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

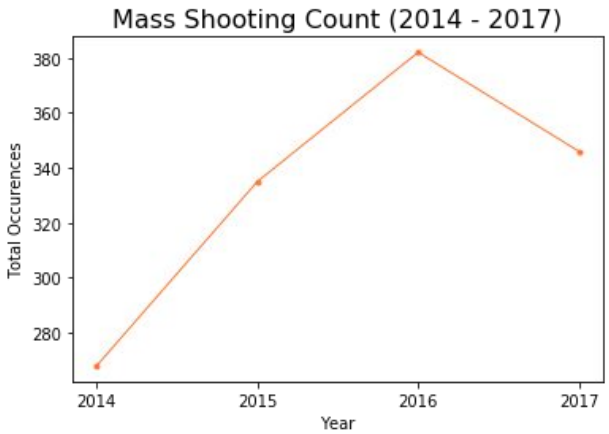
Mass Shooting Definition:
4+ victims injured or killed excluding the subject/suspect/perpetrator, one location. *(Gun Violence Archive)*

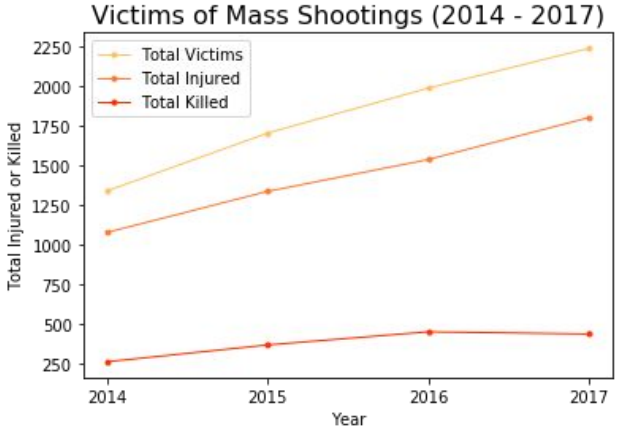
Hate Group Definition:
An organization that – based on its official statements or principles, the statements of its leaders, or its activities – has beliefs or practices that attack or malign an entire class of people, typically for their immutable characteristics. *(Southern Poverty Law Center)*

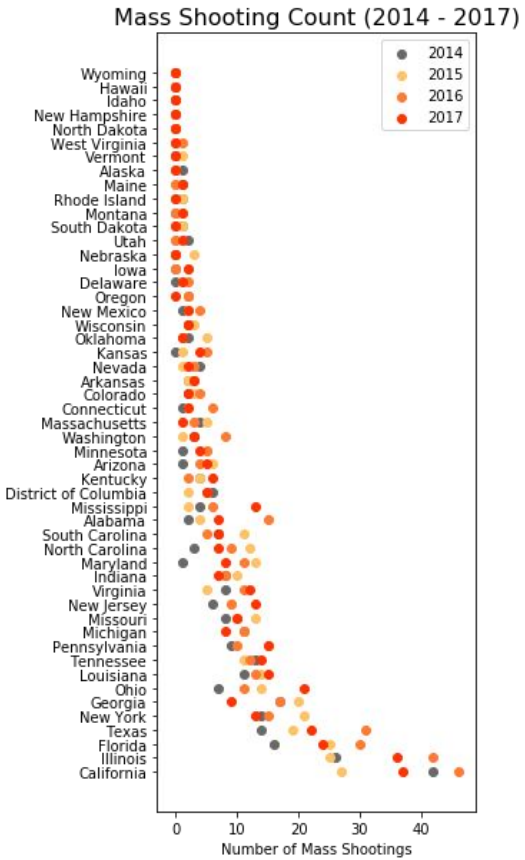
Region Definitions:
Urban - Region with a density greater than 3000 ppl / sq mi
Suburban - Region with a density greater than 1000 ppl / sq mi but less than 3000 ppl / sq mi
Rural - Region with a density less than 1000 ppl / sq mi

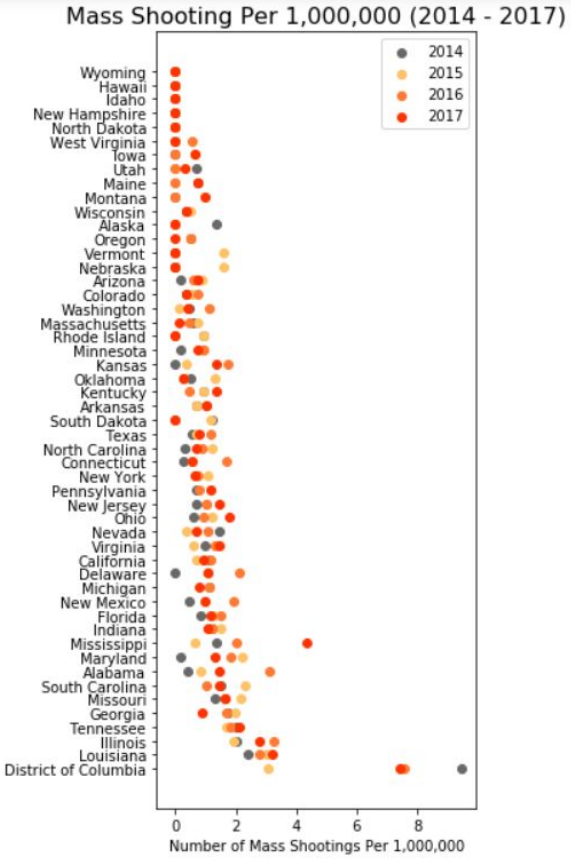
State Gun Laws:
Attorneys track and analyze gun legislation in all 50 states, evaluating bills for their relative strength or weakness. Taking note of newly enacted laws, they use an exhaustive quantitative rubric to score each state on its gun law strength, adding points for safety regulations like 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)*

