

Libraries

```
# libraries to read data

import numpy as np
import pandas as pd

import regex

# pip install pandas-profiling
# from https://github.com/ydataai/pandas-profiling.git

from pandas_profiling import ProfileReport

# libraries for making graphs

import seaborn as sns

import matplotlib.pyplot as plt
import matplotlib

# libraries for maps

import os
import json
import geopandas as gpd

# libraries for data analysis

import sklearn

Set directory
import os
os.getcwd()

'/Users/elika_sinha/Documents/UCL/11. Dissertation/Term3'

os.chdir("/Users/elika_sinha/Documents/UCL/11.
Dissertation/Term3/Datasets")
os.getcwd()

'/Users/elika_sinha/Documents/UCL/11. Dissertation/Term3/Datasets'
```

Exploratory Data Analysis or EDA

```
# CIA data called directly
CIA = pd.read_csv('/Users/elika_sinha/Documents/UCL/11.
```

```
Dissertation/Term3/Datasets/Final_cleanData/CIA.csv' )  
CIA.info()
```

```
<class 'pandas.core.frame.DataFrame'>  
RangeIndex: 850 entries, 0 to 849  
Columns: 106 entries, 0As to CIA_Composite  
dtypes: float64(105), object(1)  
memory usage: 704.0+ KB
```

```
CIA.sample(15)
```

	0As	Total households	Mean Income	Median Income	Mode
Income \					
276 E00023636		262.0	70977.061069	64191.121144	
110000.0					
396 E00023768		75.0	89600.000000	84661.764706	
110000.0					
221 E00023576		207.0	37787.922705	29904.171364	
17500.0					
289 E00023651		216.0	69256.898148	61849.250936	
110000.0					
811 E00175241		118.0	69002.542373	61718.213058	
110000.0					
282 E00023643		170.0	71411.176471	64581.881533	
110000.0					
524 E00023898		158.0	84475.949367	78500.000000	
110000.0					
373 E00023745		133.0	89351.127820	83830.508475	
110000.0					
816 E00175246		135.0	80466.666667	74561.101549	
110000.0					
570 E00023946		178.0	69498.314607	61858.304297	
110000.0					
3 E00002820		0.0	0.000000	0.000000	
0.0					
138 E00023490		341.0	61213.167155	52901.174168	
110000.0					
20 E00004609		0.0	0.000000	0.000000	
0.0					
211 E00023565		202.0	44265.841584	38043.331077	
22500.0					
32 E00014083		0.0	0.000000	0.000000	
0.0					

	Lower Quartile	LonAmALL	Damage_incident	Burglary_incident	\
276	41538.713911	51072.0	23.0	38.0	
396	55730.158730	432.0	8.0	27.0	
221	16953.924915	62628.0	0.0	0.0	
289	39529.360967	5840.0	16.0	16.0	
811	39318.541997	115776.0	58.0	42.0	
282	41797.352342	2624.0	16.0	12.0	

524	50482.233503	6370.0	15.0	20.0
373	54617.886179	2850.0	14.0	29.0
816	48566.978193	1040.0	0.0	0.0
570	39072.110286	278600.0	68.0	92.0
3	0.000000	0.0	0.0	0.0
138	32485.337243	576546.0	43.0	70.0
20	0.000000	40.0	0.0	0.0
211	22654.668166	57072.0	20.0	33.0
32	0.000000	0.0	0.0	0.0

RT303 \	Disorder_incident	...	PT999	RT061	RT199	RT442	RT226	RT234
276 0.0	123.0	...	0.0	0.0	0.0	0.0	0.0	0.0
396 0.0	106.0	...	0.0	0.0	0.0	0.0	0.0	0.0
221 0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0
289 0.0	79.0	...	0.0	0.0	0.0	0.0	0.0	0.0
811 0.0	349.0	...	0.0	0.0	0.0	0.0	0.0	0.0
282 0.0	80.0	...	0.0	0.0	0.0	0.0	0.0	0.0
524 0.0	40.0	...	0.0	0.0	0.0	0.0	0.0	0.0
373 0.0	59.0	...	0.0	0.0	0.0	0.0	0.0	0.0
816 0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0
570 0.0	236.0	...	0.0	0.0	0.0	0.0	0.0	0.0
3 0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0
138 0.0	298.0	...	0.0	0.0	0.0	0.0	0.0	28.0
20 0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0
211 0.0	145.0	...	0.0	0.0	0.0	0.0	0.0	0.0
32 0.0	0.0	...	0.0	0.0	0.0	0.0	0.0	0.0

SEV	Licensing_all	CIA_Composite
276 0.0	0.0	338778.896123
396 0.0	0.0	340884.923436
221 0.0	0.0	165081.018984
289 0.0	25.0	287135.510052
811 0.0	865.0	399199.297428
282 0.0	60.0	291284.410346

```
524 0.0          0.0 330324.182870
373 0.0          100.0 341440.522473
816 0.0          0.0 314867.746409
570 0.0          2318.0 565772.729190
3 0.0           0.0 4.000000
138 0.0          463.0 836404.678567
20 0.0           0.0 44.000000
211 0.0          270.0 186309.840827
32 0.0           0.0 4.000000

[15 rows x 106 columns]

CIA_EDA = ProfileReport(CIA)

CIA_EDA

{"version_major":2,"version_minor":0,"model_id":"d01234cb398f48c3aba3c8db675eeded"}

{"version_major":2,"version_minor":0,"model_id":"766272790dda497e918ad90917e9e732"}

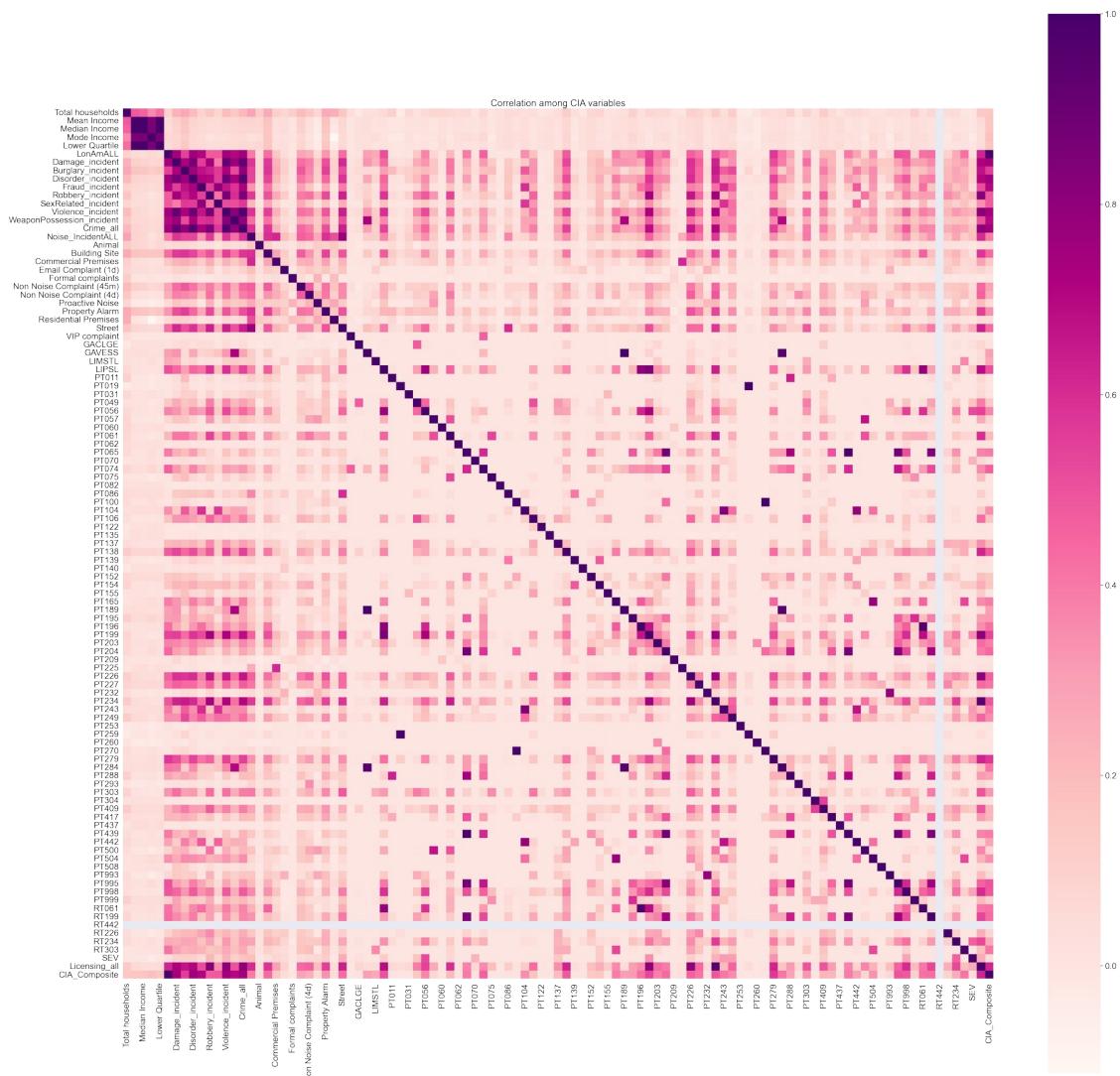
{"version_major":2,"version_minor":0,"model_id":"7e57f6f7af704c51aeee5a457e08a5cd"}

CIA_EDA.to_file(output_file=<CIA_EDA>.pdf")

CIA_corr = CIA.corr()

plt.figure(figsize=(50,50))
sns.set(font_scale=2)
sns.heatmap(CIA_corr, vmax=1, square=True, annot=False,
annot_kws={"size": 20}, cmap='RdPu')

plt.title('Correlation among CIA variables')
Text(0.5, 1.0, 'Correlation among CIA variables')
```



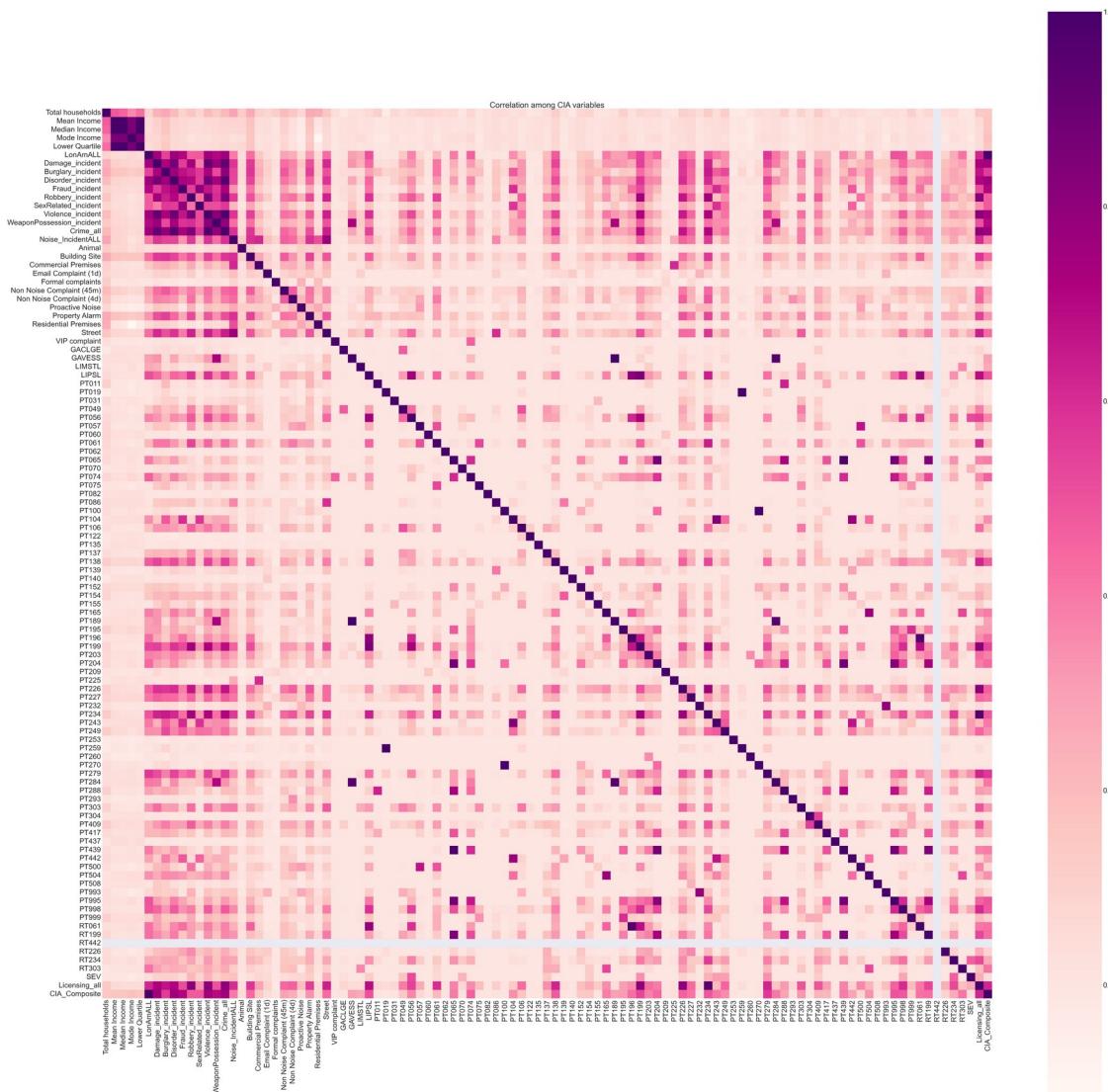
```

plt.figure(figsize=(150,150))
sns.set(font_scale=5)
sns.heatmap(CIA_corr, vmax=1, square=True, annot=False,
            annot_kws={"size": 20}, cmap='RdPu')

plt.title('Correlation among CIA variables')

Text(0.5, 1.0, 'Correlation among CIA variables')

