Project: Investigate the FBI Gun Dataset

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Introduction

> **Key notes**: "The data comes from the FBI's National Instant Criminal Background Check System. The NICS is used by to determine whether a prospective buyer is eligible to buy firearms or explosives. Gun shops call into this system to ensure that each customer does not have a criminal record or isn't otherwise ineligible to make a purchase. The data has been supplemented with state level data from census.gov.
>
> The NICS data is found in one sheet of an .xlsx file. It contains the number of firearm checks by month, state, and type.
>
> The U.S. census data is found in a .csv file. It contains several variables at the state level. Most variables just have one data point per state (2016), but a few have data for more than one year."
>
> **Questions to explore**:
>
> - 1. The highest purchages record happened in which state for the persons under 18 years, percent on April 1, 2010?
> - 2. In which state did asian alone buy minmum number of guns in terms of percent (>0), July 1, 2016?
> - 3. What is the total annual payroll of all the states ($, 1000) in 2015?
> - 4. What is the average revenue of firms of all the states in 2012?
> - 5. What census data is most associated with high gun per capita?
> - 6. Which states have had the highest growth in gun registrations?
> - 7. What is the overall trend of gun purchases?
> - 8. How many guns were registered in total in January?
> - 9. How many guns were registered in total in September, 2003?
> - 10. What type of gun has highest quantity, and the relationship to totals?
> - 11. What is the sum of registered gun in each state over time?

In [32]:

```
# Set up import statements for all of the packages that are planed to use;
# Include a 'magic word' so that visualizations are plotted;
# call on dataframe to display the first 5 rows.

import pandas as pd
import numpy as np
import datetime
from statistics import mode
% matplotlib inline
import matplotlib.pyplot as plt
%config InlineBackend.figure_format = 'retina'
import seaborn as sns
sns.set_style('darkgrid')
df = pd.read_csv('U.S. Census Data.csv', sep =',')
```

Data Wrangling

> **Key notes**: In this section of the report, the following work will be done: load the data; check for cleanliness; trim and clean dataset for analysis.

General Properties

In [33]:

```
# Load data and print out a few lines

df.head()
```

Out[33]:

	Fact	Fact Note	Alabama	Alaska	Arizona	Arkansas	California	Colorado	Co
0	Population estimates, July 1, 2016, (V2016)	NaN	4,863,300	741,894	6,931,071	2,988,248	39,250,017	5,540,545	3,5
1	Population estimates base, April 1, 2010, (V2...	NaN	4,780,131	710,249	6,392,301	2,916,025	37,254,522	5,029,324	3,5
2	Population, percent change - April 1, 2010 (es...	NaN	1.70%	4.50%	8.40%	2.50%	5.40%	10.20%	0.1
3	Population, Census, April 1, 2010	NaN	4,779,736	710,231	6,392,017	2,915,918	37,253,956	5,029,196	3,5
4	Persons under 5 years, percent, July 1, 2016, ...	NaN	6.00%	7.30%	6.30%	6.40%	6.30%	6.10%	5.2

5 rows × 52 columns

In [34]:

```
# Reading an Excel file in python using pandas
# call on dataframe to display the first 5 rows

xl = pd.ExcelFile('gun_data.xlsx')

xl.sheet_names
[u'Sheet1']

df1 = xl.parse("Sheet1")
df1.head()
```

Out[34]:

	month	state	permit	permit_recheck	handgun	long_gun	other	multiple	adı
0	2017-09	Alabama	16717.0	0.0	5734.0	6320.0	221.0	317	0.0
1	2017-09	Alaska	209.0	2.0	2320.0	2930.0	219.0	160	0.0
2	2017-09	Arizona	5069.0	382.0	11063.0	7946.0	920.0	631	0.0
3	2017-09	Arkansas	2935.0	632.0	4347.0	6063.0	165.0	366	51.
4	2017-09	California	57839.0	0.0	37165.0	24581.0	2984.0	0	0.0

5 rows × 27 columns

In [35]:

```
# return a tuple of the dimensions of the dataframe.

df.shape, df1.shape
```

Out[35]:

```
((85, 52), (12485, 27))
```

In [36]:

```
# print the column labels in the dataframe.

for i, v in enumerate(df.columns):
    print(i, v)
```

0 Fact
1 Fact Note
2 Alabama
3 Alaska
4 Arizona
5 Arkansas
6 California
7 Colorado
8 Connecticut
9 Delaware
10 Florida
11 Georgia
12 Hawaii
13 Idaho
14 Illinois
15 Indiana
16 Iowa
17 Kansas
18 Kentucky
19 Louisiana
20 Maine
21 Maryland
22 Massachusetts
23 Michigan
24 Minnesota
25 Mississippi
26 Missouri
27 Montana
28 Nebraska
29 Nevada
30 New Hampshire
31 New Jersey
32 New Mexico
33 New York
34 North Carolina
35 North Dakota
36 Ohio
37 Oklahoma
38 Oregon
39 Pennsylvania
40 Rhode Island
41 South Carolina
42 South Dakota
43 Tennessee
44 Texas
45 Utah
46 Vermont
47 Virginia
48 Washington
49 West Virginia
50 Wisconsin
51 Wyoming