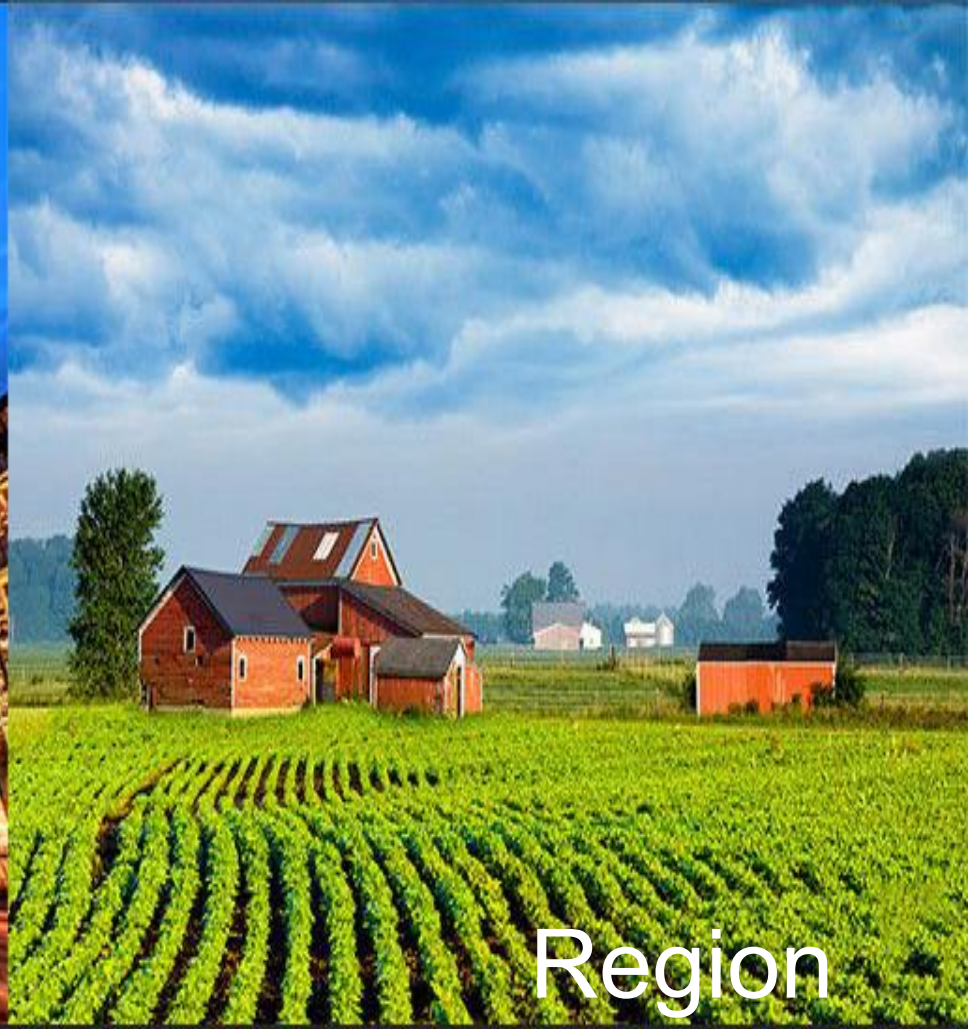
General Overview







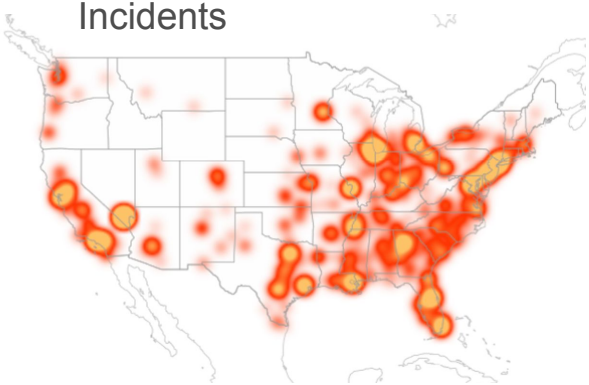




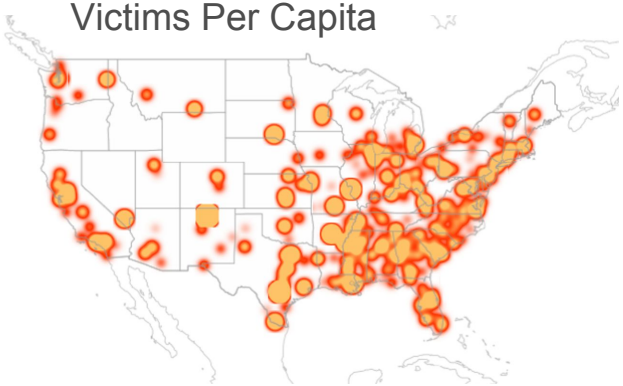
Region

Region

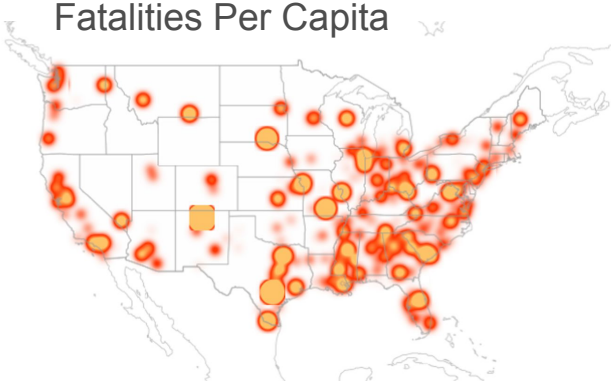
Incidents



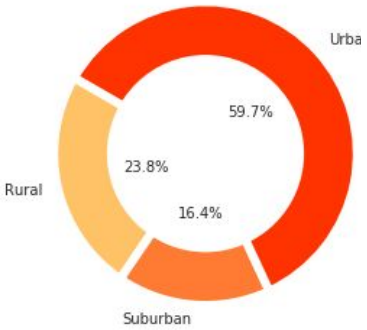
Victims Per Capita



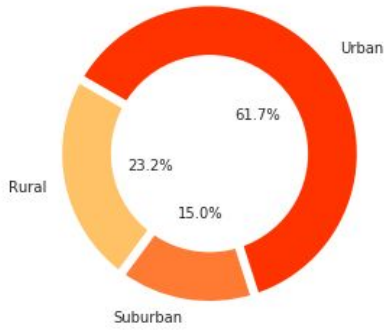
Fatalities Per Capita



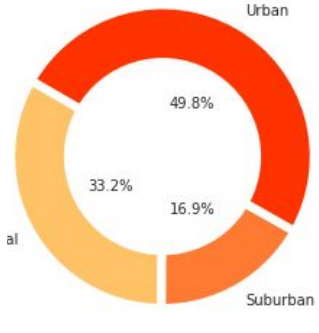
% Total Incidents by Density Type

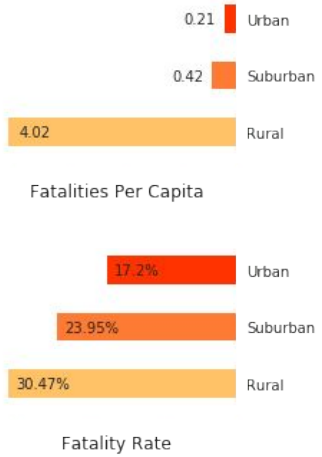


% Total Victims by Density Type

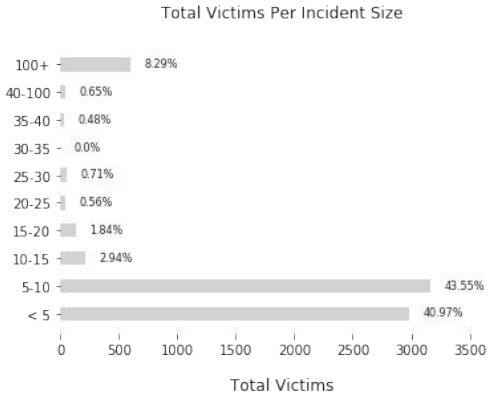


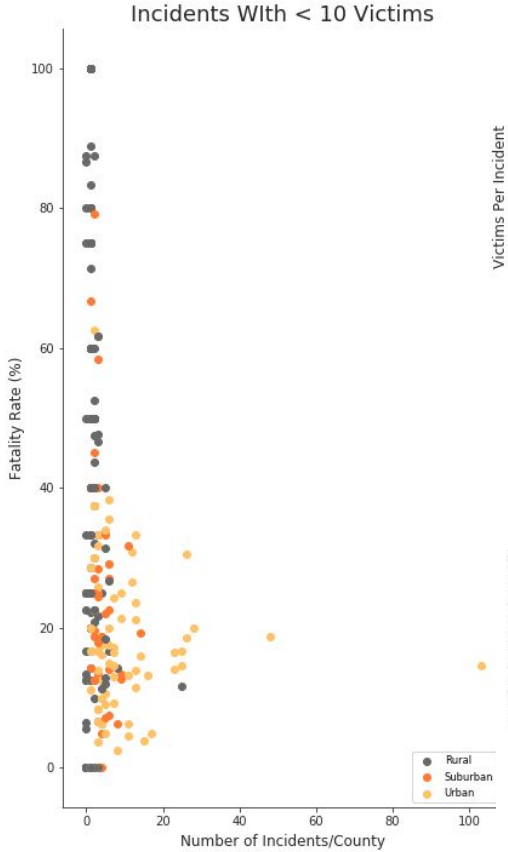
% Total Fatalities by Density Type

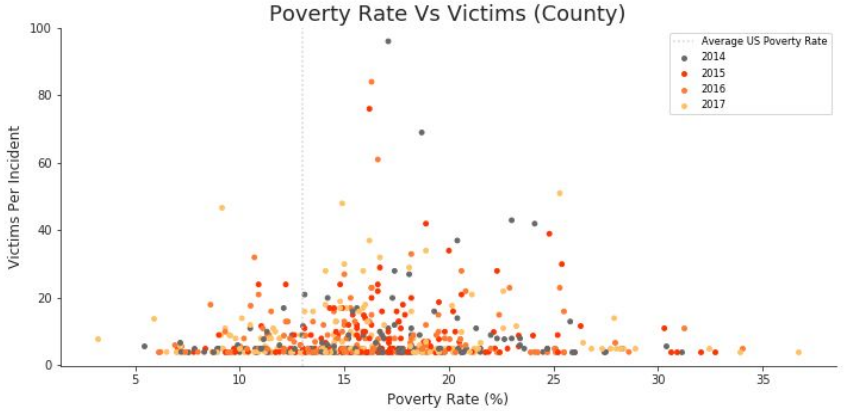


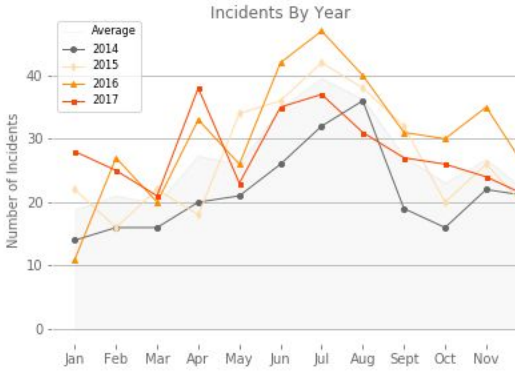


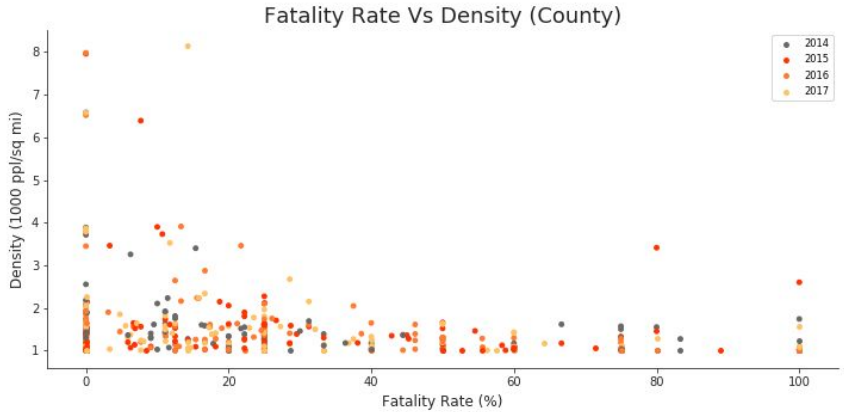
Region


Total Victims Per Incident Size
100+
40-100
35-40
30-35
25-30
20-25
15-20
10-15
5-10
< 5
8.29%
0.65%
0.48%
0.0%
0.71%
0.56%
1.84%
2.94%
43.55%
40.97%
0
500
1000
1500
2000
2500
3000
3500
Total Victims


Incidents WIth < 10 Victims
Fatality Rate (%)
Number of Incidents/County
Rural
Suburban
Urban


Poverty Rate Vs Victims (County)
Victims Per Incident
Poverty Rate (%)
Average US Poverty Rate
2014
2015
2016
2017