```



```
from numpy import asarray
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
CIA_scaled = scaler.fit_transform(CIA.iloc[:, 1:106])
print(CIA_scaled)

[[0.0000000e+00 0.0000000e+00 0.0000000e+00 ... 0.0000000e+00
 0.0000000e+00 7.85806816e-05]
 [0.0000000e+00 0.0000000e+00 0.0000000e+00 ... 0.0000000e+00
 0.0000000e+00 0.0000000e+00]
 [0.0000000e+00 0.0000000e+00 0.0000000e+00 ... 0.0000000e+00
 0.0000000e+00 1.30967803e-06]
 ...
 [1.76470588e-01 3.35211147e-01 2.92899626e-01 ... 0.0000000e+00
 0.0000000e+00 1.12972024e-02]
 [1.94477791e-01 2.70430496e-01 2.16741769e-01 ... 0.0000000e+00]
```

```

0.00000000e+00 4.88447858e-02]
[1.60864346e-01 4.62999444e-01 4.12673016e-01 ... 0.00000000e+00
 0.00000000e+00 1.38169168e-02]]

CIA_scaled2 = pd.DataFrame(CIA_scaled, columns = CIA.iloc[:, 1:106].columns)
CIA_scaled2.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 850 entries, 0 to 849
Columns: 105 entries, Total households to CIA_Composite
dtypes: float64(105)
memory usage: 697.4 KB

CIA_scaled2.sample(10)

      Total households  Mean Income  Median Income  Mode Income \
787        0.318127    0.762946    0.732834  1.000000
369        0.247299    0.804685    0.780953  1.000000
846        0.141657    0.530159    0.478394  0.250000
432        0.176471    0.437778    0.396860  0.204545
838        0.153661    0.335341    0.276217  0.113636
425        0.175270    0.484976    0.439178  0.250000
552        0.429772    0.608443    0.551437  1.000000
495        0.226891    0.478883    0.438695  0.250000
475        0.084034    0.890295    0.880438  1.000000
100        0.325330    0.645275    0.597924  1.000000

      Lower Quartile  LonAmALL  Damage_incident  Burglary_incident \
787        0.688273  0.001056    0.006098   0.005545
369        0.721088  0.000993    0.048780   0.038817
846        0.409476  0.002055    0.009146   0.020333
432        0.353121  0.001467    0.000000   0.000000
838        0.234122  0.011269    0.000000   0.000000
425        0.381932  0.001506    0.051829   0.060998
552        0.485523  0.052546    0.060976   0.062847
495        0.384736  0.002006    0.045732   0.059150
475        0.824783  0.000127    0.000000   0.000000
100        0.547870  0.002636    0.027439   0.049908

      Disorder_incident  Fraud_incident  ...  PT999  RT061  RT199
RT442 \
787        0.000000    0.000000  ...  0.0    0.0    0.0
0.0
369        0.004864    0.004484  ...  0.0    0.0    0.0
0.0
846        0.001459    0.004484  ...  0.0    0.0    0.0
0.0
432        0.007296    0.013453  ...  0.0    0.0    0.0
0.0
838        0.000000    0.000000  ...  0.0    0.0    0.0

```

```
0.0
425      0.008268      0.000000 ... 0.0 0.0 0.0
0.0
552      0.079280      0.000000 ... 0.0 0.0 0.0
0.0
495      0.101654      0.013453 ... 0.0 0.0 0.0
0.0
475      0.000000      0.000000 ... 0.0 0.0 0.0
0.0
100      0.012160      0.000000 ... 0.0 0.0 0.0
0.0
```

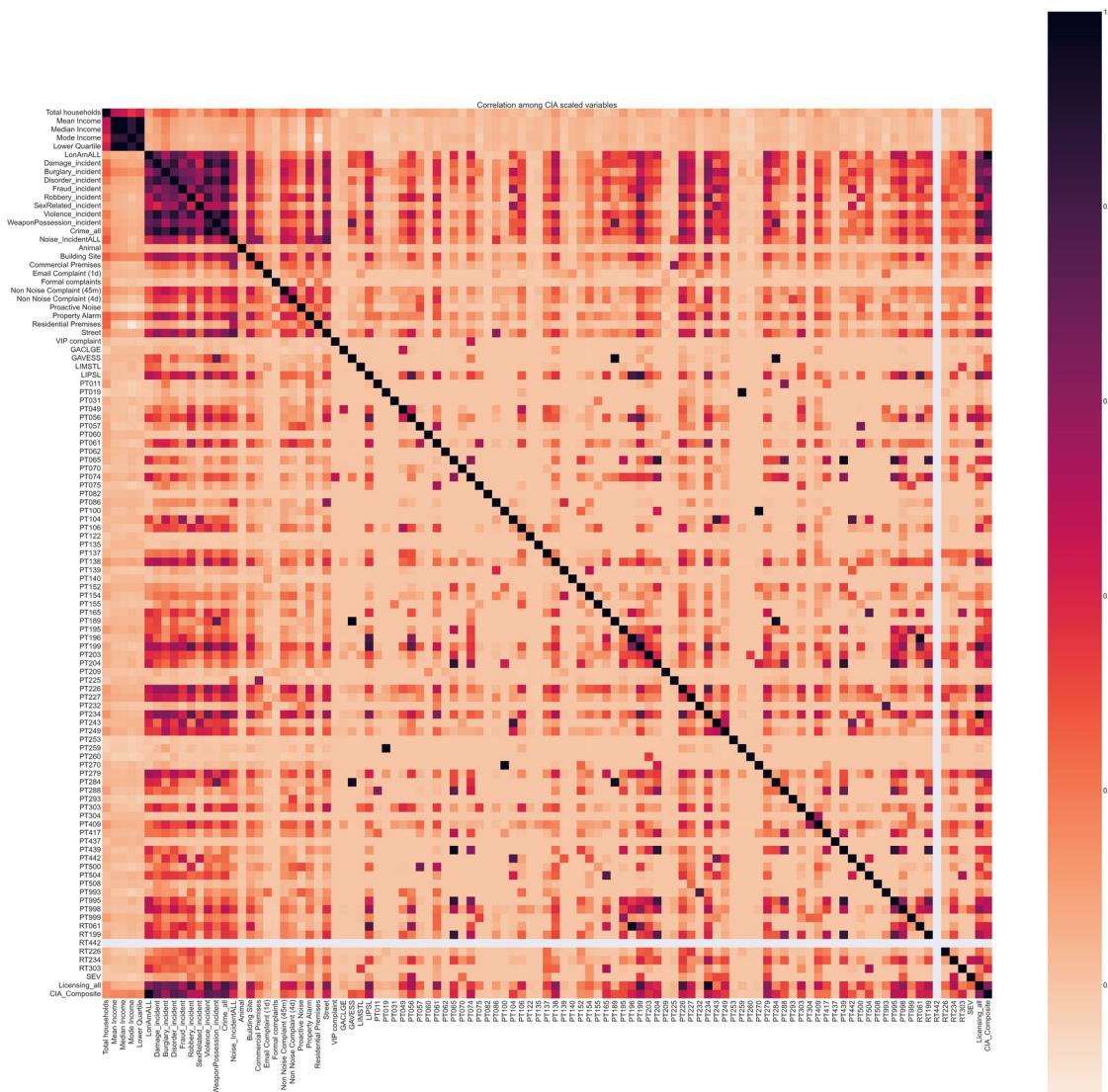
	RT226	RT234	RT303	SEV	Licensing_all	CIA_Composite
787	0.0	0.0	0.0	0.0	0.002439	0.028889
369	0.0	0.0	0.0	0.0	0.000000	0.029841
846	0.0	0.0	0.0	0.0	0.000000	0.016090
432	0.0	0.0	0.0	0.0	0.000000	0.013173
838	0.0	0.0	0.0	0.0	0.000000	0.019021
425	0.0	0.0	0.0	0.0	0.000000	0.014670
552	0.0	0.0	0.0	0.0	0.029680	0.074797
495	0.0	0.0	0.0	0.0	0.000000	0.015144
475	0.0	0.0	0.0	0.0	0.000000	0.031234
100	0.0	0.0	0.0	0.0	0.011791	0.027392

[10 rows x 105 columns]

```
CIA_scaled_corr = CIA_scaled2.corr()

plt.figure(figsize=(150,150))
sns.set(font_scale=5)
sns.heatmap(CIA_scaled_corr, vmax=1, square=True, annot=False,
annot_kws={"size": 20}, cmap='rocket_r')

plt.title('Correlation among CIA scaled variables')
Text(0.5, 1.0, 'Correlation among CIA scaled variables')
```



```
extracted_col = CIA["OAs"]
```

```
CIA_Scaled = pd.concat([CIA_scaled2, extracted_col], axis = 1, join = 'outer', ignore_index=False, sort=False)
```

```
print(CIA_Scaled)
```

	Total households	Mean Income	Median Income	Mode Income	\
0	0.000000	0.000000	0.000000	0.000000	
1	0.000000	0.000000	0.000000	0.000000	
2	0.000000	0.000000	0.000000	0.000000	
3	0.000000	0.000000	0.000000	0.000000	
4	0.000000	0.000000	0.000000	0.000000	
..
845	0.188475	0.369958	0.330243	0.159091	
846	0.141657	0.530159	0.478394	0.250000	
847	0.176471	0.335211	0.292900	0.159091	
848	0.194478	0.270430	0.216742	0.113636	

849		0.160864	0.462999	0.412673	0.159091		
0	Lower	Quartile	LonAmALL	Damage_incident	Burglary_incident	\	
0	0.000000	0.000000		0.000000		0.000000	
1	0.000000	0.000000		0.000000		0.000000	
2	0.000000	0.000000		0.000000		0.000000	
3	0.000000	0.000000		0.000000		0.000000	
4	0.000000	0.000000		0.009146		0.007394	
	
845		0.291087	0.019493	0.039634		0.011091	
846		0.409476	0.002055	0.009146		0.020333	
847		0.255074	0.002416	0.112805		0.066543	
848		0.192809	0.043369	0.057927		0.014787	
849		0.343364	0.002314	0.000000		0.000000	
	Disorder_incident	Fraud_incident	...	RT061	RT199	RT442	
RT226	\						
0		0.000000	0.000000	...	0.0	0.0	0.0
0.0		0.000000	0.000000	...	0.0	0.0	0.0
1		0.000000	0.000000	...	0.0	0.0	0.0
0.0		0.000000	0.000000	...	0.0	0.0	0.0
2		0.000000	0.000000	...	0.0	0.0	0.0
0.0		0.000000	0.000000	...	0.0	0.0	0.0
3		0.000000	0.000000	...	0.0	0.0	0.0
0.0		0.022374	0.000000	...	0.0	0.0	0.0
4		0.022374	0.000000	...	0.0	0.0	0.0
0.0	