In [37]:

```
for i, v in enumerate(df1.columns):
    print(i, v)
```

```
0 month
1 state
2 permit
3 permit_recheck
4 handgun
5 long_gun
6 other
7 multiple
8 admin
9 prepawn_handgun
10 prepawn_long_gun
11 prepawn_other
12 redemption_handgun
13 redemption_long_gun
14 redemption_other
15 returned_handgun
16 returned_long_gun
17 returned_other
18 rentals_handgun
19 rentals_long_gun
20 private_sale_handgun
21 private_sale_long_gun
22 private_sale_other
23 return_to_seller_handgun
24 return_to_seller_long_gun
25 return_to_seller_other
26 totals
```

In [38]:

```
# return the datatypes of the columns.

df.dtypes
```

Out[38]:

```
Fact                  object
Fact Note             object
Alabama               object
Alaska                object
Arizona               object
Arkansas              object
California            object
Colorado              object
Connecticut           object
Delaware              object
Florida               object
Georgia               object
Hawaii                object
```

```
Idaho                object

Illinois             object
Indiana              object
Iowa                 object
Kansas               object
Kentucky             object
Louisiana            object
Maine                object
Maryland             object
Massachusetts        object
Michigan             object
Minnesota            object
Mississippi          object
Missouri             object
Montana              object
Nebraska             object
Nevada               object
New Hampshire        object
New Jersey           object
New Mexico           object
New York             object
North Carolina       object
North Dakota         object
Ohio                 object
Oklahoma             object
Oregon               object
Pennsylvania         object
Rhode Island         object
South Carolina       object
South Dakota         object
Tennessee            object
Texas                object
Utah                 object
Vermont              object
Virginia             object
Washington           object
West Virginia        object
Wisconsin            object
Wyoming              object
dtype: object
```

In [39]:

```
df1.dtypes
```

Out[39]:

```
month                           object
state                           object
permit                         float64
permit_recheck                 float64
handgun                        float64
long_gun                       float64
other                          float64
multiple                         int64
admin                          float64
prepawn_handgun                float64
prepawn_long_gun               float64
prepawn_other                  float64
redemption_handgun             float64
redemption_long_gun            float64
redemption_other               float64
returned_handgun               float64
returned_long_gun              float64
returned_other                 float64
rentals_handgun                float64
rentals_long_gun               float64
private_sale_handgun           float64
private_sale_long_gun          float64
private_sale_other             float64
return_to_seller_handgun       float64
return_to_seller_long_gun      float64
return_to_seller_other         float64
totals                           int64
dtype: object
```

In [40]:

```
# check for duplicates in the data.

sum(df.duplicated())
```

Out[40]:

```
3
```

In [41]:

```
# check for duplicates in the data.

sum(df1.duplicated())
```

Out[41]:

```
0
```

In [42]:

```
#  check if any value is NaN in DataFrame and in how many columns

df.isnull().any().any(), sum(df.isnull().any())
```

Out[42]:

```
(True, 52)
```

In [43]:

```
# check NaN exist in which column

df.isnull().any()
```

Out[43]:

```
Fact                 True
Fact Note            True
Alabama              True
Alaska               True
Arizona              True
Arkansas             True
California           True
Colorado             True
Connecticut          True
Delaware             True
Florida              True
Georgia              True
Hawaii               True
Idaho                True
Illinois             True
Indiana              True
Iowa                 True
Kansas               True
Kentucky             True
Louisiana            True
Maine                True
Maryland             True
Massachusetts        True
Michigan             True
Minnesota            True
Mississippi          True
Missouri             True
```

```
Montana           True

Nebraska          True
Nevada            True
New Hampshire     True
New Jersey        True
New Mexico        True
New York          True
North Carolina    True
North Dakota      True
Ohio              True
Oklahoma          True
Oregon            True
Pennsylvania      True
Rhode Island      True
South Carolina    True
South Dakota      True
Tennessee         True
Texas             True
Utah              True
Vermont           True
Virginia          True
Washington        True
West Virginia     True
Wisconsin         True
Wyoming           True
dtype: bool
```

In [44]:

```
df1.isnull().any().any(), sum(df1.isnull().any())
```

Out[44]:

```
(True, 23)
```

In [45]:

```
df1.isnull().any()
```

Out[45]:

```
month                         False
state                         False
permit                         True
permit_recheck                 True
handgun                        True
long_gun                       True
other                          True
multiple                      False
admin                          True
prepawn_handgun                True
prepawn_long_gun               True
prepawn_other                  True
redemption_handgun             True
redemption_long_gun            True
redemption_other               True
returned_handgun               True
returned_long_gun              True
returned_other                 True
rentals_handgun                True
rentals_long_gun               True
private_sale_handgun           True
private_sale_long_gun          True
private_sale_other             True
return_to_seller_handgun       True
return_to_seller_long_gun      True
return_to_seller_other         True
totals                        False
dtype: bool
```

