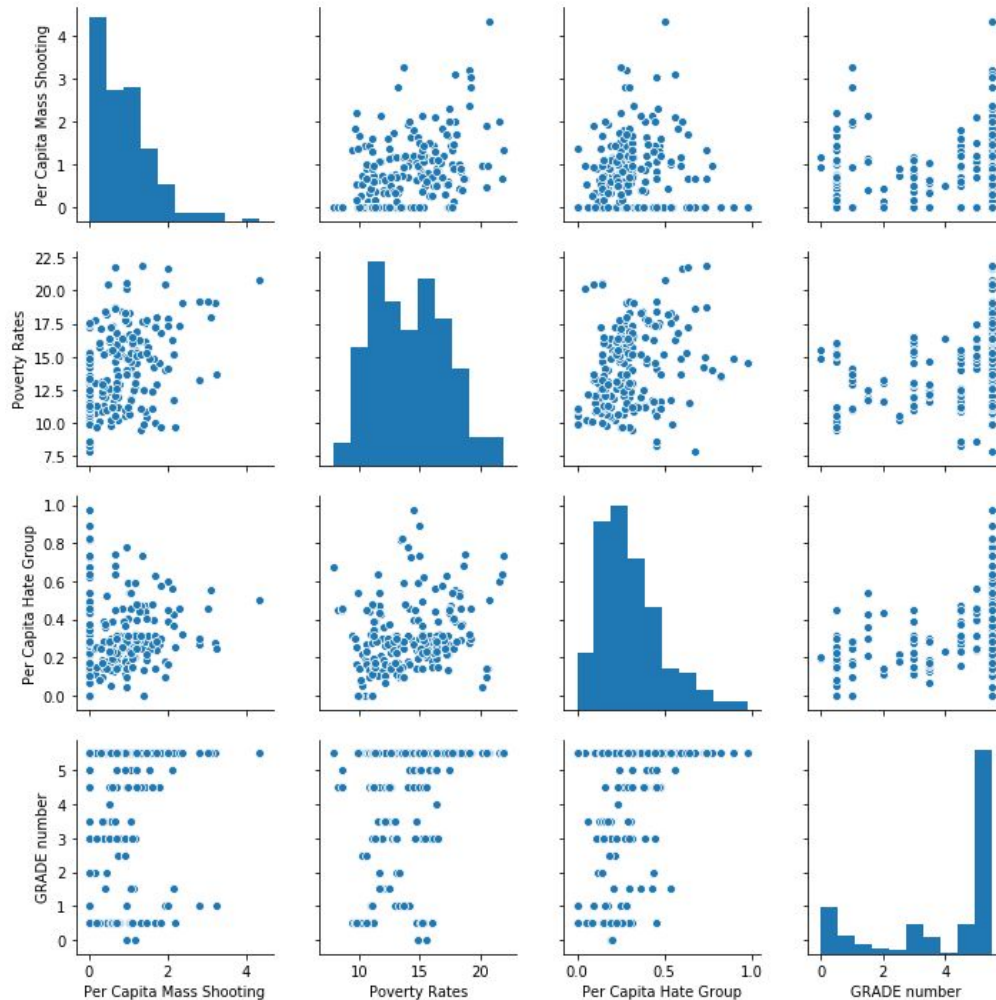


Poverty Rates Vs Incidents (County)
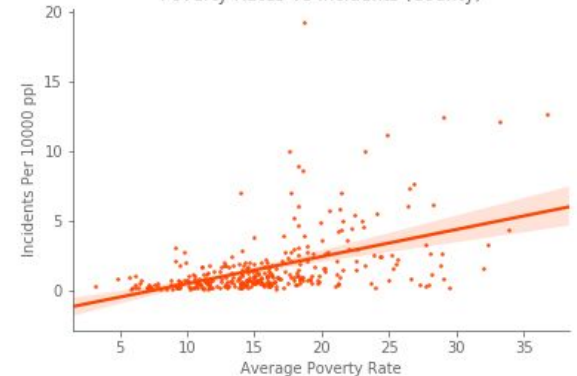
# Regression - States with at least 1 mass shooting
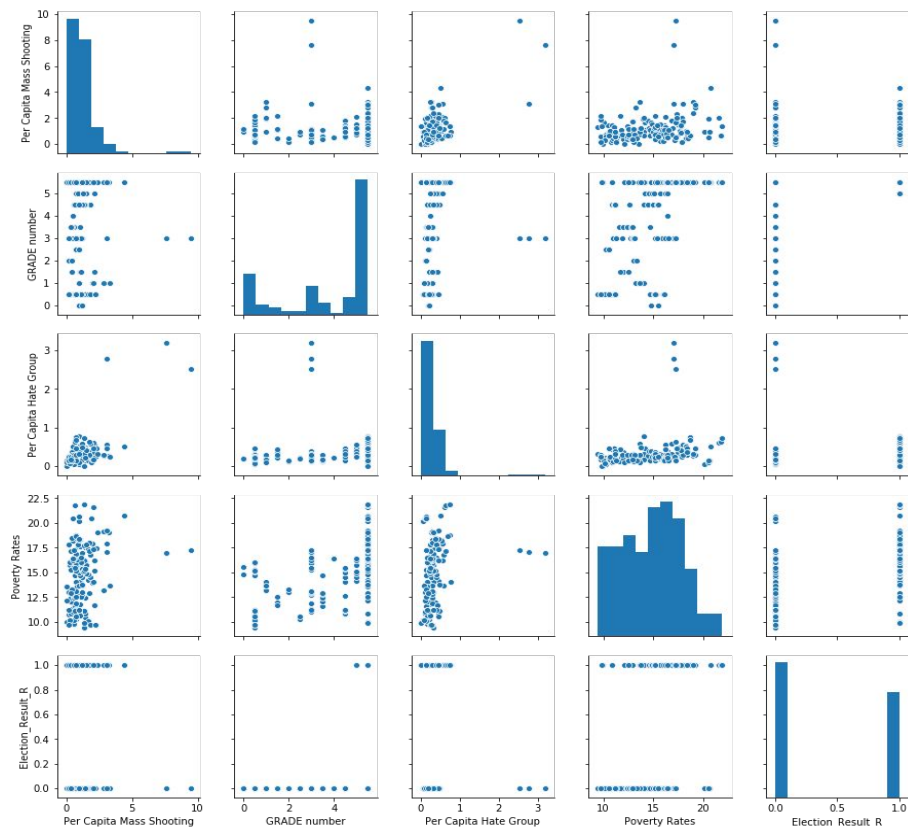


```
                        OLS Regression Results
==============================================================================
Dep. Variable:     Per Capita Mass Shooting   R-squared:                0.525
Model:                                 OLS    Adj. R-squared:           0.512
Method:                      Least Squares    F-statistic:              40.93
Date:                   Sat, 30 Mar 2019      Prob (F-statistic):    4.60e-23
Time:                        19:38:03         Log-Likelihood:         -177.12
No. Observations:                  153        AIC:                      364.2
Df Residuals:                      148        BIC:                      379.4
Df Model:                            4
Covariance Type:               nonrobust
==============================================================================
                        coef    std err       t      P>|t|    [0.025    0.975]
------------------------------------------------------------------------------
const                  0.0037     0.345     0.011    0.992    -0.678    0.685
GRADE number          -0.0824     0.050    -1.662    0.099    -0.180    0.016
Per Capita Hate Group  1.9998     0.172    11.658    0.000     1.661    2.339
Poverty Rates          0.0537     0.027     1.957    0.052    -0.001    0.108
Election_Result_R      0.1007     0.184     0.547    0.585    -0.263    0.464
==============================================================================
```