845		0.134241	0.000000	...	0.0	0.0	0.0
0.0		0.001459	0.004484	...	0.0	0.0	0.0
846		0.001459	0.004484	...	0.0	0.0	0.0
0.0		0.155156	0.000000	...	0.0	0.0	0.0
847		0.155156	0.000000	...	0.0	0.0	0.0
0.0		0.031615	0.004484	...	0.0	0.0	0.0
848		0.031615	0.004484	...	0.0	0.0	0.0
0.0		0.000000	0.000000	...	0.0	0.0	0.0
849		0.000000	0.000000	...	0.0	0.0	0.0
0.0		0.000000	0.000000	...	0.0	0.0	0.0
	RT234	RT303	SEV	Licensing_all	CIA_Composite	0As	
0	0.0	0.0	0.0	0.000000	7.858068e-05	0	
1	0.0	0.0	0.0	0.000000	0.000000e+00	E00002661	
2	0.0	0.0	0.0	0.000000	1.309678e-06	E00002663	
3	0.0	0.0	0.0	0.000000	1.870969e-07	E00002820	
4	0.0	0.0	0.0	0.000000	1.197420e-05	E00004172	
	
845	0.0	0.0	0.0	0.019109	2.870944e-02	E00175275	
846	0.0	0.0	0.0	0.000000	1.609025e-02	E00175276	
847	0.0	0.0	0.0	0.000000	1.129720e-02	E00175277	

848	0.0	0.0	0.0	0.000000	4.884479e-02	E00175278
849	0.0	0.0	0.0	0.000000	1.381692e-02	E00175279

[850 rows x 106 columns]

CIA_Scaled.sample(10)

	Total	households	Mean	Income	Median	Income	Mode	Income	\
1	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	
485	0.182473	0.419094	0.374485	0.159091					
232	0.222089	0.549393	0.506036	0.250000					
75	0.261705	0.910219	0.903687	1.000000					
79	0.182473	0.656863	0.604874	1.000000					
262	0.168067	0.820948	0.801228	1.000000					
558	0.171669	0.600024	0.529199	1.000000					
91	0.172869	0.849958	0.829140	1.000000					
844	0.120048	0.415074	0.377209	0.159091					
249	0.169268	0.509093	0.464421	0.250000					
	Lower	Quartile	LonAmALL	Damage_incident	Burglary_incident				\
1	0.000000	0.000000		0.000000		0.000000			
485	0.322816	0.002463		0.021341		0.025878			
232	0.452221	0.002793		0.012195		0.018484			
75	0.859437	0.000280		0.039634		0.051756			
79	0.553640	0.000106		0.000000		0.000000			
262	0.725517	0.000553		0.021341		0.031423			
558	0.412066	0.084218		0.067073		0.136784			
91	0.767386	0.000579		0.003049		0.012939			
844	0.332803	0.002541		0.000000		0.000000			
249	0.401854	0.000599		0.012195		0.020333			
	Disorder_incident	Fraud_incident	...	RT061	RT199	RT442			
RT226	\								
1	0.000000	0.000000	...	0.0	0.0	0.0			
0.0									
485	0.003405	0.000000	...	0.0	0.0	0.0			
0.0									
232	0.005837	0.000000	...	0.0	0.0	0.0			
0.0									
75	0.035019	0.000000	...	0.0	0.0	0.0			
0.0									
79	0.000000	0.000000	...	0.0	0.0	0.0			
0.0									
262	0.028696	0.000000	...	0.0	0.0	0.0			
0.0									
558	0.072957	0.013453	...	0.0	0.0	0.0			
0.0									
91	0.006809	0.000000	...	0.0	0.0	0.0			
0.0									
844	0.000000	0.000000	...	0.0	0.0	0.0			

```

0.0
249          0.016537          0.000000 ...      0.0      0.0      0.0
0.0

    RT234  RT303  SEV  Licensing_all  CIA_Composite  OAs
1      0.0      0.0      0.0      0.000000      0.000000  E00002661
485     0.0      0.0      0.0      0.000000      0.013166  E00023858
232     0.0      0.0      0.0      0.000000      0.017514  E00023590
75      0.0      0.0      0.0      0.000000      0.032036  E00023426
79      0.0      0.0      0.0      0.000000      0.025048  E00023430
262     0.0      0.0      0.0      0.000000      0.029761  E00023622
558     1.0      0.0      0.0      0.494389      0.105912  E00023933
91      0.0      0.0      0.0      0.017483      0.030577  E00023442
844     0.0      0.0      0.0      0.000000      0.013218  E00175274
249     0.0      0.0      0.0      0.000000      0.014337  E00023609

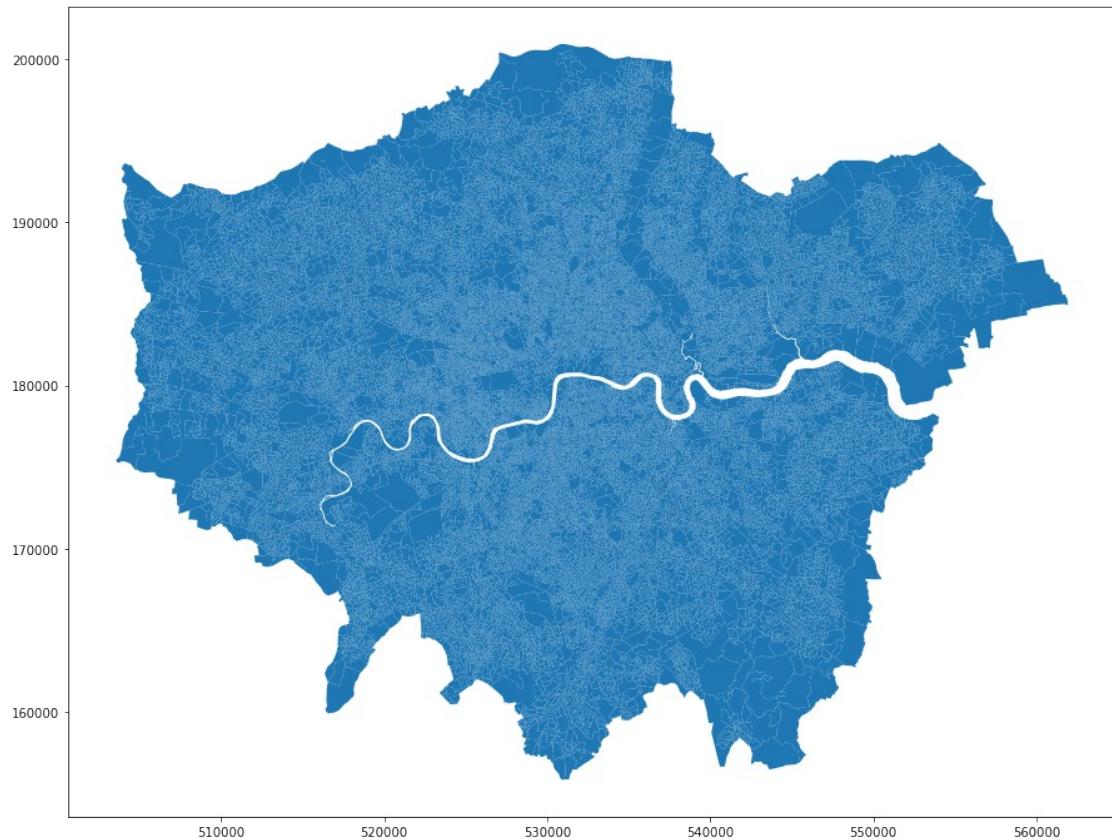
```

[10 rows x 106 columns]

```
sns.set(font_scale=1)
```

```
OAs =
gpd.read_file('https://github.com/Elika-Sinha/WCC_Temp/blob/main/OAs.zip?raw=true')
OAs.plot(figsize=(15,15))
```

<AxesSubplot:>



OAs.sample(5)

	OA11CD	LSOA11CD	MSOA11CD	WD11CD_BF	WD11NM_BF
LAD11CD \					
186 E00016163	E01003206	E02000659	E05000438	Blackheath	
E09000023					
16045 E00005480	E01001095	E02000224	E05000159	Purley	
E09000008					
16806 E00006414	E01001289	E02000259	E05000180	Hobayne	
E09000009					
8688 E00023761	E01004703	E02000966	E05000639	Little Venice	
E09000033					
17699 E00016457	E01003255	E02000673	E05000444	Forest Hill	
E09000023					

	LAD11NM	RGN11CD	RGN11NM	LSOA11NM
MSOA11NM \				
186 007	Lewisham	E12000007	London	Lewisham 007E
16045 031	Croydon	E12000007	London	Croydon 031D
16806 022	Ealing	E12000007	London	Ealing 022C
8688 007	Westminster	E12000007	London	Westminster 007B
				Westminster

```
17699      Lewisham E12000007 London      Lewisham 021B      Lewisham
021
```

	USUALRES	HHOLDRES	COMESTRES	POPDEN	HHOLDS	AVHHOLDSZ	\
186	332	332	0	113.3	129	2.6	
16045	267	267	0	56.4	99	2.7	
16806	265	265	0	82.3	100	2.7	
8688	366	366	0	288.2	147	2.5	
17699	262	262	0	112.9	135	1.9	

geometry

186	POLYGON ((538486.589 175985.428, 538462.368 17...
16045	POLYGON ((532262.820 162658.351, 532360.441 16...
16806	POLYGON ((515675.691 181163.938, 515838.910 18...
8688	POLYGON ((526506.131 181958.567, 526569.301 18...
17699	POLYGON ((535241.448 173059.095, 535271.000 17...

```
OAs_WCC = OAs[OAs["LAD11NM"] == 'Westminster']
```

```
OAs_WCC = OAs_WCC.drop(columns=["LSOA11CD", "MSOA11CD", "WD11CD_BF",
"WD11NM_BF", "LAD11CD", "LAD11NM", "RGN11CD", "RGN11NM", "LSOA11NM",
"MSOA11NM", "COMESTRES"])
```

```
OAs_WCC.sample(5)
```

	OA11CD	USUALRES	HHOLDRES	POPDEN	HHOLDS	AVHHOLDSZ	\
9141	E00023636	352	352	141.4	177	2.0	
10440	E00023614	294	294	164.2	135	2.2	
7752	E00023476	418	418	149.3	219	1.9	
6628	E00175204	121	121	111.0	70	1.7	
23109	E00023877	579	570	138.2	218	2.6	

geometry

9141	POLYGON ((526695.000 180998.000, 526713.000 18...
10440	POLYGON ((525304.051 182004.203, 525136.842 18...
7752	POLYGON ((525342.645 181096.551, 525339.124 18...
6628	POLYGON ((527125.000 179501.000, 527143.000 17...
23109	POLYGON ((523851.086 182668.640, 523851.677 18...

```
OAs_WCC.plot(edgecolor='black', facecolor='None', figsize=(15,15))
```

```
<AxesSubplot:>
```



```
0As_WCC = 0As_WCC.rename(columns={"OA11CD": "0As"})
```

```
0As_WCC.sample(5)
```