In [46]:

```
# displays a concise summary of the dataframe;
# including the number of non-null values in each column.

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 85 entries, 0 to 84
Data columns (total 52 columns):
Fact                  80 non-null object
Fact Note             28 non-null object
Alabama               65 non-null object
Alaska                65 non-null object
Arizona               65 non-null object
Arkansas              65 non-null object
California            65 non-null object
Colorado              65 non-null object
```

```
Connecticut       65 non-null object
Delaware          65 non-null object
Florida           65 non-null object
Georgia           65 non-null object
Hawaii            65 non-null object
Idaho             65 non-null object
Illinois          65 non-null object
Indiana           65 non-null object
Iowa              65 non-null object
Kansas            65 non-null object
Kentucky          65 non-null object
Louisiana         65 non-null object
Maine             65 non-null object
Maryland          65 non-null object
Massachusetts     65 non-null object
Michigan          65 non-null object
Minnesota         65 non-null object
Mississippi       65 non-null object
Missouri          65 non-null object
Montana           65 non-null object
Nebraska          65 non-null object
Nevada            65 non-null object
New Hampshire     65 non-null object
New Jersey        65 non-null object
New Mexico        65 non-null object
New York          65 non-null object
North Carolina    65 non-null object
North Dakota      65 non-null object
Ohio              65 non-null object
Oklahoma          65 non-null object
Oregon            65 non-null object
Pennsylvania      65 non-null object
Rhode Island      65 non-null object
South Carolina    65 non-null object
South Dakota      65 non-null object
Tennessee         65 non-null object
Texas             65 non-null object
Utah              65 non-null object
Vermont           65 non-null object
Virginia          65 non-null object
Washington        65 non-null object
West Virginia     65 non-null object
Wisconsin         65 non-null object
Wyoming           65 non-null object
dtypes: object(52)
memory usage: 34.6+ KB
```

In [47]:

```
df1.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 12485 entries, 0 to 12484
Data columns (total 27 columns):
month                        12485 non-null object
state                        12485 non-null object
permit                       12461 non-null float64
permit_recheck               1100 non-null float64
handgun                      12465 non-null float64
long_gun                     12466 non-null float64
other                        5500 non-null float64
multiple                     12485 non-null int64
admin                        12462 non-null float64
prepawn_handgun              10542 non-null float64
prepawn_long_gun             10540 non-null float64
prepawn_other                5115 non-null float64
redemption_handgun           10545 non-null float64
redemption_long_gun          10544 non-null float64
redemption_other             5115 non-null float64
returned_handgun             2200 non-null float64
returned_long_gun            2145 non-null float64
returned_other               1815 non-null float64
rentals_handgun              990 non-null float64
rentals_long_gun             825 non-null float64
private_sale_handgun         2750 non-null float64
private_sale_long_gun        2750 non-null float64
private_sale_other           2750 non-null float64
return_to_seller_handgun     2475 non-null float64
return_to_seller_long_gun    2750 non-null float64
return_to_seller_other       2255 non-null float64
totals                       12485 non-null int64
dtypes: float64(23), int64(2), object(2)
memory usage: 2.6+ MB
```

In [48]:

```
# Generates descriptive statistics, excluding NaN values.

df.describe()
```

Out[48]:

	Fact	Fact Note	Alabama	Alaska	Arizona	Arkansas	California	Colorado	Connec
count	80	28	65	65	65	65	65	65	65
unique	80	15	65	64	64	64	63	64	63
top	1	(c)	16.10%	7.30%	50.30%	50.90%	6.80%	3.30%	5.70%
freq	1	6	1	2	2	2	2	2	2

4 rows × 52 columns

In [49]:

```
df1.describe()
```

Out[49]:

	permit	permit_recheck	handgun	long_gun	other
count	12461.000000	1100.000000	12465.000000	12466.000000	5500.000000
mean	6413.629404	1165.956364	5940.881107	7810.847585	360.471636
std	23752.338269	9224.200609	8618.584060	9309.846140	1349.478273
min	0.000000	0.000000	0.000000	0.000000	0.000000
25%	0.000000	0.000000	865.000000	2078.250000	17.000000
50%	518.000000	0.000000	3059.000000	5122.000000	121.000000
75%	4272.000000	0.000000	7280.000000	10380.750000	354.000000
max	522188.000000	116681.000000	107224.000000	108058.000000	77929.000000

8 rows × 25 columns

Data Cleaning

In [50]:

```
# drop duplicates
# Confirm changes

df.drop_duplicates(inplace=True)
sum(df.duplicated())
```

Out[50]:

```
0
```

In [51]:

```
df1.drop_duplicates(inplace=True)
sum(df.duplicated())
```

Out[51]:

```
0
```

In [52]:

```
# Change column name in df1 into lower case for the convenience of analysis
# Confirm changes

df.rename(columns = lambda x: x.lower(), inplace = True)
df.head()
```