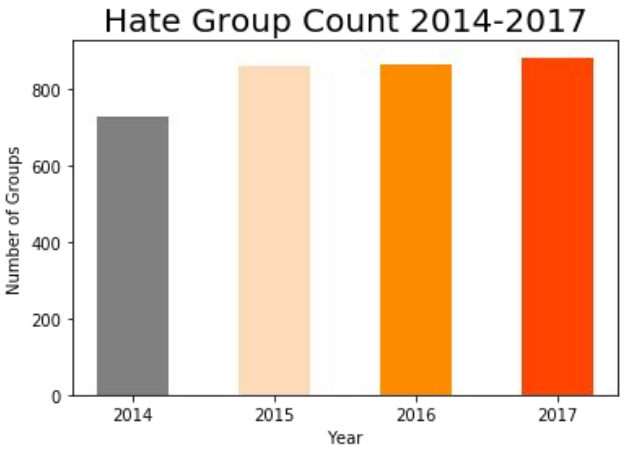

Incidents By Year
Number of Incidents
Average
2014
2015
2016
2017
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sept
Oct
Nov

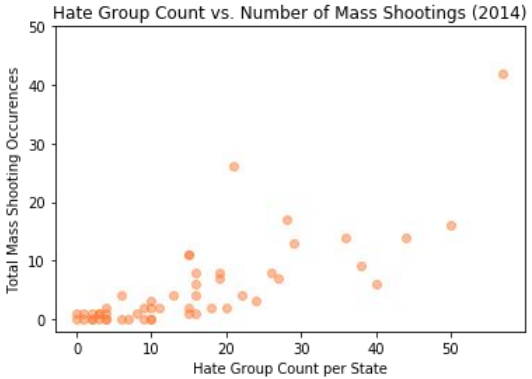

Fatality Rate Vs Density (County)
Density (1000 ppl/sq mi)
Fatality Rate (%)
2014
2015
2016
2017

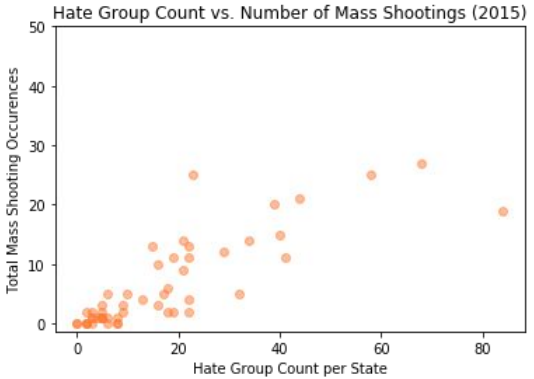

Hate Groups

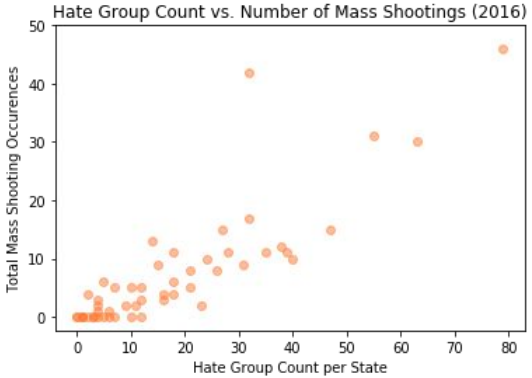
Hate Groups

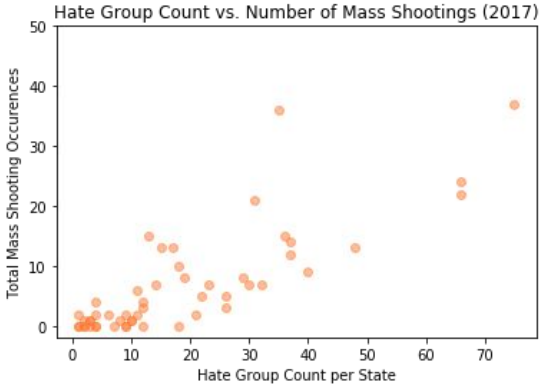
There is a consistent positive, linear correlation between number of hate groups in a state and the number of mass shooting occurrences





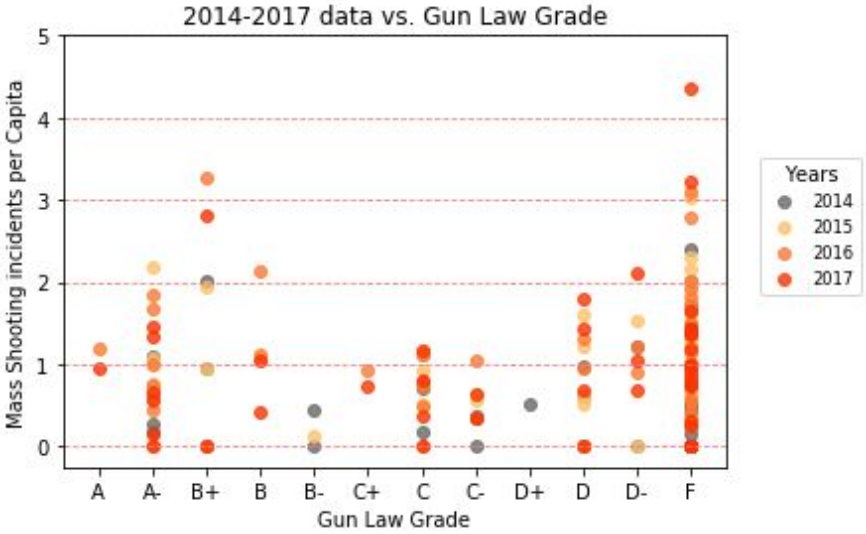


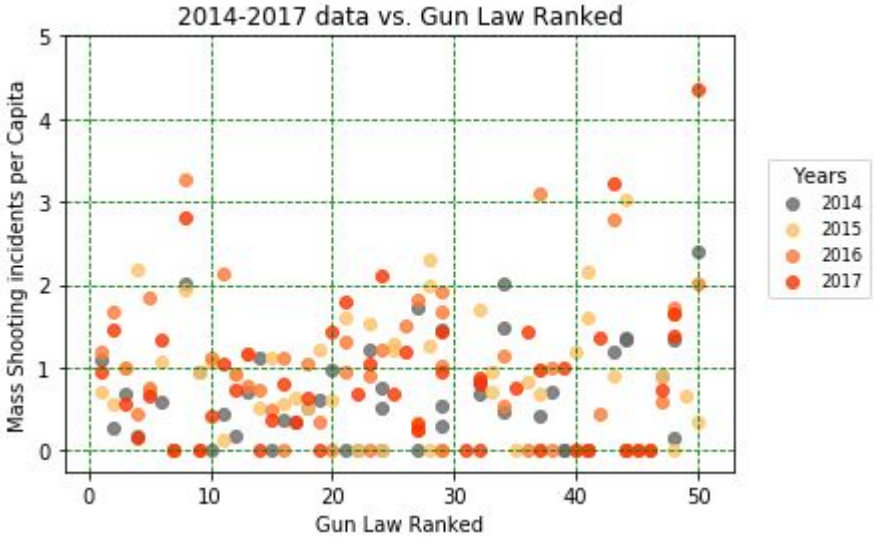





Gun Laws

Gun Laws





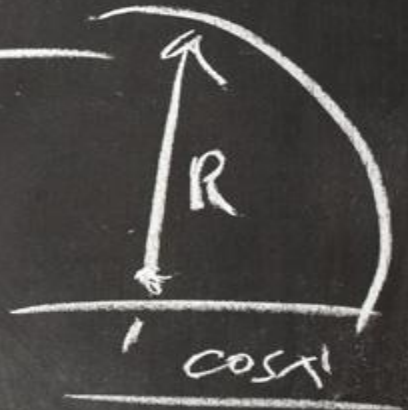
*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)

Quantitative Analysis

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

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

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



$$R = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum^{n} \dots}$$

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.

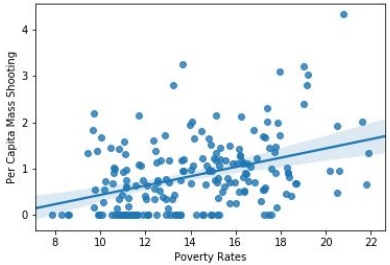
Regression Exploration

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)

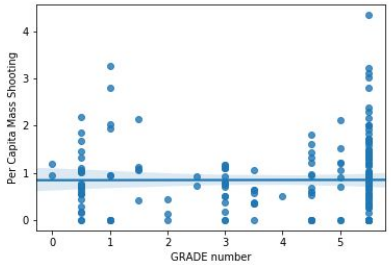
Mass Shooting Per Capita = 0.1004*Poverty Rates - 0.5716

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.

Regression Exploration

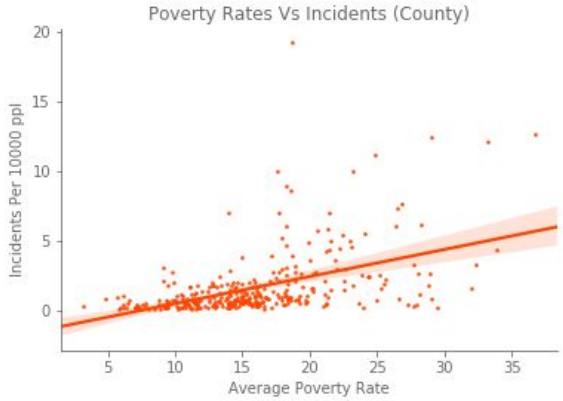
OLS Regression Results

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.