	0As	USUALRES	HHOLDRES	POPDEN	HHOLDS	AVHHOLDSZ	\
7694	E00023599	206	206	282.2	106	1.9	
20480	E00023540	348	348	221.7	152	2.3	
16320	E00023550	295	295	207.7	130	2.3	
1484	E00023796	270	270	135.7	114	2.4	
5657	E00024081	293	293	293.0	141	2.1	

	geometry
7694	POLYGON ((525298.000 182361.000, 525214.251 18...
20480	POLYGON ((529140.755 178173.532, 529272.566 17...
16320	POLYGON ((528986.000 178009.999, 529021.000 17...
1484	POLYGON ((525826.249 182907.399, 525894.808 18...
5657	POLYGON ((524988.905 181601.946, 525021.788 18...

```
CIA_Explore = pd.merge(0As_WCC, CIA, on=["0As"])
```

```
CIA_Explore.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 783 entries, 0 to 782
```

```

Columns: 112 entries, 0As to CIA_Composite
dtypes: float64(107), geometry(1), int64(3), object(1)
memory usage: 691.2+ KB

CIA_Explore.to_csv('CIA_Explore.csv', encoding='utf-8', index=False)

CIA_Explore_Scaled = pd.merge(0As_WCC, CIA_Scaled, on=["0As"])

CIA_Explore.sample(5)

```

	0As	USUALRES	HHOLDRES	POPDEN	HHOLDS	AVHHOLDSZ	\
229	E00024089	408	405	287.3	207		2.0
128	E00023928	311	311	91.5	183		1.7
634	E00023540	348	348	221.7	152		2.3
351	E00023897	230	230	353.8	122		1.9
280	E00024073	326	279	156.0	132		2.1

	geometry	Total
households \		
229	POLYGON ((525457.802 182158.690, 525446.571 18...	
224.0		
128	POLYGON ((530024.699 180965.358, 530084.014 18...	
155.0		
634	POLYGON ((529140.755 178173.532, 529272.566 17...	
175.0		
351	POLYGON ((526632.541 182626.826, 526634.008 18...	
138.0		
280	POLYGON ((525402.949 181687.394, 525405.191 18...	
159.0		

	Mean Income	Median Income	...	PT999	RT061	RT199	RT442
RT226 \							
229	52925.892857	45878.378378	...	0.0	0.0	0.0	0.0
0.0							
128	56666.451613	49877.551020	...	0.0	0.0	0.0	0.0
0.0							
634	44876.000000	37355.975924	...	0.0	0.0	0.0	0.0
0.0							
351	55257.971014	48213.872832	...	0.0	0.0	0.0	0.0
0.0							
280	29954.088050	24809.895833	...	0.0	0.0	0.0	0.0
0.0							

	RT234	RT303	SEV	Licensing_all	CIA_Composite
229	0.0	0.0	0.0	35.0	1.700430e+05
128	310.0	0.0	350.0	7977.0	1.130339e+06
634	0.0	0.0	0.0	0.0	1.796994e+05
351	0.0	0.0	0.0	0.0	1.804234e+05
280	0.0	0.0	0.0	120.0	4.724963e+05

[5 rows x 112 columns]

```
CIA_Explore.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 783 entries, 0 to 782
Columns: 112 entries, OAs to CIA_Composite
dtypes: float64(107), geometry(1), int64(3), object(1)
memory usage: 691.2+ KB
```

```
CIA_Explore_Scaled.sample(5)
```

```
    OAs  USUALRES  HHOLDRES  POPDEN  HHOLDS  AVHHOLDSZ \
309  E00023832      213      213   173.2     127      1.7
671  E00023981      198      198   155.9     112      1.8
669  E00023901      232      232   610.5     109      2.1
85   E00023521      290      290   367.1     148      2.0
689  E00175256      165      165   550.0      66      2.5
```

```
                    geometry  Total
households \
309  POLYGON ((528379.728 181826.245, 528422.000 18...
0.200480
671  POLYGON ((529549.880 178082.563, 529580.793 17...
0.134454
669  POLYGON ((526594.950 182592.595, 526613.761 18...
0.158463
85   POLYGON ((527845.785 181948.384, 527774.000 18...
0.264106
689  POLYGON ((529825.796 178561.227, 529821.810 17...
0.099640
```

```
    Mean Income  Median Income ... PT999  RT061  RT199  RT442
RT226 \
309      0.669560      0.620164 ...  0.0    0.0    0.0    0.0
0.0
671      0.688510      0.646386 ...  0.0    0.0    0.0    0.0
0.0
669      0.433397      0.390901 ...  0.0    0.0    0.0    0.0
0.0
85       0.710976      0.673882 ...  0.0    0.0    0.0    0.0
0.0
689      0.489230      0.421058 ...  0.0    0.0    0.0    0.0
0.0
```

```
    RT234  RT303  SEV  Licensing_all  CIA_Composite
309      0.0    0.0    0.0      0.048788      0.026141
671      0.0    0.0    0.0      0.000000      0.026190
669      0.0    0.0    0.0      0.003253      0.011541
85       0.0    0.0    0.0      0.002846      0.028260
689      0.0    0.0    0.0      0.000000      0.013734
```

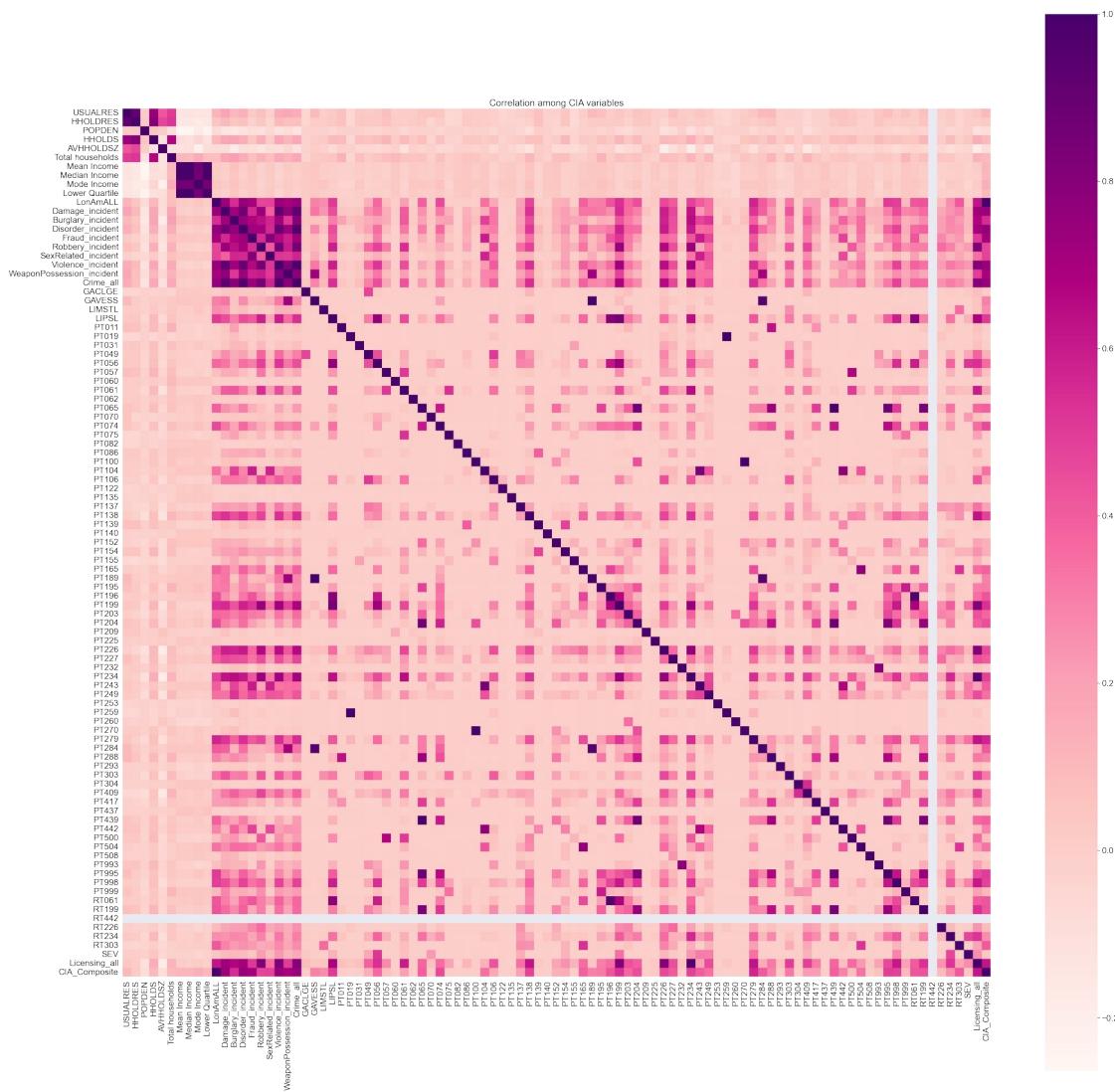
```
[5 rows x 112 columns]
CIA_Explore_Scaled.info()

<class 'geopandas.geodataframe.GeoDataFrame'>
Int64Index: 783 entries, 0 to 782
Columns: 112 entries, 0As to CIA_Composite
dtypes: float64(107), geometry(1), int64(3), object(1)
memory usage: 691.2+ KB

CIA_corr_all = CIA_Explore.corr()

plt.figure(figsize=(50,50))
sns.set(font_scale=2)
sns.heatmap(CIA_corr_all, vmax=1, square=True, annot=False,
annot_kws={"size": 20}, cmap='RdPu')

plt.title('Correlation among CIA variables')
Text(0.5, 1.0, 'Correlation among CIA variables')
```