Out[52]:

	fact	fact note	alabama	alaska	arizona	arkansas	california	colorado	cor
0	Population estimates, July 1, 2016, (V2016)	NaN	4,863,300	741,894	6,931,071	2,988,248	39,250,017	5,540,545	3,5
1	Population estimates base, April 1, 2010, (V2...	NaN	4,780,131	710,249	6,392,301	2,916,025	37,254,522	5,029,324	3,5
2	Population, percent change - April 1, 2010 (es...	NaN	1.70%	4.50%	8.40%	2.50%	5.40%	10.20%	0.1
3	Population, Census, April 1, 2010	NaN	4,779,736	710,231	6,392,017	2,915,918	37,253,956	5,029,196	3,5
4	Persons under 5 years, percent, July 1, 2016, ...	NaN	6.00%	7.30%	6.30%	6.40%	6.30%	6.10%	5.2

5 rows × 52 columns

In [53]:

```
# As the NaN values are of string type therefore thty can't treated by filling w
ith means
# since they don't affect the arithmetic calculation nor satistical analysis
# so it is better to replace those NaN values with a common string type value wh
ich doesn't indicate anything
# For the numerical type of NaN, as each row has specific meaning, thus we can't
fill them with mean

# As for df, numericial type of data was mispresented as string type, thus first
task is to convert them into float
# Skip the first 2 columns as they should be string type, so leave them unchange
d

col = df.iloc[:,2:].columns
for c in col:
    df[c] = df[c].str.extract('(\d+)').astype(float)

# comfirm changes
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 82 entries, 0 to 84
Data columns (total 52 columns):
fact                  80 non-null object
fact note             28 non-null object
alabama               65 non-null float64
alaska                64 non-null float64
arizona               65 non-null float64
arkansas              65 non-null float64
california            65 non-null float64
colorado              65 non-null float64
connecticut           65 non-null float64
delaware              65 non-null float64
florida               65 non-null float64
georgia               65 non-null float64
hawaii                64 non-null float64
idaho                 65 non-null float64
illinois              65 non-null float64
indiana               65 non-null float64
iowa                  65 non-null float64
kansas                65 non-null float64
kentucky              65 non-null float64
louisiana             65 non-null float64
maine                 64 non-null float64
maryland              65 non-null float64
massachusetts         65 non-null float64
michigan              64 non-null float64
minnesota             65 non-null float64
mississippi           65 non-null float64
missouri              65 non-null float64
montana               65 non-null float64
```

```
nebraska          65 non-null float64
nevada            65 non-null float64
new hampshire     65 non-null float64
new jersey        65 non-null float64
new mexico        65 non-null float64
new york          65 non-null float64
north carolina    65 non-null float64
north dakota      65 non-null float64
ohio              65 non-null float64
oklahoma          65 non-null float64
oregon            65 non-null float64
pennsylvania      65 non-null float64
rhode island      65 non-null float64
south carolina    65 non-null float64
south dakota      65 non-null float64
tennessee         65 non-null float64
texas             65 non-null float64
utah              65 non-null float64
vermont           64 non-null float64
virginia          65 non-null float64
washington        65 non-null float64
west virginia     64 non-null float64
wisconsin         65 non-null float64
wyoming           64 non-null float64
dtypes: float64(50), object(2)
memory usage: 34.0+ KB

/Users/shilinli/anaconda3/lib/python3.6/site-packages/ipykernel_laun
cher.py:11: FutureWarning: currently extract(expand=None) means expa
nd=False (return Index/Series/DataFrame) but in a future version of
pandas this will be changed to expand=True (return DataFrame)
  # This is added back by InteractiveShellApp.init_path()
```

In [54]:

```python
# Replace the all NaN in df with 'No Record'

df.fillna('No record', inplace = True)

# Confirm changes

df.isnull().any()
```

Out[54]:

```
fact              False
fact note         False
alabama           False
alaska            False
arizona           False
arkansas          False
california        False
colorado          False
connecticut       False
```

```
delaware          False

florida           False
georgia           False
hawaii            False
idaho             False
illinois          False
indiana           False
iowa              False
kansas            False
kentucky          False
louisiana         False
maine             False
maryland          False
massachusetts     False
michigan          False
minnesota         False
mississippi       False
missouri          False
montana           False
nebraska          False
nevada            False
new hampshire     False
new jersey        False
new mexico        False
new york          False
north carolina    False
north dakota      False
ohio              False
oklahoma          False
oregon            False
pennsylvania      False
rhode island      False
south carolina    False
south dakota      False
tennessee         False
texas             False
utah              False
vermont           False
virginia          False
washington        False
west virginia     False
wisconsin         False
wyoming           False
dtype: bool
```

In [55]:

```
col1 = df1.iloc[:,np.r_[2:7, 8:26]].columns
for c in col1:
    c_mean = df1[c].mean()
    df1[c].fillna(c_mean, inplace = True)

# Confirm changes

df1.isnull().any()
```