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.

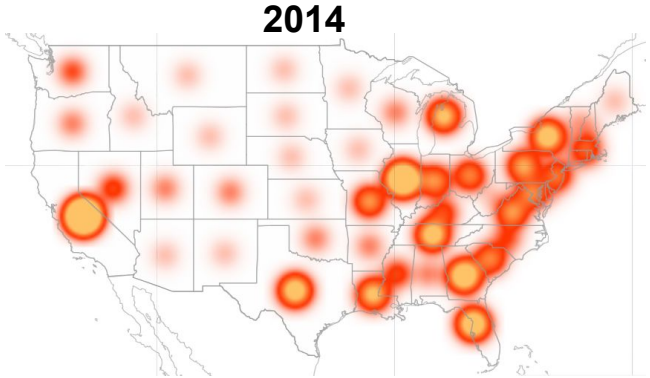
Where are mass shootings happening most often and where are they the deadliest?
There is a relationship between higher poverty rates and a higher amount of people affected by a mass shooting. The incidents occur the most in dense population centers, however, fatality rates are highest in the rural areas.

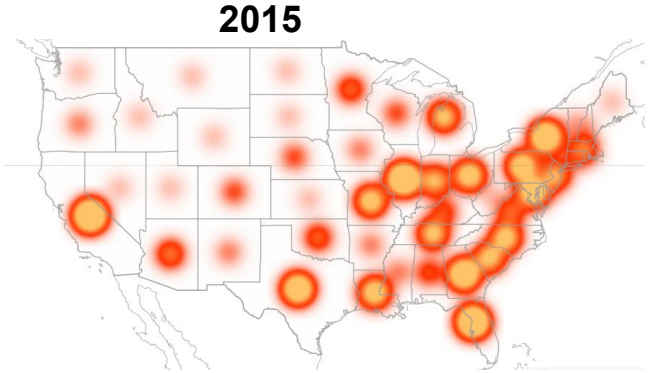
Does gun legislation have any relationship to number of mass shootings?
There does not seem to be a noticeable linear correlation between gun law strength and mass shootings.
Note, this study disregards gun crime.

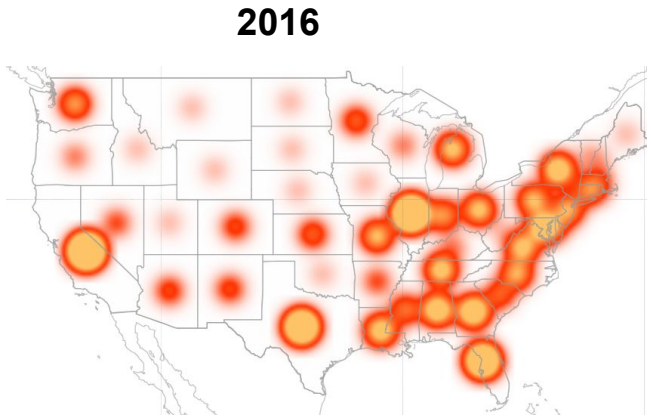
Does hate group activity have any correlation with number of mass shootings?
Hate group activity does not have any significant effect on the number of mass shootings overall. However, in states which experience at least one mass shooting there is a positive linear correlation between number of hate groups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

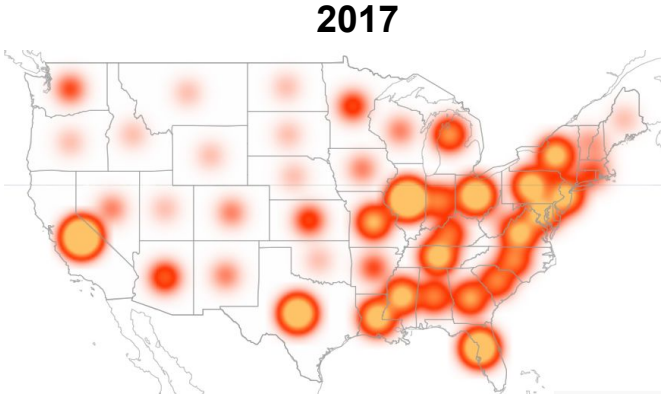
Appendix

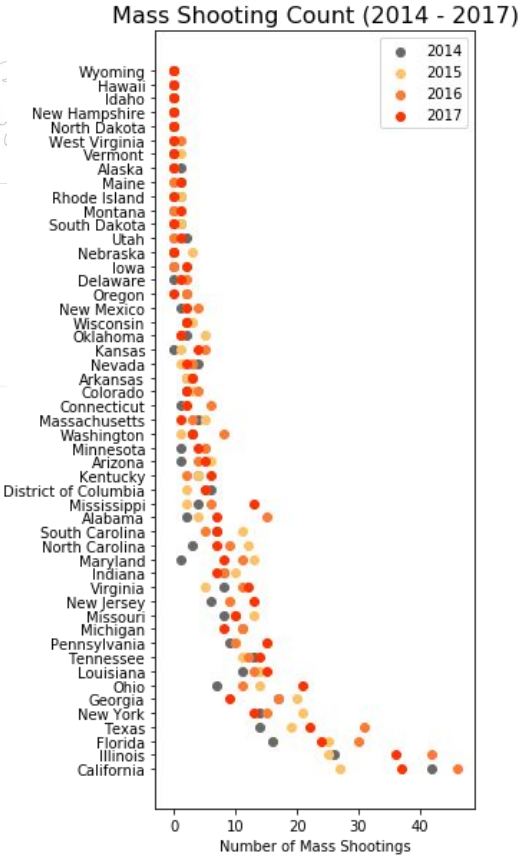
Mass Shootings Analysis: Total Count by State