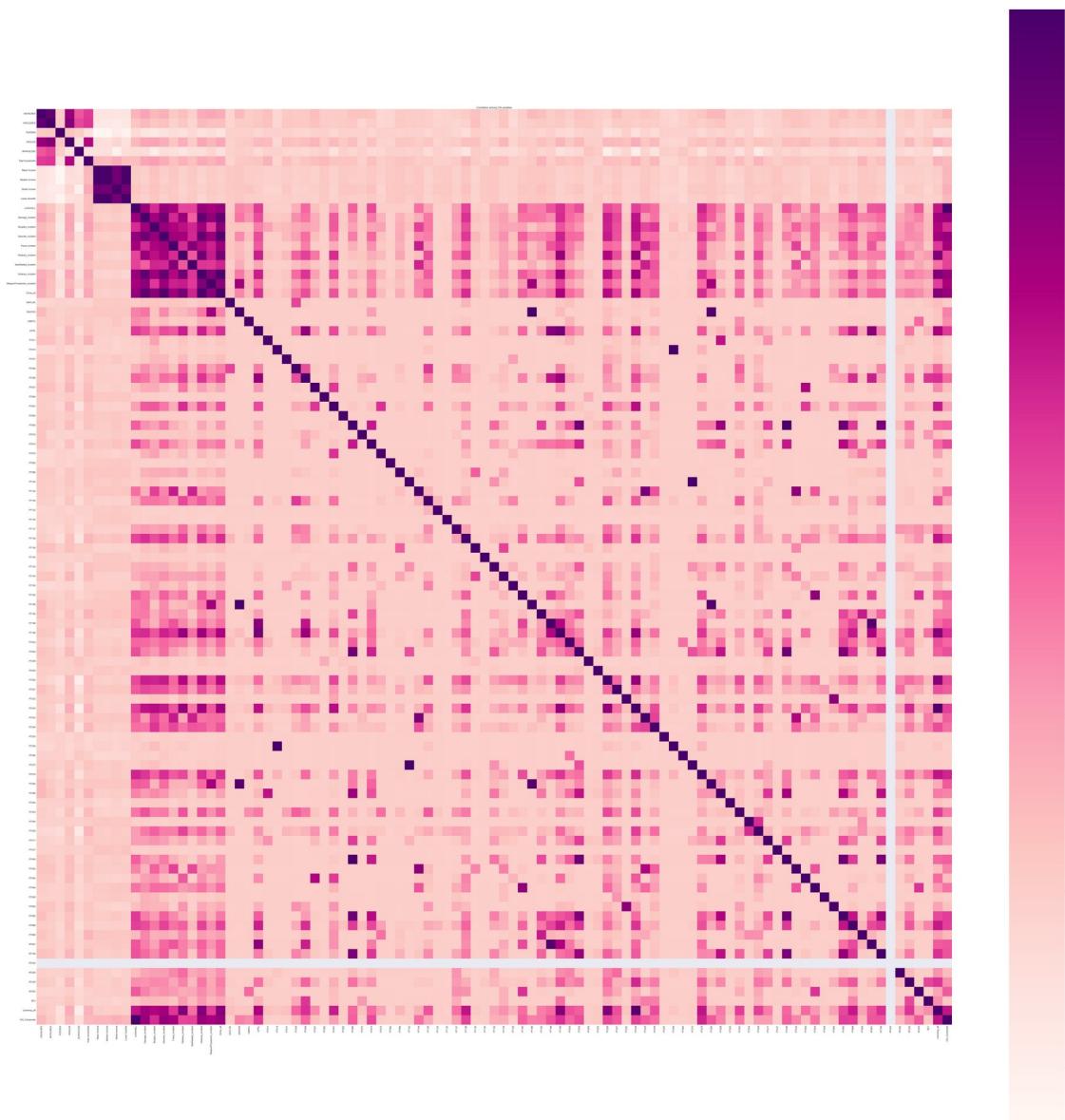


```

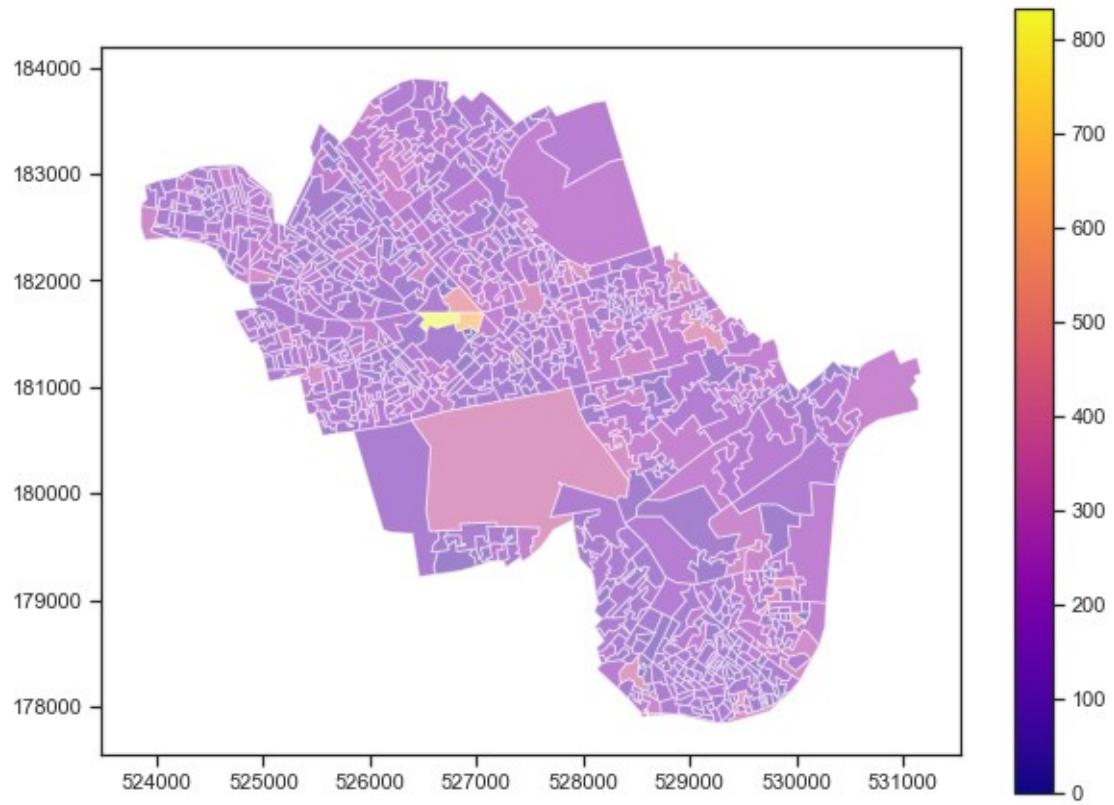
plt.figure(figsize=(200,200))
sns.set(font_scale=2)
sns.heatmap(CIA_corr_all, vmax=1, square=True, annot=False,
            annot_kws={"size": 20}, cmap='RdPu')

plt.title('Correlation among CIA variables')

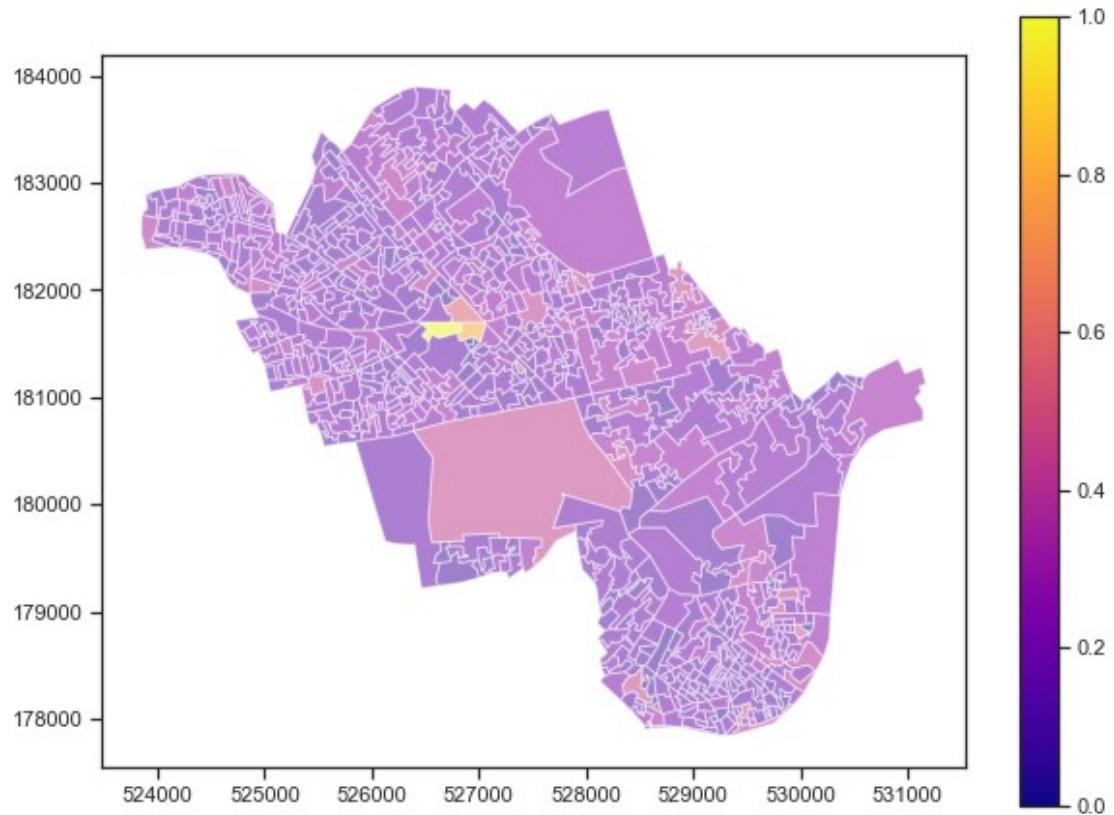
Text(0.5, 1.0, 'Correlation among CIA variables')
    
```



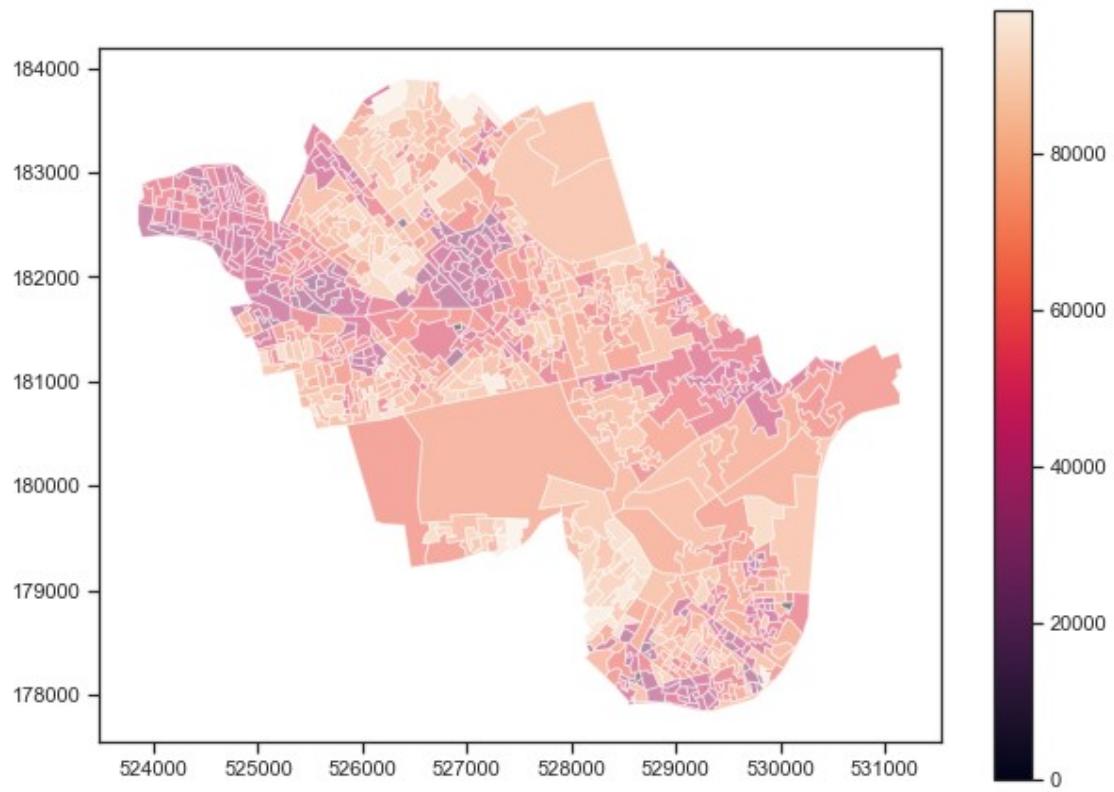
```
sns.set(font_scale=1)
sns.set_style("whitegrid", {'axes.grid' : False})
sns.set_theme(style="ticks")
POPDEN = CIA_Explore.plot(column='POPDEN', markersize=0.5,
alpha=0.5,legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),
cmap='Spectral')
TotalHH = CIA_Explore.plot(column='Total households', markersize=0.5,
alpha=0.5,legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),
cmap='plasma')
```



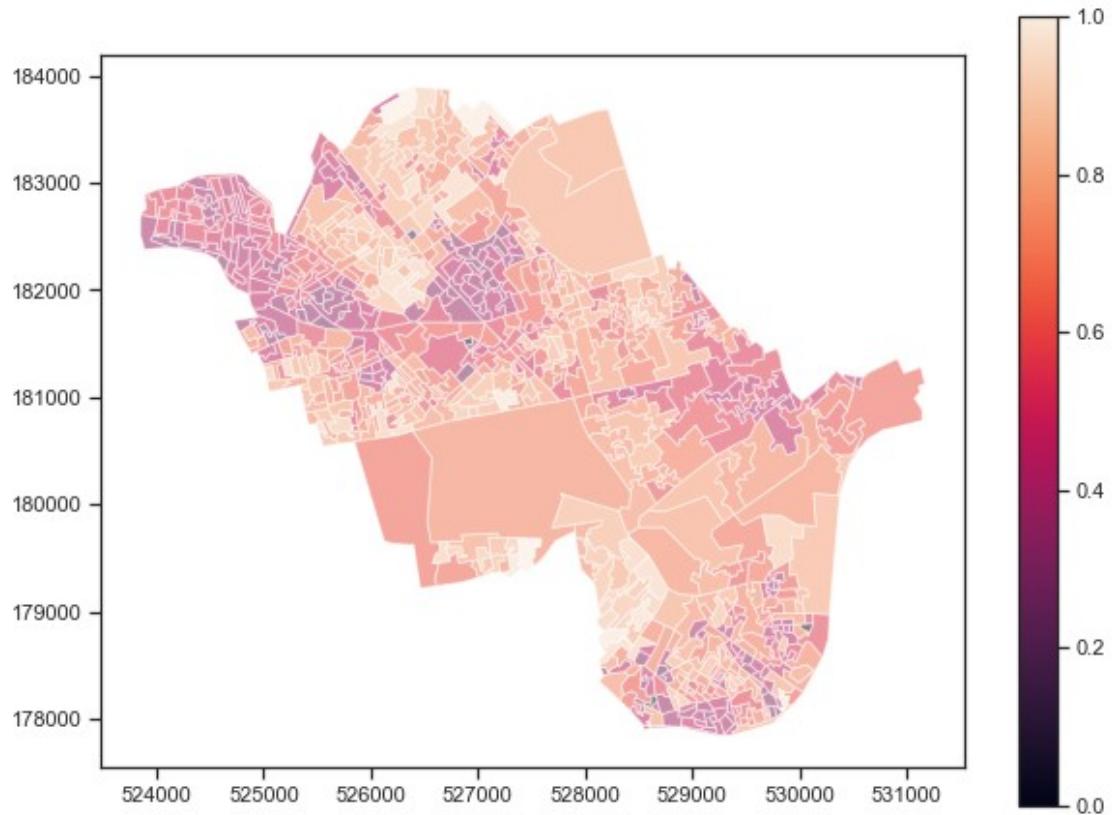
```
TotalHH_scaled = CIA_Explore_Scaled.plot(column='Total households',
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},
figsize=(10,10), cmap='plasma')
```