Out[55]:

```
month                        False
state                        False
permit                       False
permit_recheck               False
handgun                      False
long_gun                     False
other                        False
multiple                     False
admin                        False
prepawn_handgun              False
prepawn_long_gun             False
prepawn_other                False
redemption_handgun           False
redemption_long_gun          False
redemption_other             False
returned_handgun             False
returned_long_gun            False
returned_other               False
rentals_handgun              False
rentals_long_gun             False
private_sale_handgun         False
private_sale_long_gun        False
private_sale_other           False
return_to_seller_handgun     False
return_to_seller_long_gun    False
return_to_seller_other       False
totals                       False
dtype: bool
```

In [56]:

```
# Convert string into datatime format in df1

df1.month = pd.to_datetime(df1['month'], errors='coerce')

# Confirm changes

df1.head()
```

Out[56]:

	month	state	permit	permit_recheck	handgun	long_gun	other	multiple	adı
0	2017-09-01	Alabama	16717.0	0.0	5734.0	6320.0	221.0	317	0.0
1	2017-09-01	Alaska	209.0	2.0	2320.0	2930.0	219.0	160	0.0
2	2017-09-01	Arizona	5069.0	382.0	11063.0	7946.0	920.0	631	0.0
3	2017-09-01	Arkansas	2935.0	632.0	4347.0	6063.0	165.0	366	51.
4	2017-09-01	California	57839.0	0.0	37165.0	24581.0	2984.0	0	0.0

5 rows × 27 columns

Exploratory Data Analysis

Research Question 1: The highest purchages record happened in which state for the persons under 18 years, percent on April 1, 2010?

In [57]:

```
# Find out which state had such max value

df.iloc[7, 2:].idxmax(axis = 1)
```

Out[57]:

```
'utah'
```

In [58]:

```
# Print out the exact number

df.iloc[7, 2:].loc['utah']
```

Out[58]:

```
31.0
```

> Utah state had highest purchages record for persons under 18 years, percent on April 1, 2010, and the percent is 31.

Research Question 2: In which state did asian alone buy minmum number of guns in terms of percent (>0), July 1, 2016?

In [59]:

```
# select the target state

asi_jul_16 = df.iloc[15, 2:]

# select the state whose total annual payroll is above 0

for t in asi_jul_16.index:
    if asi_jul_16.loc[t] == 0:
        asi_jul_16.drop([t], inplace = True)

# Print out the index of which had the minimum value

asi_jul_16.idxmin()
```

Out[59]:

```
'alabama'
```

In [60]:

```
# Print out the exact number

asi_jul_16.loc['alabama']
```

Out[60]:

```
1.0
```

> In alabama state, asian alone bought the minimum number of gun in terms of percent, which is 1%.

Research Question 3: What is the total annual payroll of all the states ($, 1000) in 2015?

In [61]:

```
df.iloc[52, 2:].sum()
```

Out[61]:

```
1531393139.0
```

> The total annual payroll of att states in 2015 is 1531393139 ($, 1000).

Research Question 4: What is the average revenue of firms of all the states in 2012?

In [62]:

```
df.iloc[55, 2:].mean()
```

Out[62]:

```
133749.26000000001
```

> The average revenue of firms of all the states in 2012 is around 133749.26 dollor.

Research Question 5: What census data is most associated with high gun per capita?

In [63]:

```
# Synchronize both dataframe at 2010

state_df1 = df1.query('month == "2010-04-01"').state.str.lower().tolist()
state_df = df.iloc[3, 2:].index.tolist()
```

In [64]:

```
# Compare the element difference in column of 'state'

miss_state = []
def miss_states(state):
    for s in state:
        if s not in state_df:
            miss_state.append(s)
    return miss_state

miss_states(state_df1)
```

Out[64]:

```
['district of columbia',
 'guam',
 'mariana islands',
 'puerto rico',
 'virgin islands']
```

In [65]:

```
# Convert all vaules in column of'state' from df1 in lower case in order to matc
h
# the format in column of 'state' from df for later calculatation
# Confirm changes

df1['state'] = df1.state.str.lower()
```

In [66]:

```
# Use query to select common elements in columns of 'state' from both dataframe

gun_tot_2010 = df1.query('month == "2010-04-01" & state != @miss_state')
```

In [67]:

```
# Use assertation function to confirm 'state' columns' elements from both datafr
ame are idental

assert(gun_tot_2010.state.tolist() == df.iloc[3, 2:].index.tolist())
```

In [68]:

```
# Set index to be state in order to do arithmetic calculation

gun_tot_2010.set_index('state', inplace = True)
```

In [69]:

```
# Calcluate the high gun per capita

avg_2010 = gun_tot_2010.totals/df.iloc[3, 2:]
```

In [70]:

```
# Find out the index which points to the highest value

avg_2010.idxmax()
```

Out[70]:

```
'utah'
```

In [71]:

```
# Print out the value

avg_2010.loc['utah']
```

Out[71]:

```
54695.5
```

> The highest gun per capita was 54695.5, that occurred at utah in 2010.