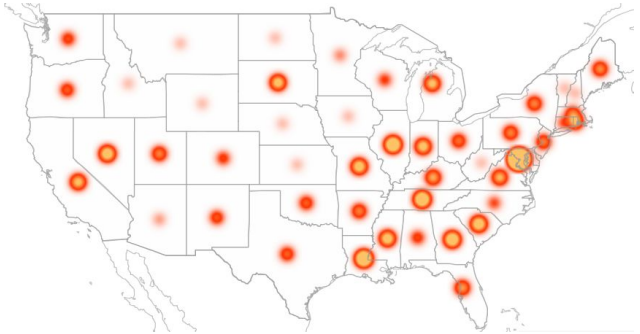




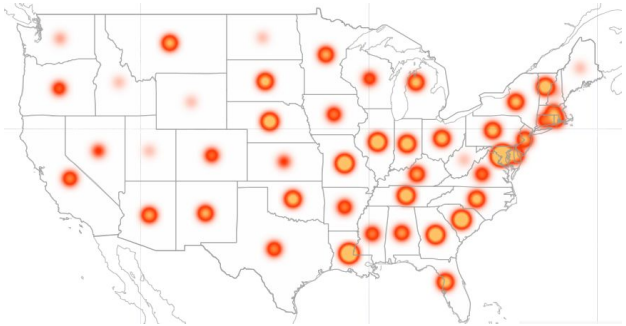


Mass Shootings Analysis: Per 100,000,000 people

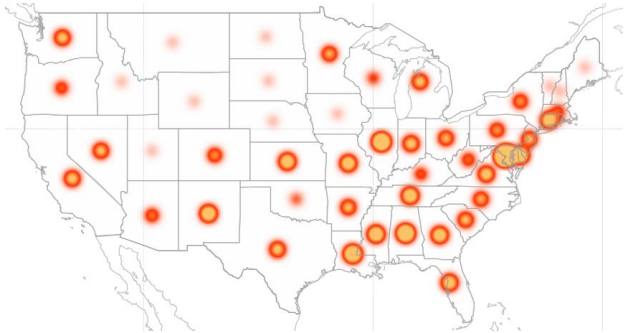
2014



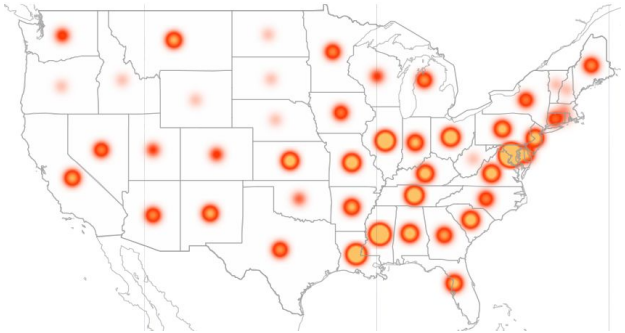
2015

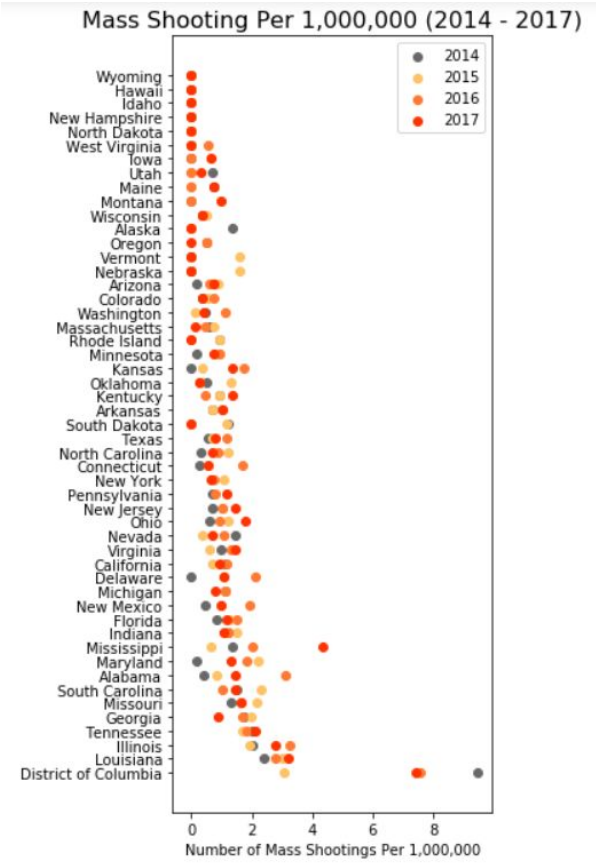


2016



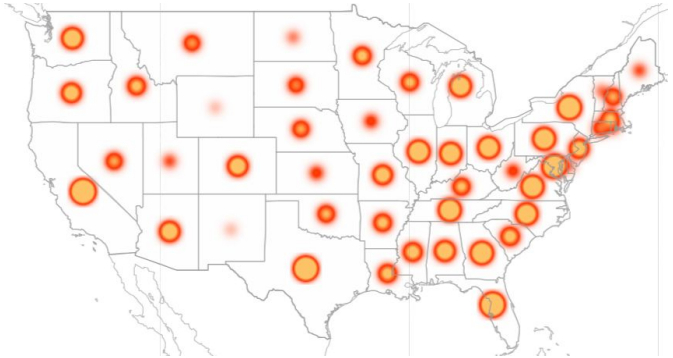
2017



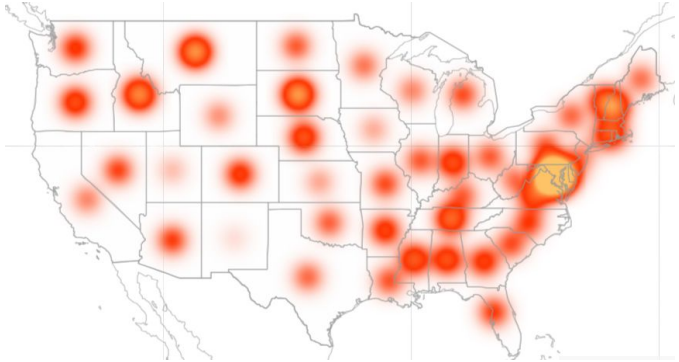


Hate Groups 2017

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



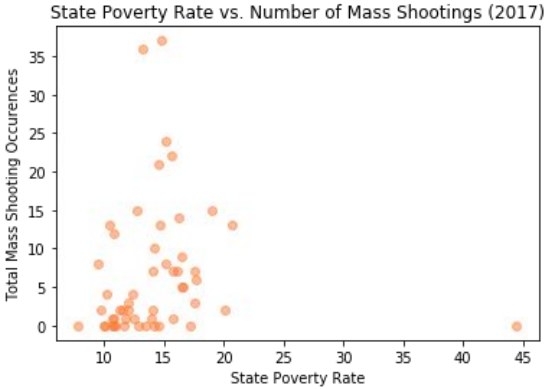
Total Count 2017



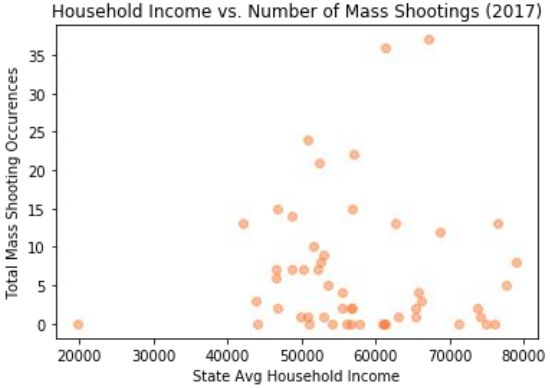
Per Capita 2017

2017 Census Data

Mass Shootings Analysis: US Census Overview

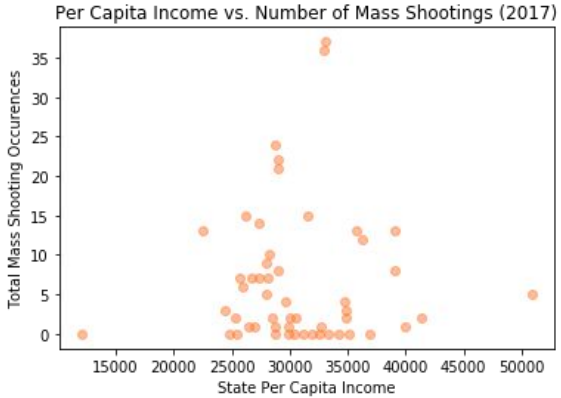


- There appears to be no strong correlation between state poverty rate and mass shootings

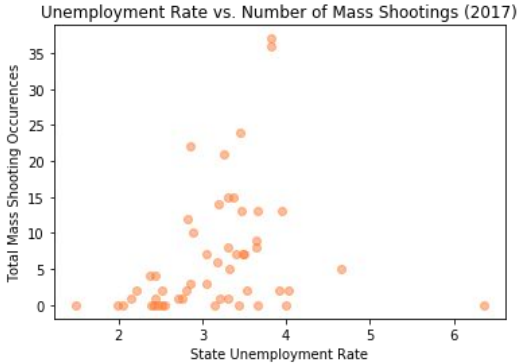


- There does not appear to be a strong correlation between state household income and mass shootings
- States with an average household income of over $70k did not experience more than 15 mass shootings in 2017

Mass Shootings Analysis: US Census Overview

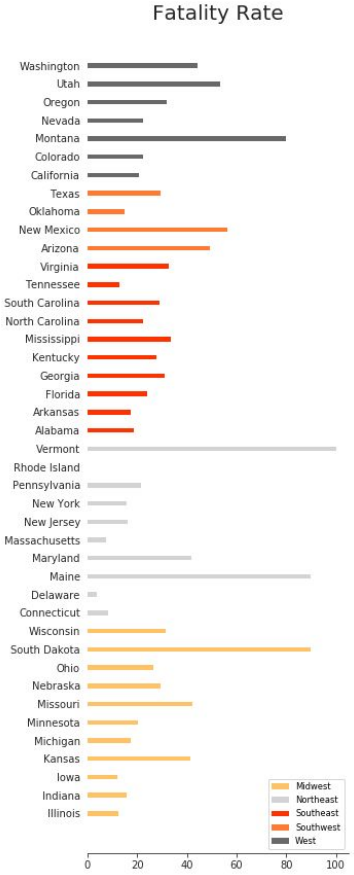


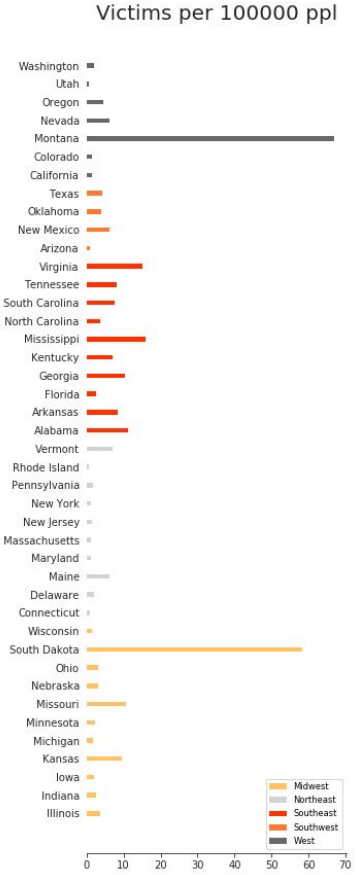
- There does not appear to be a strong linear correlation between per capita income and mass shootings
- States with a per capita income of $35k or less experience a higher number of mass shootings

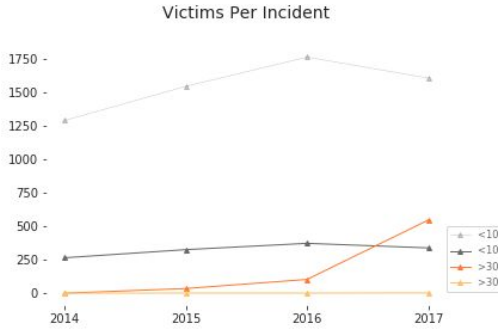


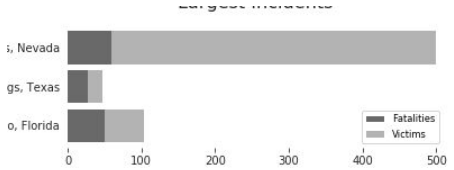
- There does not appear to be a strong correlation between per unemployment and mass shootings