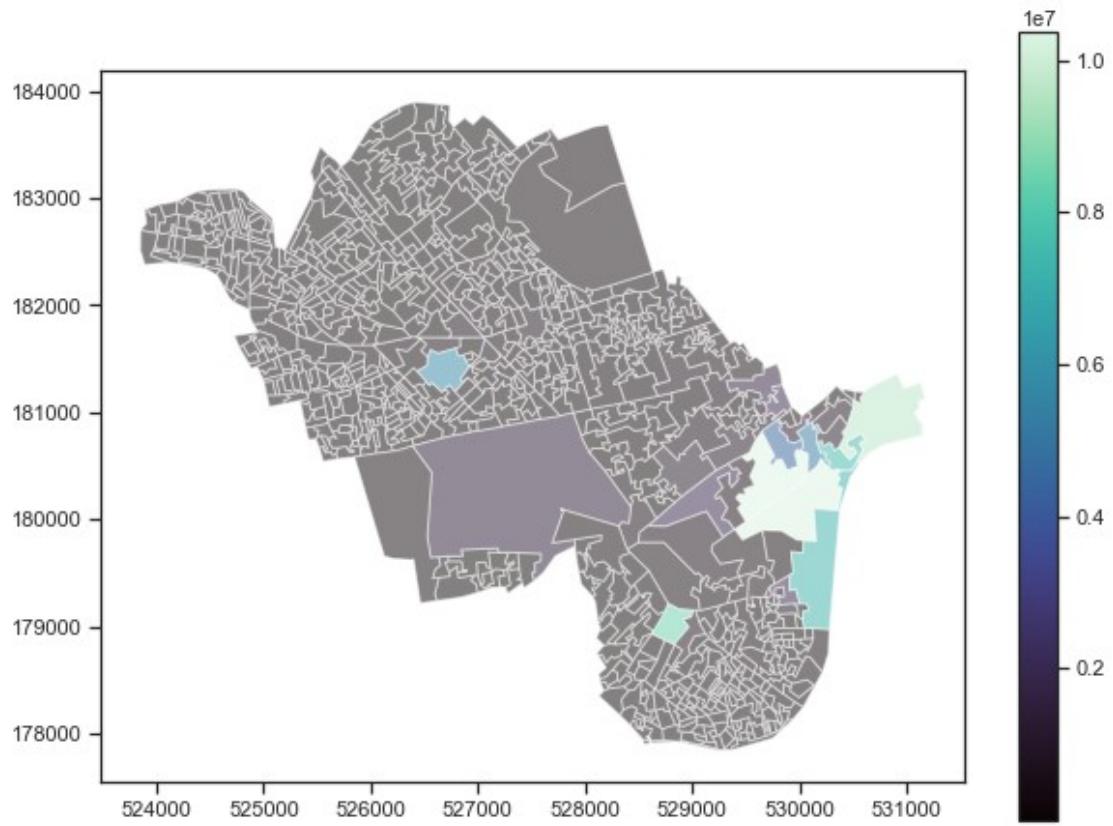
```
MeanIncome = CIA_Explore.plot(column='Mean Income', markersize=0.5,  
alpha=0.5, legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),  
cmap='rocket')
```



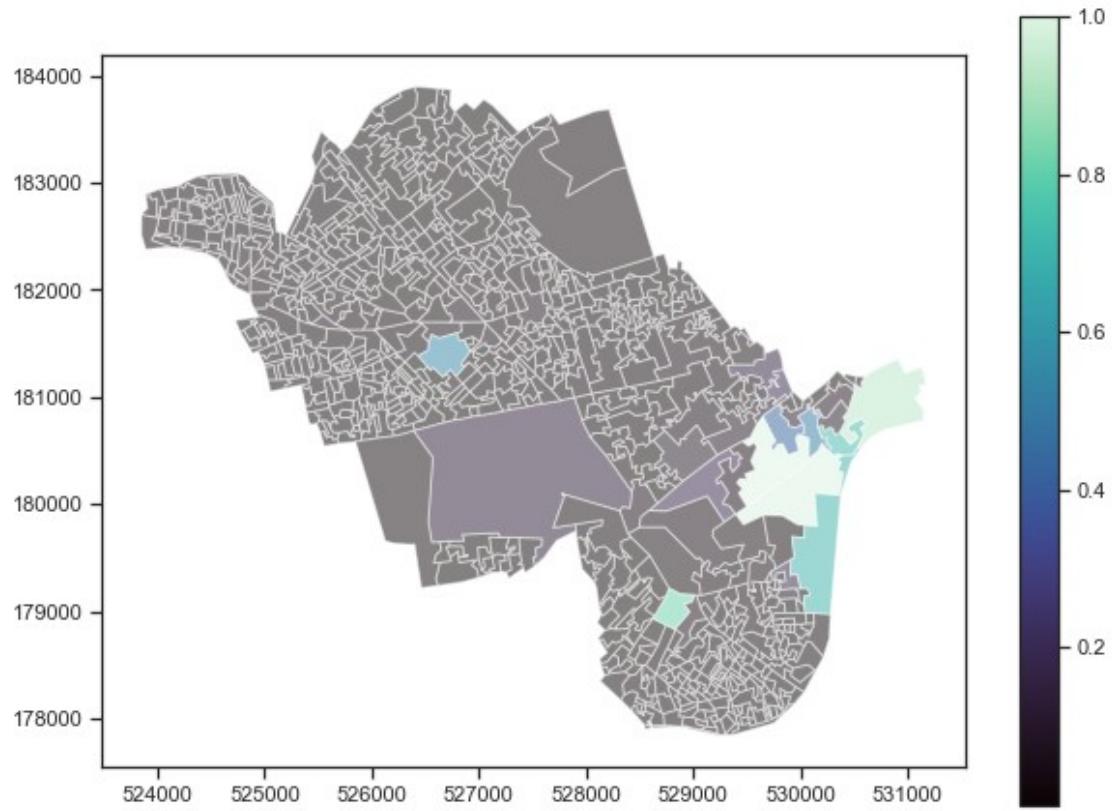
```
MeanIncome_scaled = CIA_Explore_Scaled.plot(column='Mean Income',
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},
figsize=(10,10), cmap='rocket')
```



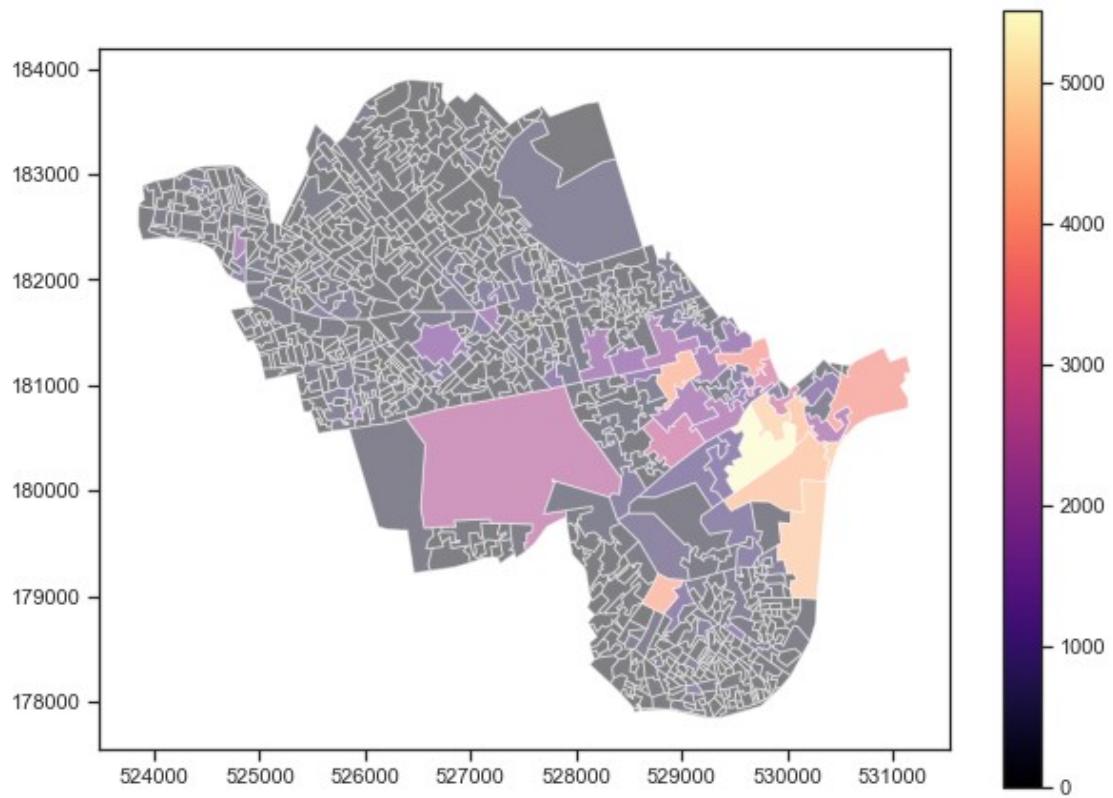
```
AM_Total = CIA_Explore.plot(column='LonAmALL', markersize=0.5,  
alpha=0.5, legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),  
cmap='mako')
```



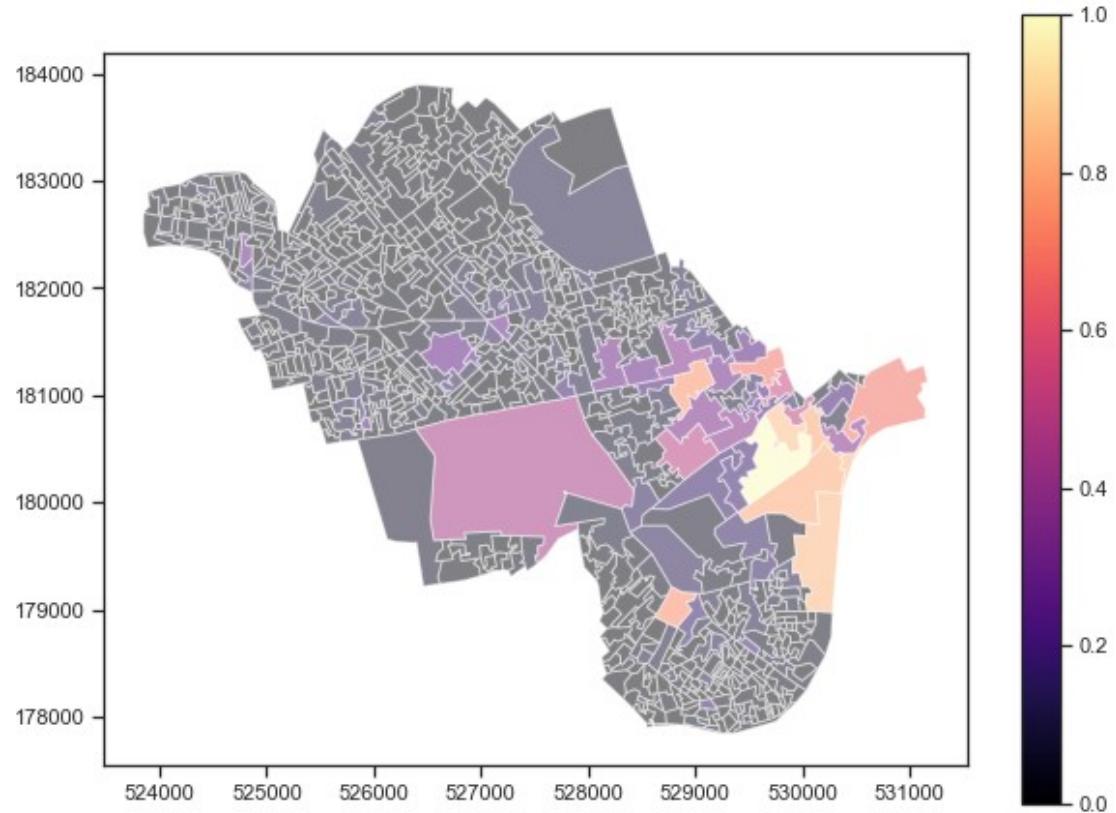
```
AM_Total_scaled = CIA_Explore_Scaled.plot(column='LonAmALL',
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},
figsize=(10,10), cmap='mako')
```