In [72]:

```
# Same for 2016
# Synchronize both dataframe at 2016

state_df1_2016 = df1.query('month == "2016-07-01"').state.str.lower().tolist()
state_df_2016 = df.iloc[0, 2:].index.tolist()
```

In [73]:

```
# Compare the element difference in columns of 'state'

miss_state_2016 = []
def miss_states(state):
    for s in state:
        if s not in state_df_2016:
            miss_state_2016.append(s)
    return miss_state_2016

miss_states(state_df1_2016)
```

Out[73]:

```
['district of columbia',
 'guam',
 'mariana islands',
 'puerto rico',
 'virgin islands']
```

In [74]:

```
# Use query to select common elements in columns of 'state' from both dataframe

gun_tot_2016 = df1.query('month == "2016-07-01" & state != @miss_state')
```

In [75]:

```
# Use assertation function to confirm 'state' column's elements from both datafr
ame are idental

assert(gun_tot_2016.state.tolist() == df.iloc[0, 2:].index.tolist())
```

In [76]:

```
# Set index to be state in order to do arithmetic calculation

gun_tot_2016.set_index('state', inplace = True)
```

In [77]:

```
# Calcluate the high gun per capita

avg_2016 = gun_tot_2016.totals/df.iloc[0, 2:]
```

In [78]:

```
# Find out the index which points to the highest value

avg_2016.idxmax()
```

Out[78]:

```
'kentucky'
```

In [79]:

```
# Print out the value

avg_2010.loc['kentucky']
```

Out[79]:

```
52815.25
```

> The highest gun per capita was 52815.25, that occurred at 'kentucky' in 2016.

Research Question 6: Which states have had the highest growth in gun registrations?

In [80]:

```
# Groupby time, state and sum of totals

gun_alltime = df1.groupby(['month', 'state'])['totals'].sum()
```

In [81]:

```
# Find out the earliest and latest registration date

cur_date = df1['month'].max()
ear_date = df1['month'].min()
```

In [82]:

```
# The amount of registed guns from lastest substract the earliest

gun_grow_tot = gun_alltime.loc[cur_date] - gun_alltime.loc[ear_date]

# Find out the index of maximum value

gun_grow_tot.idxmax()
```

Out[82]:

```
'kentucky'
```

In [83]:

```
# Print out the exact numbers

gun_grow_tot.loc['kentucky']
```

Out[83]:

```
397866
```

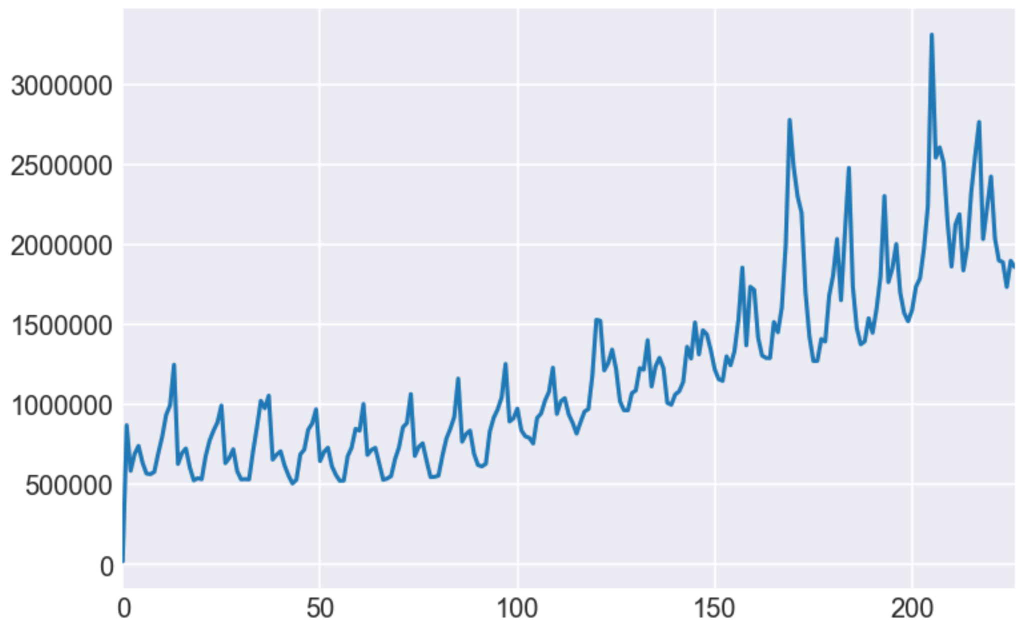
> 'kentucky' have had the highest growth in gun registrations over time, and the total registed number of guns is 397866 to date.

Research Question 7: What is the overall trend of gun purchases?

In [84]:

```
# Groupby time and sum of totals
# This function is intended to be used with data where observations are
# nested within sampling units that were measured at multiple timepoints

gun_trend = df1.groupby(['month'])['totals'].sum()

ax = sns.tsplot(data = gun_trend, err_style="unit_traces");
```

```
/Users/shilinli/anaconda3/lib/python3.6/site-packages/seaborn/timese
ries.py:183: UserWarning: The tsplot function is deprecated and will
be removed or replaced (in a substantially altered version) in a fut
ure release.
  warnings.warn(msg, UserWarning)
```



> The overall trend is increasing, the speed is becoming faster over time.