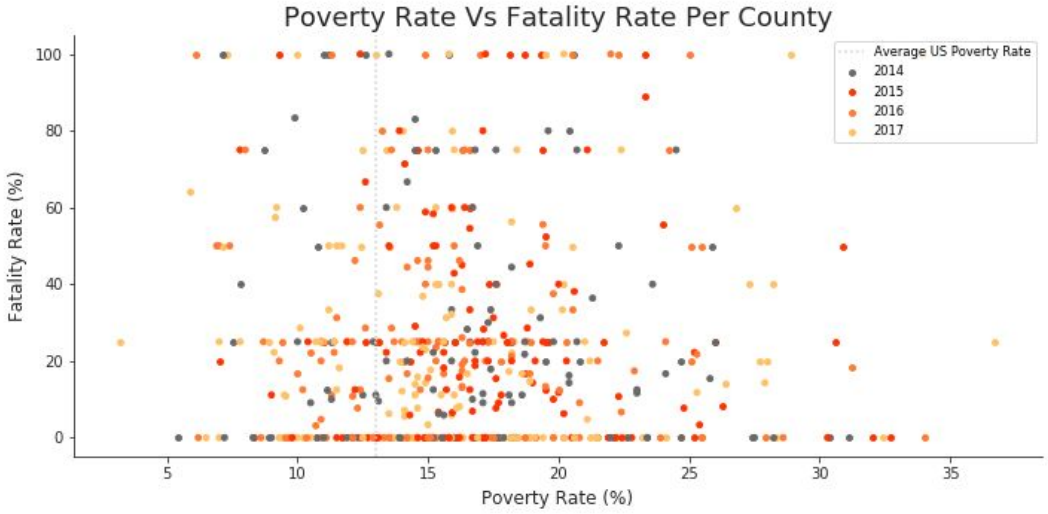
Regional Studies - Census Data



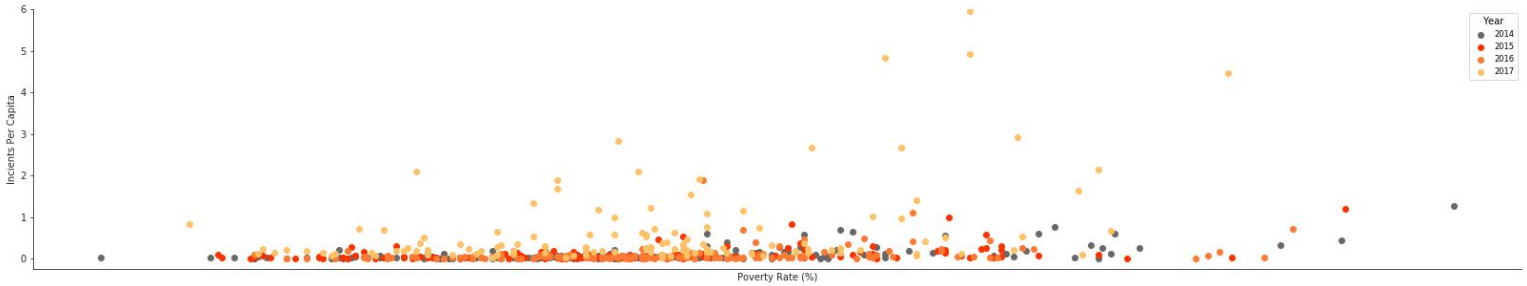


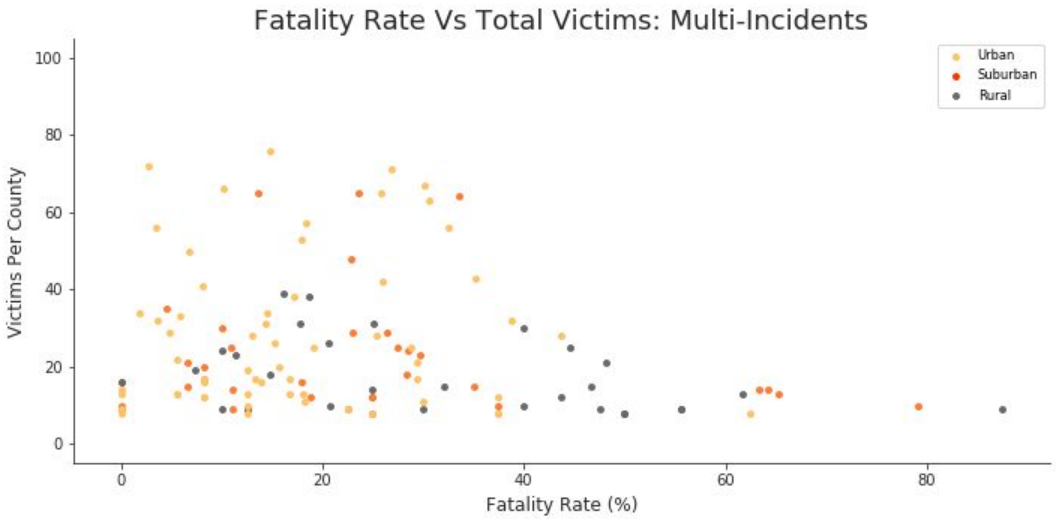


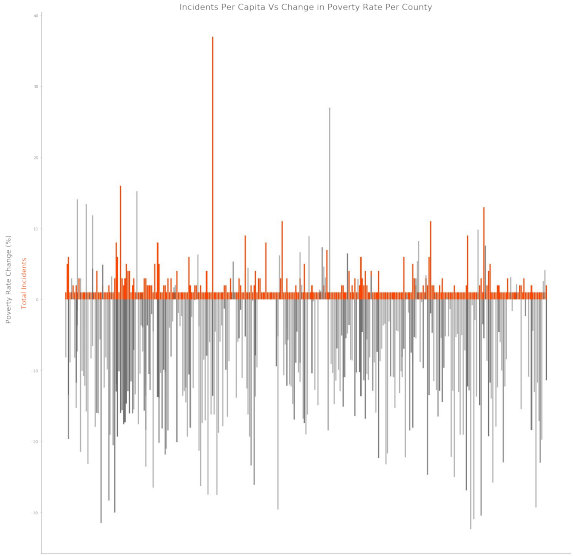




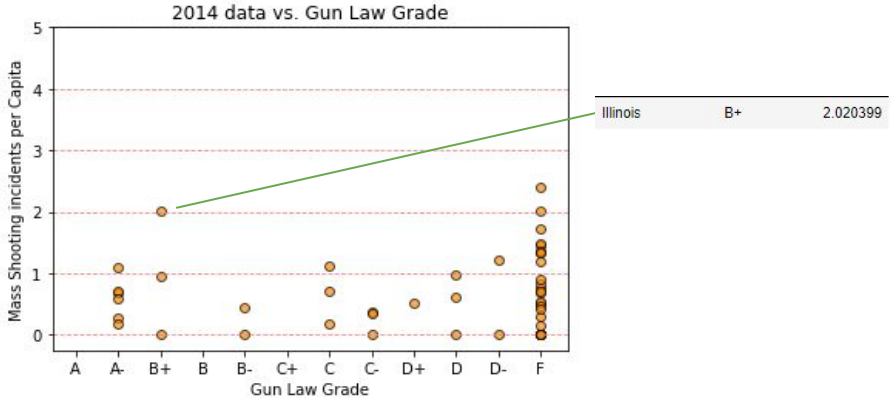
Regional Studies - Census Data

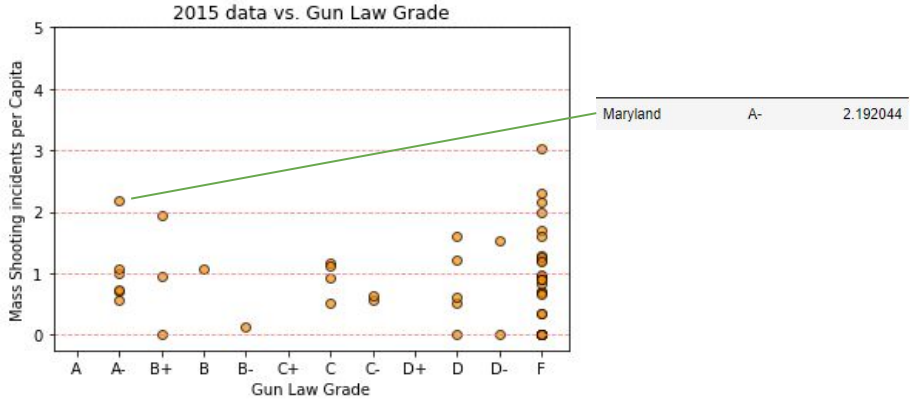


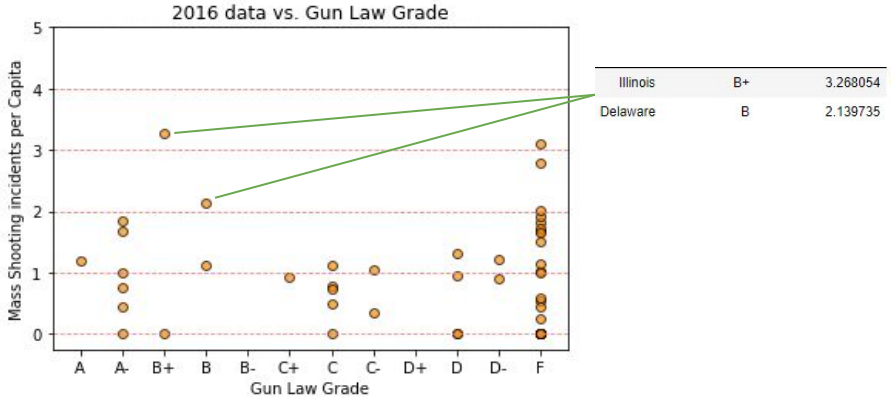


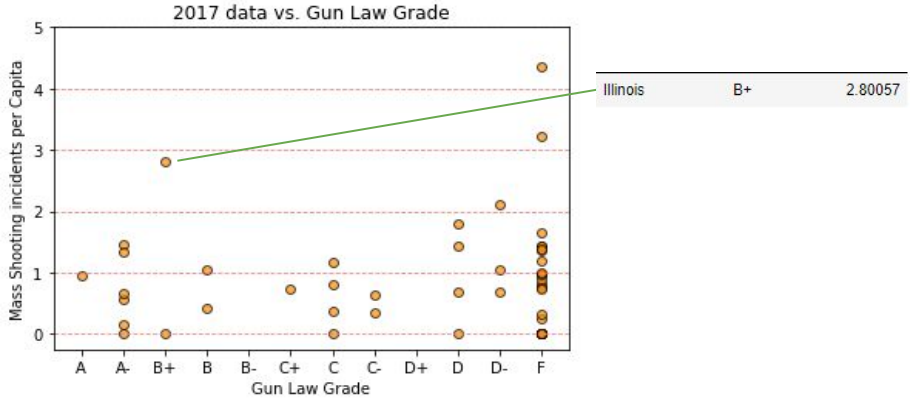