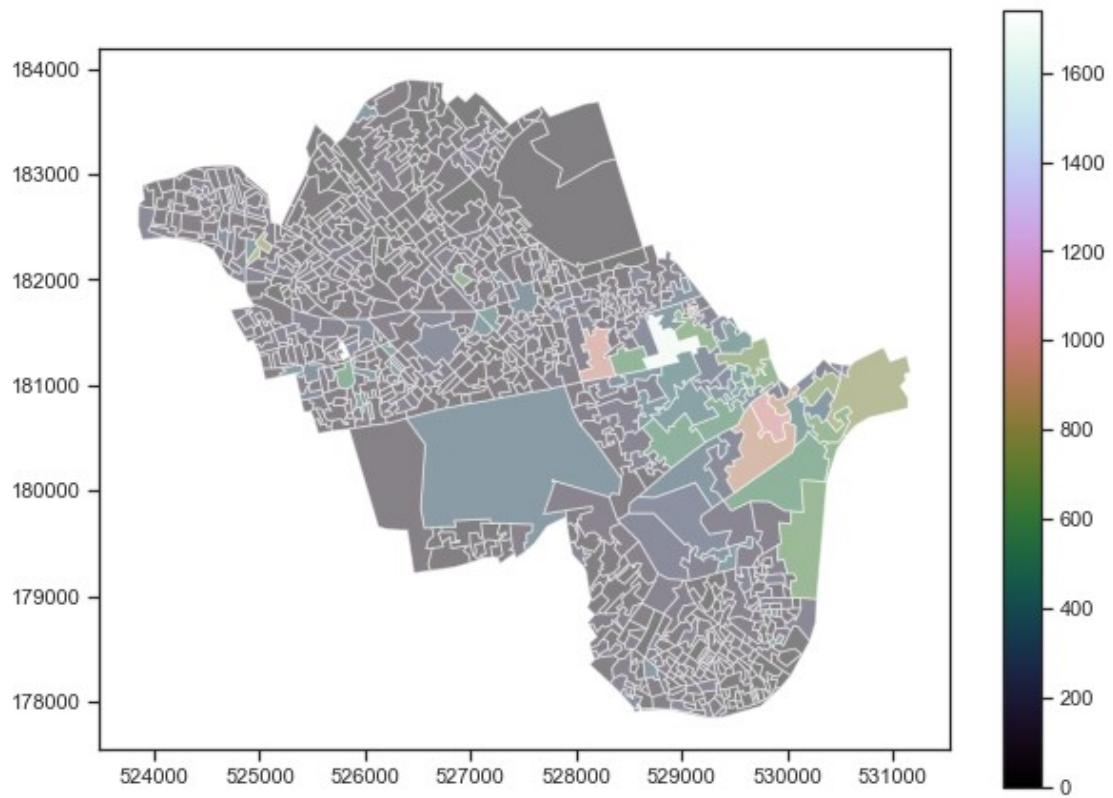


```
Crime_Total = CIA_Explore.plot(column='Crime_all', markersize=0.5,  
alpha=0.5, legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),  
cmap='magma')
```



```
Crime_Total_scaled = CIA_Explore_Scaled.plot(column='Crime_all',
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},
figsize=(10,10), cmap='magma')
```

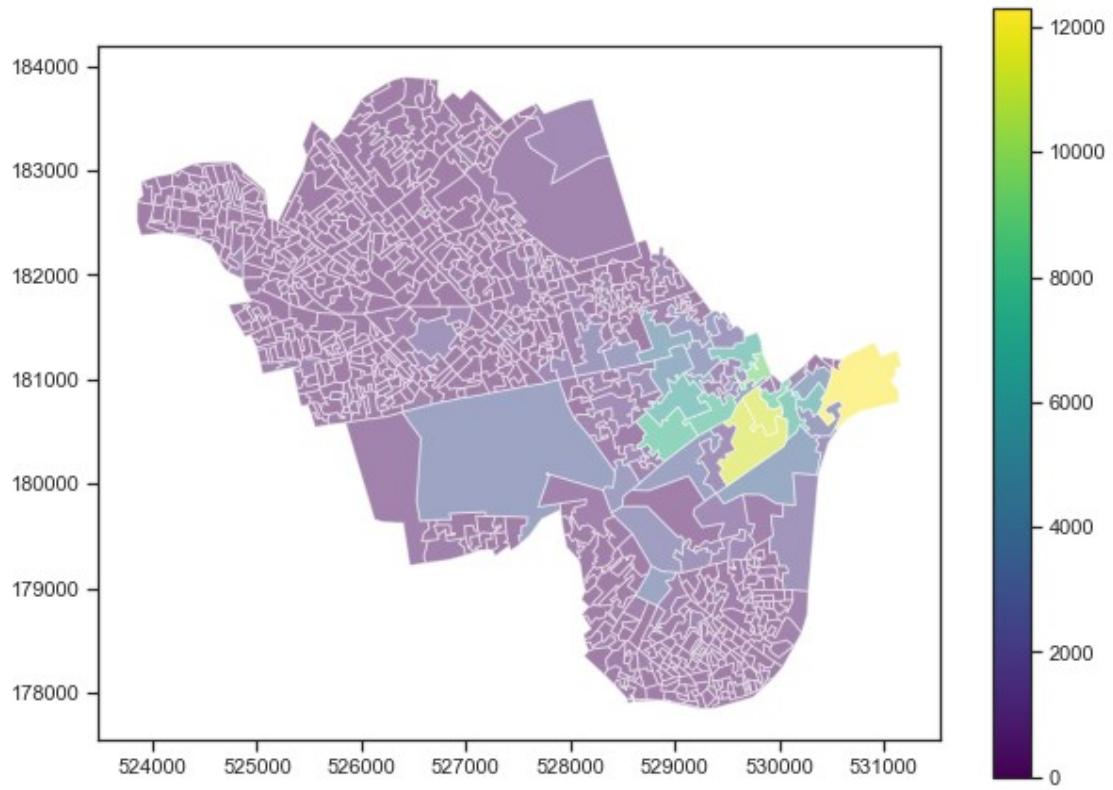




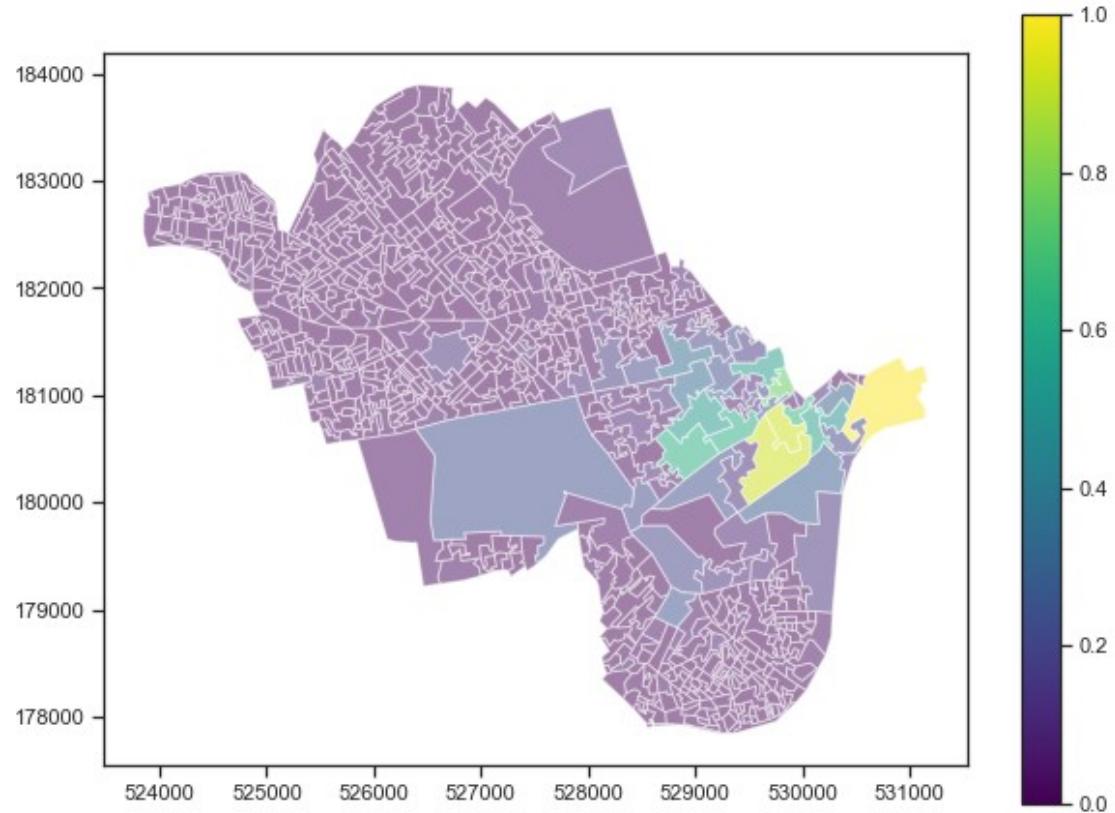
```
Noise_total_scaled =  
CIA_Explore_Scaled.plot(column='Noise_IncidentALL', markersize=0.5,  
alpha=0.5, legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),  
cmap='cubehelix')
```

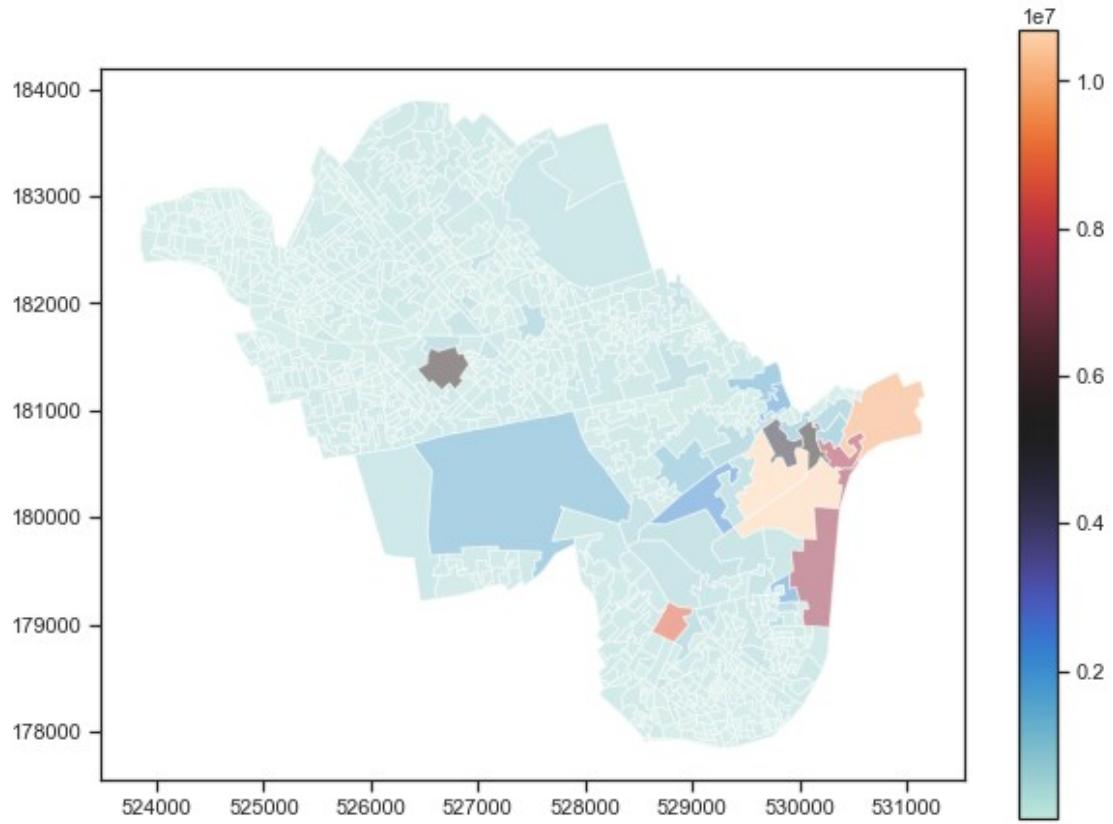


```
Licensing_total = CIA_Explore.plot(column='Licensing_all',  
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},  
figsize=(10,10), cmap='viridis')
```