Research Question 8: How many guns were registered in total in January?

In [85]:

```
# Extract month from datetime column (month)
# Copy the dataframe and add a new column with this newly generated month

month_data = df1.month.dt.strftime("%B")

df_test = df1.copy()

df_test['registed_month']= month_data
```

In [86]:

```
# Find all the rows in January and February and sum the totals
# Use substration to find the answer

feb_gun = df_test.query('registed_month == "February"')
jan_gun = df_test.query('registed_month == "January"')
feb_gun.totals.sum() - jan_gun.totals.sum()
```

Out[86]:

```
1792105
```

> The total registered guns in January was 1792105 pieces.

Research Question 9: How many guns were registered in total in September, 2003?

In [87]:

```
# Census were recorded on every 1st day of each month
# Target the desired date
# Find out the number

tot_oct01_03 = df1.query('month == "2003-10-01"')
tot_sep01_03 = df1.query('month == "2003-09-01"')
tot_oct01_03.groupby(['month'])['totals'].sum().tolist()[0] - \
tot_sep01_03.groupby(['month'])['totals'].sum().tolist()[0]
```

Out[87]:

```
117064
```

> The total registed guns in September of 2003 were 117064 pieces.

Research Question 10: What type of gun has highest quantity, and the relationship to totals?

In [88]:

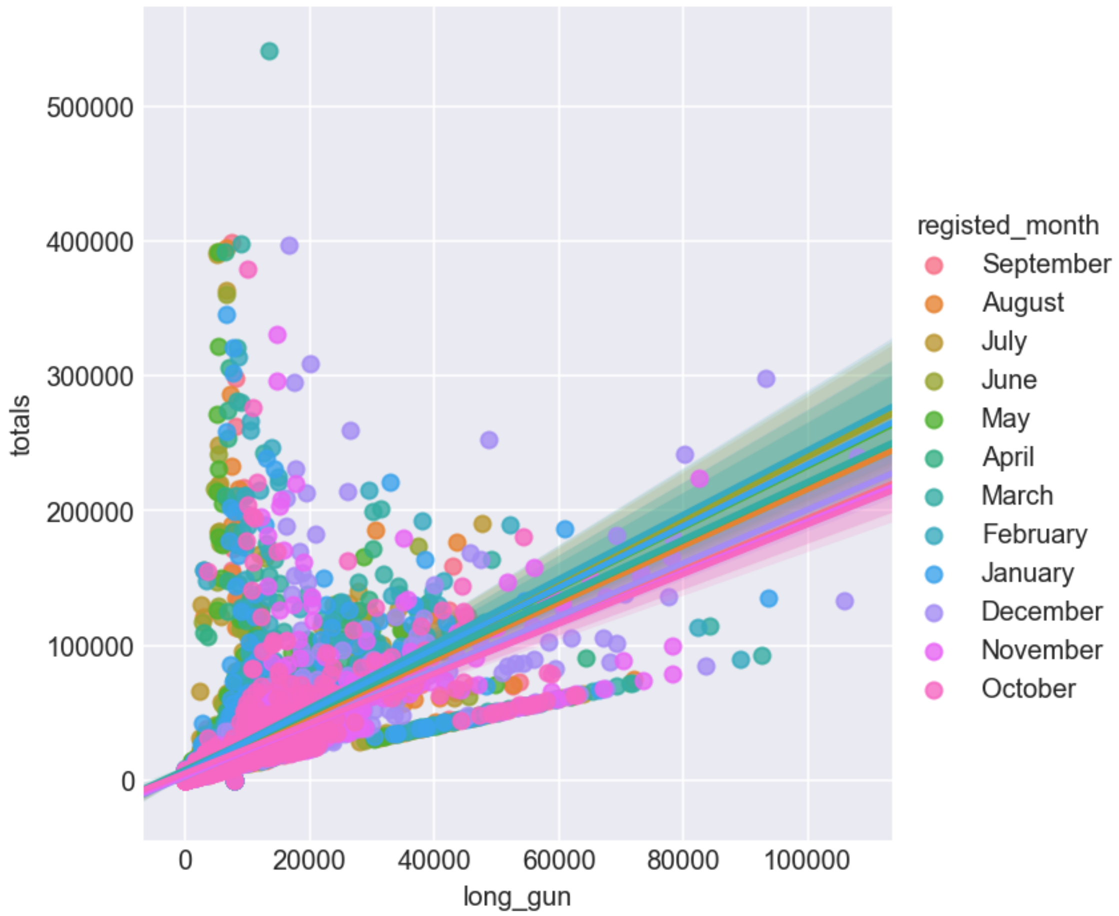
```
gun_type = {}
col_state = df1.columns[2:25]

for c in col_state:
    gun_type[c] = df1[c].sum()

max(gun_type, key=gun_type.get)
```

Out[88]:

```
'long_gun'
```

In [89]:

```
sns.lmplot(x = 'long_gun', y = 'totals', hue = 'registed_month', data = df_test)
;
```