Gun Laws

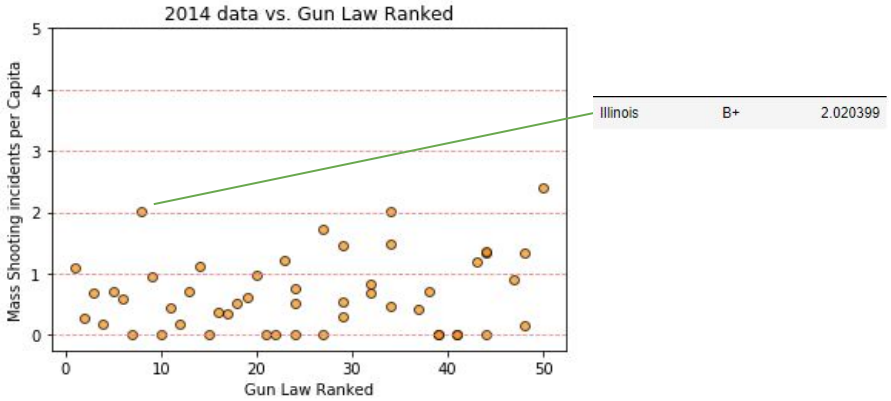


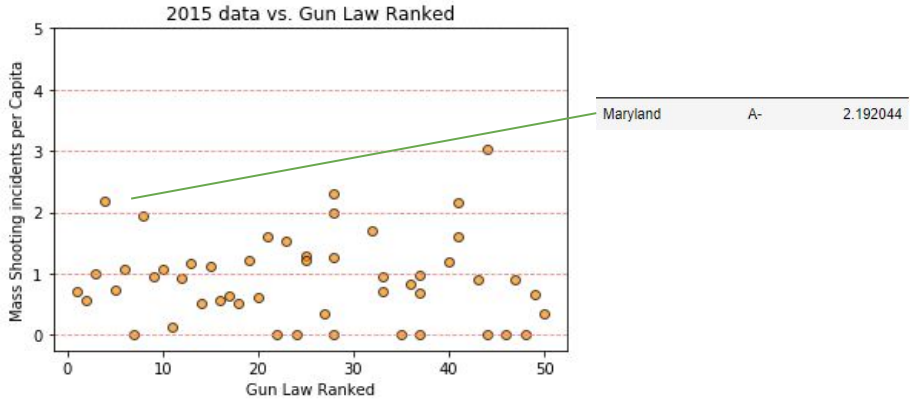


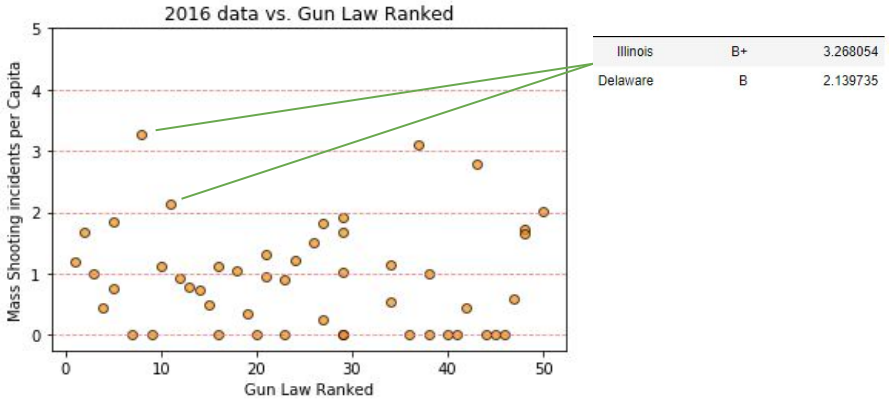


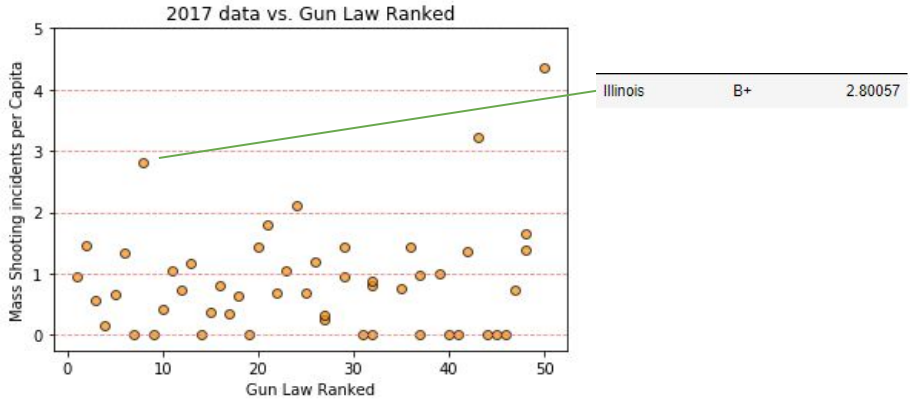


*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)





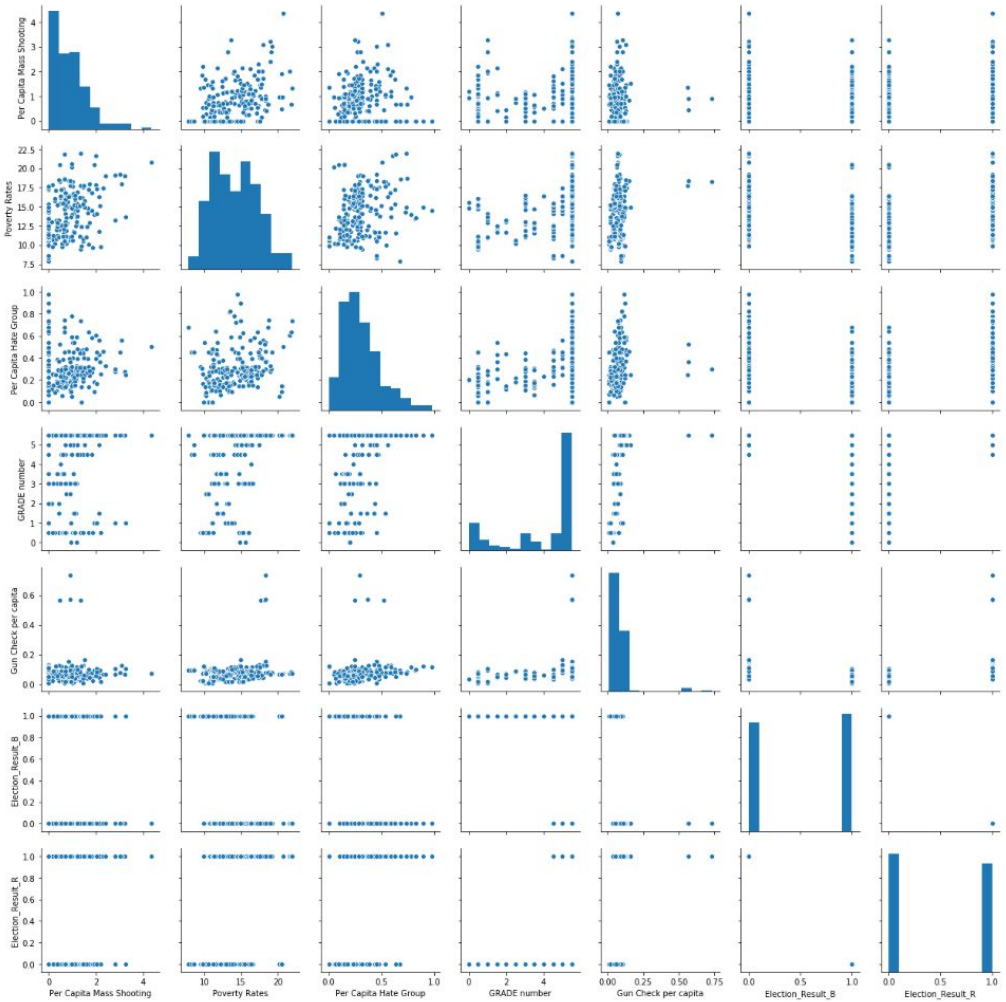




*Mass Shooting incidents of each State per 1,000,000 people (to avoid decimal in these charts)

Regressions

Regressions 1



OLS Regression Results

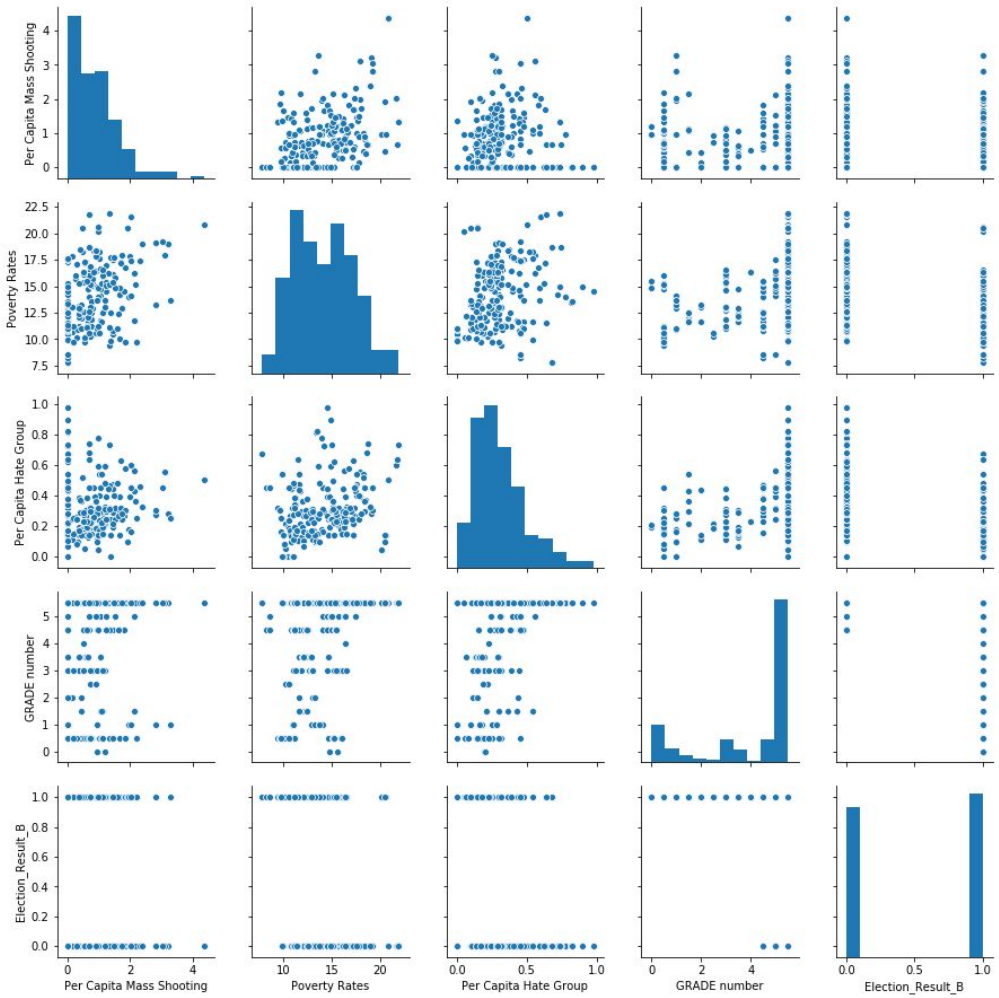
Dep. Variable:	Per Capita Mass Shooting	R-squared:	0.196
Model:	OLS	Adj. R-squared:	0.175
Method:	Least Squares	F-statistic:	9.438
Date:	Sun, 31 Mar 2019	Prob (F-statistic):	4.54e-08
Time:	14:19:12	Log-Likelihood:	-209.79
No. Observations:	200	AIC:	431.6
Df Residuals:	194	BIC:	451.4
Df Model:	5		
Covariance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

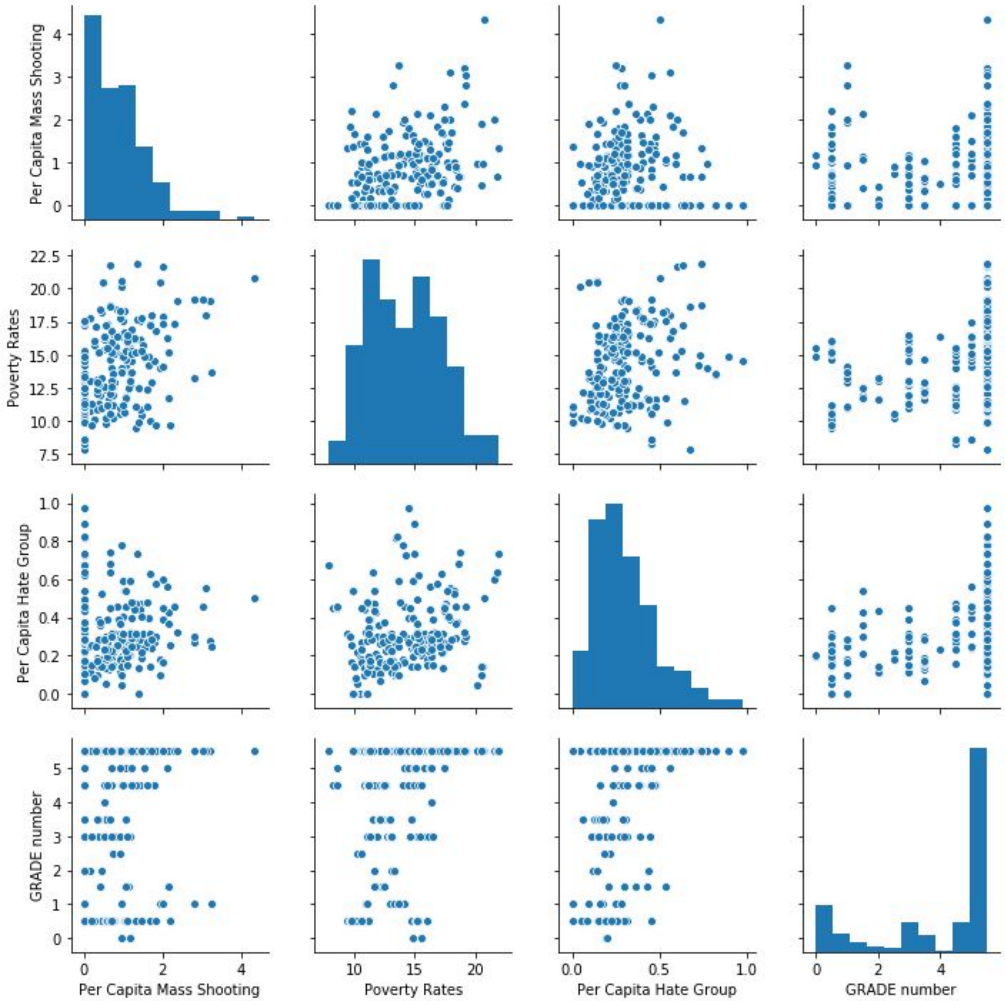
Dep. Variable:	Per Capita Mass Shooting	R-squared:	0.193
Model:	OLS	Adj. R-squared:	0.177
Method:	Least Squares	F-statistic:	11.70
Date:	Sat, 30 Mar 2019	Prob (F-statistic):	1.56e-08
Time:	17:05:54	Log-Likelihood:	-210.06
No. Observations:	200	AIC:	430.1
Df Residuals:	195	BIC:	446.6
Df Model:	4		
Covariance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



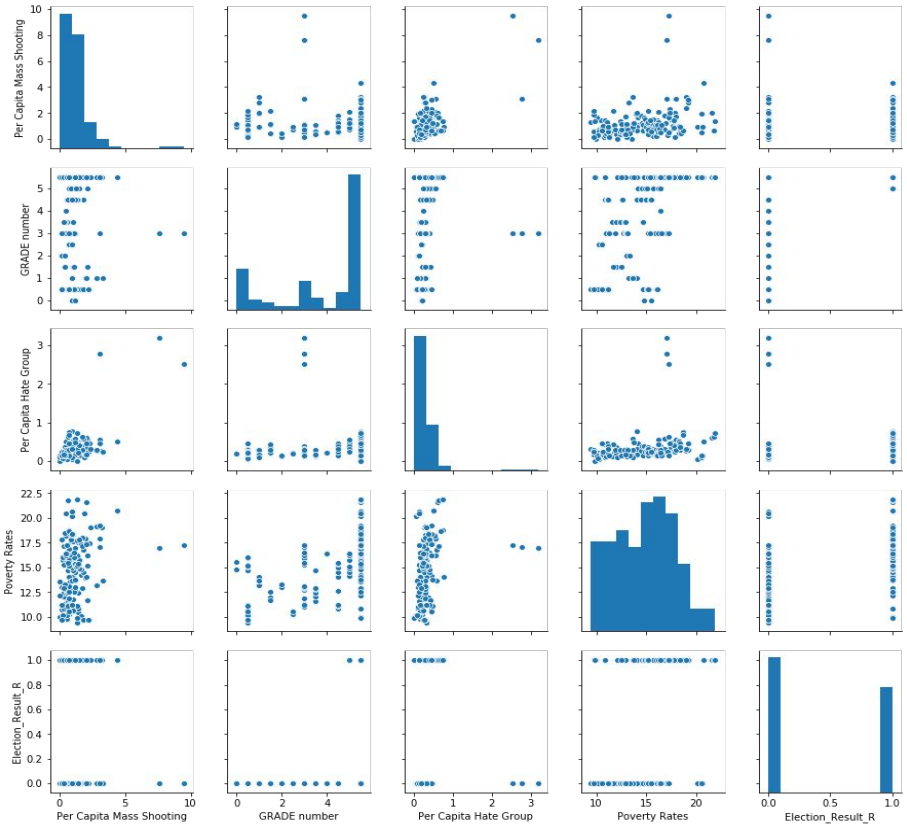
OLS Regression Results

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 - 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