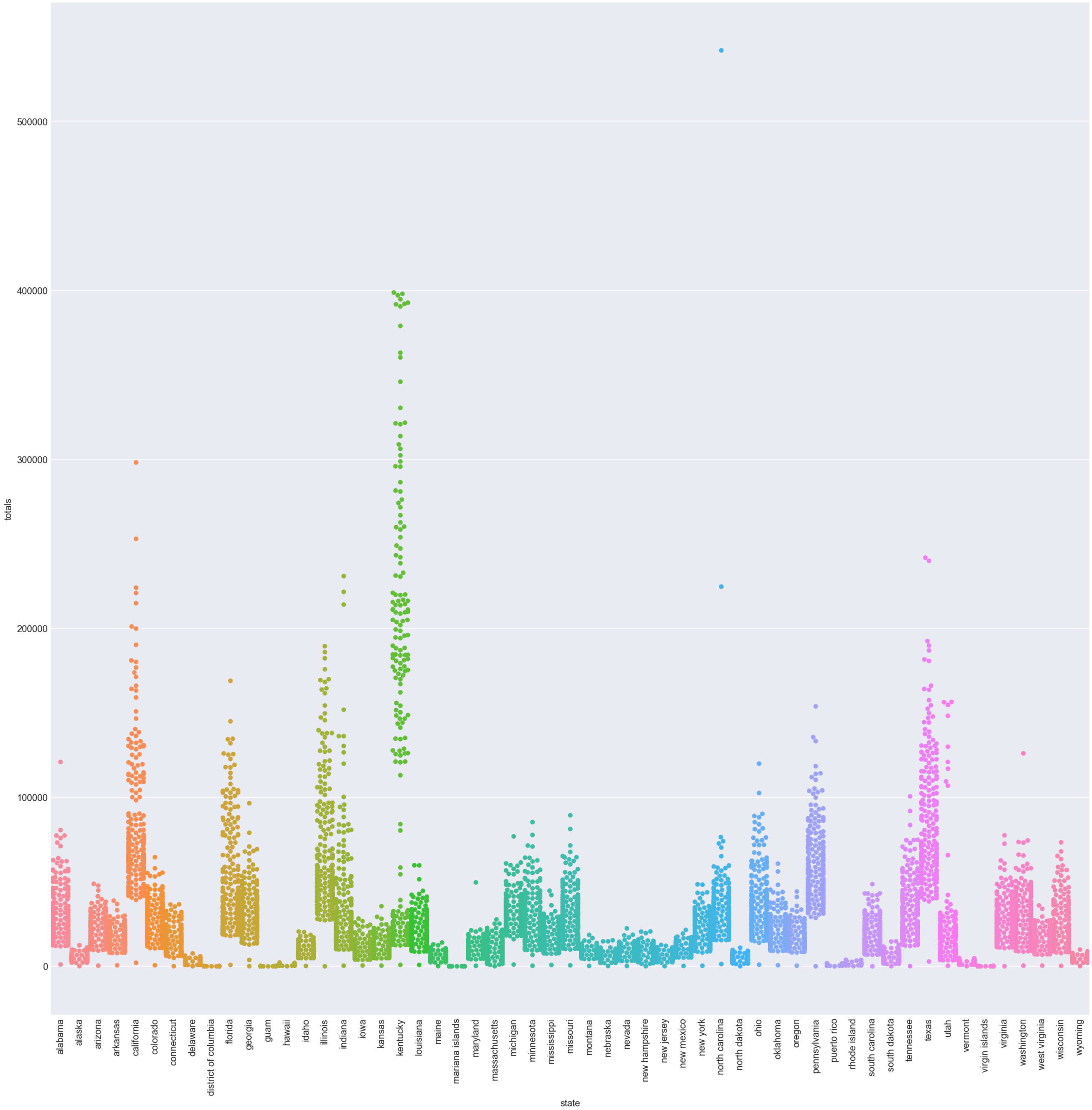


Long gun is highest registed type of gun in number among the others, it is positively correlated with totals. The estimated linear regression is shown as the blue line, the estimates varies in the light blue shade with 95% confident level.

Research Question 11: What is the sum of registered gun in each state over time?

In [90]:

```
plt.subplots(figsize=(20,20))
plt.xticks(rotation=90);
sns.swarmplot(x='state', y='totals', data=df1);
```



Conclusions

> In current study, a good amount of profound analysis has been carried out. Prior to each step, deailed instructions was given and interpretions was also provided afterwards. The dataset included 2 tables, but they have to be loaded by different measures. The data was ranging from 1998 to 2017, which consisted of detailed information of registered gun. Based on such substantial data, the analysis would be more reliable as opposed to small scale analysis.
>
> The limitations of current study were obvious as well, data was seperated into two tables which could affect the process of analysis. On the other hand, the population estimation were only recorded for 2010 and 2016, which limit some analysis to a small range, same for many other parameters, such as "Foreign born persons, percent", "Veterans, 2011-2015", etc.

In [92]:

```
from subprocess import call
call(['python', '-m', 'nbconvert', 'Investigate_FBI_Gun_Dataset.ipynb'])
```

Out[92]:

```
0
```