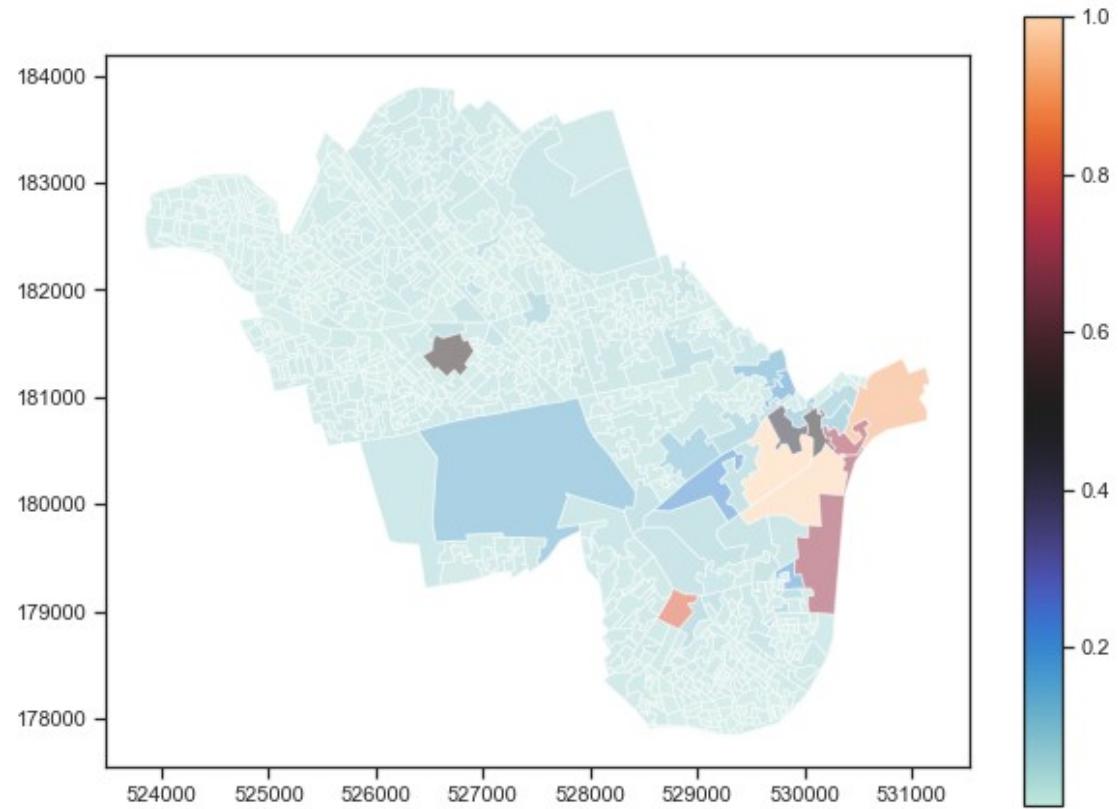


```
Licensing_total_scaled =
CIA_Explore_Scaled.plot(column='Licensing_all', markersize=0.5,
alpha=0.5, legend=True, legend_kwds={'shrink': 0.75}, figsize=(10,10),
cmap='viridis')
```



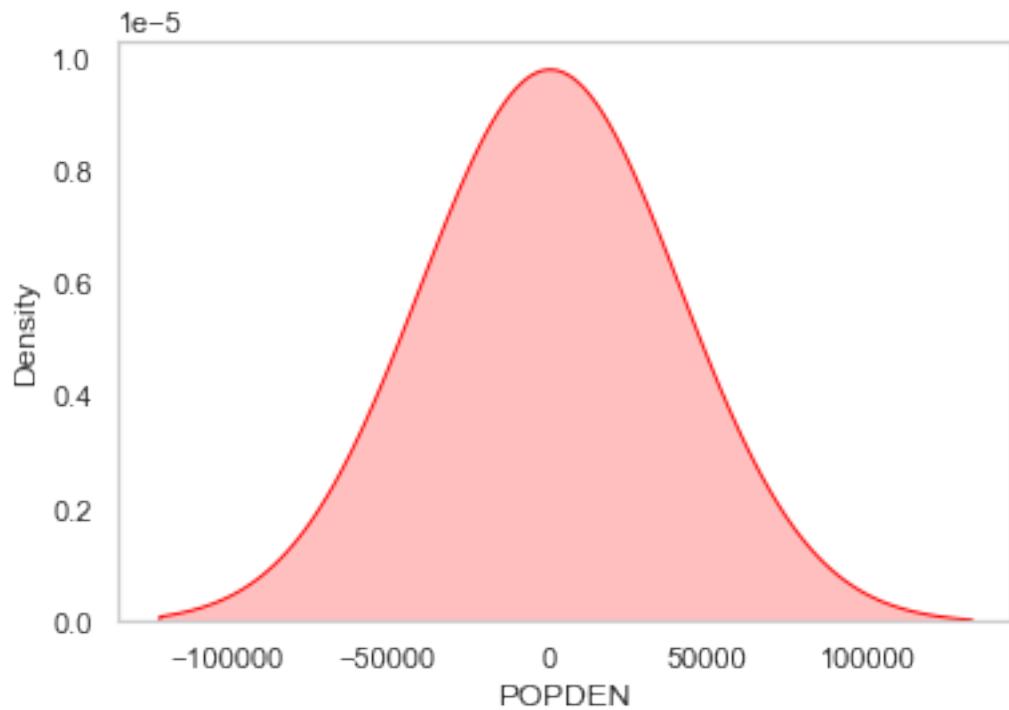


```
CompositeCIA_scaled = CIA_Explore_Scaled.plot(column='CIA_Composite',
markersize=0.5, alpha=0.5, legend=True, legend_kwds={'shrink': 0.75},
figsize=(10,10), cmap='icefire')
```

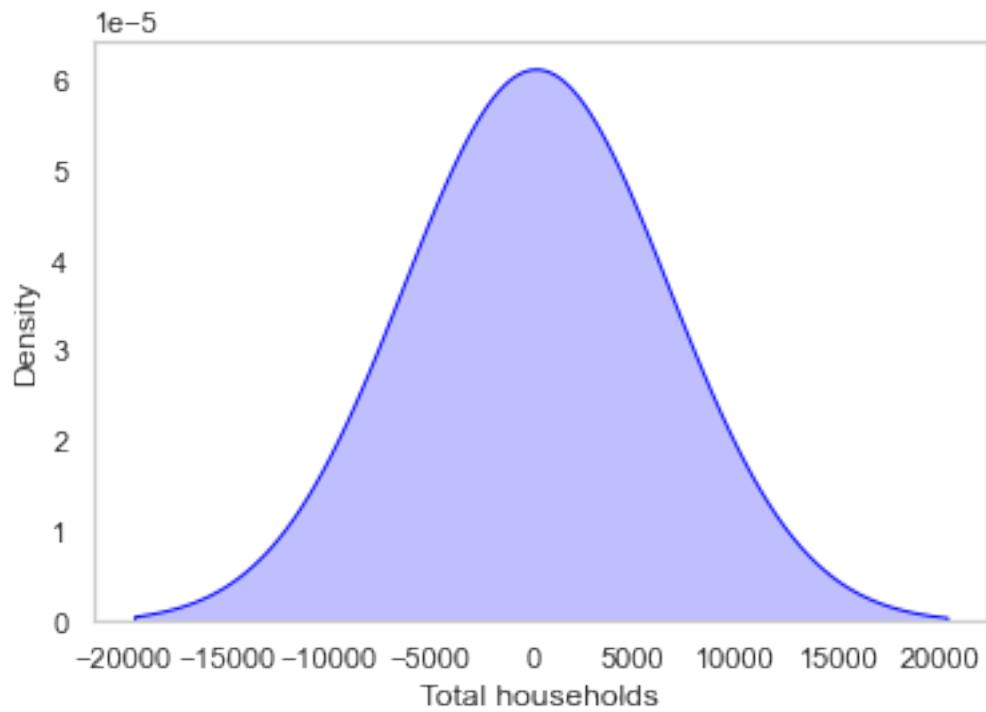


```
%matplotlib inline
matplotlib.use('TkAgg')

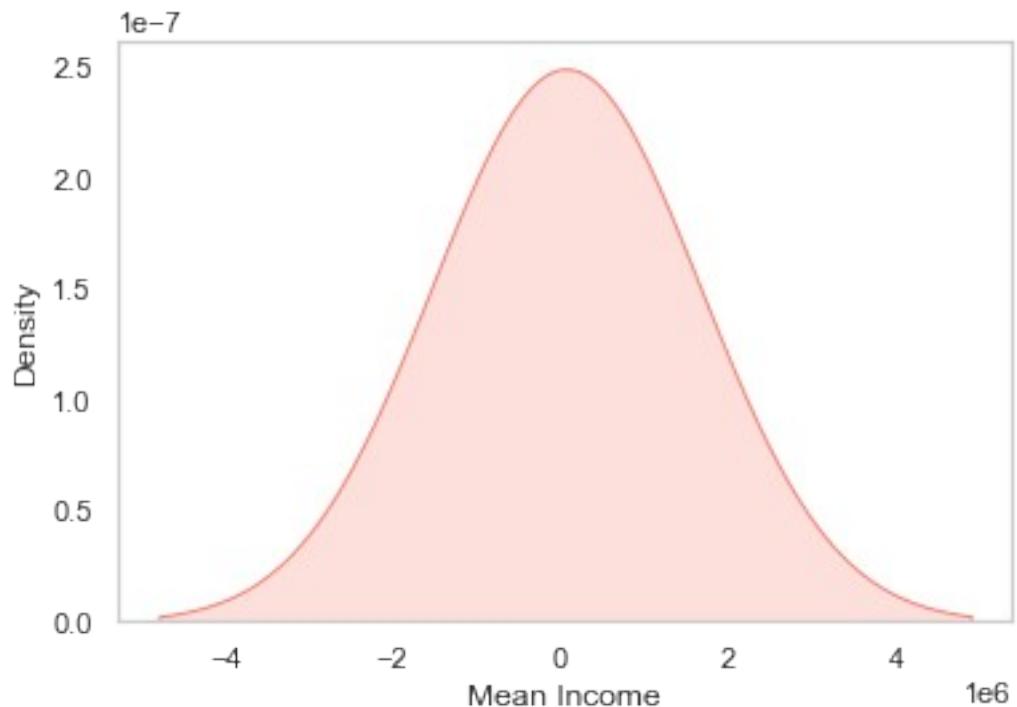
sns.kdeplot(CIA_Explore['POPDEN'], shade=True, bw_method=100,
color="red")
plt.show()
```



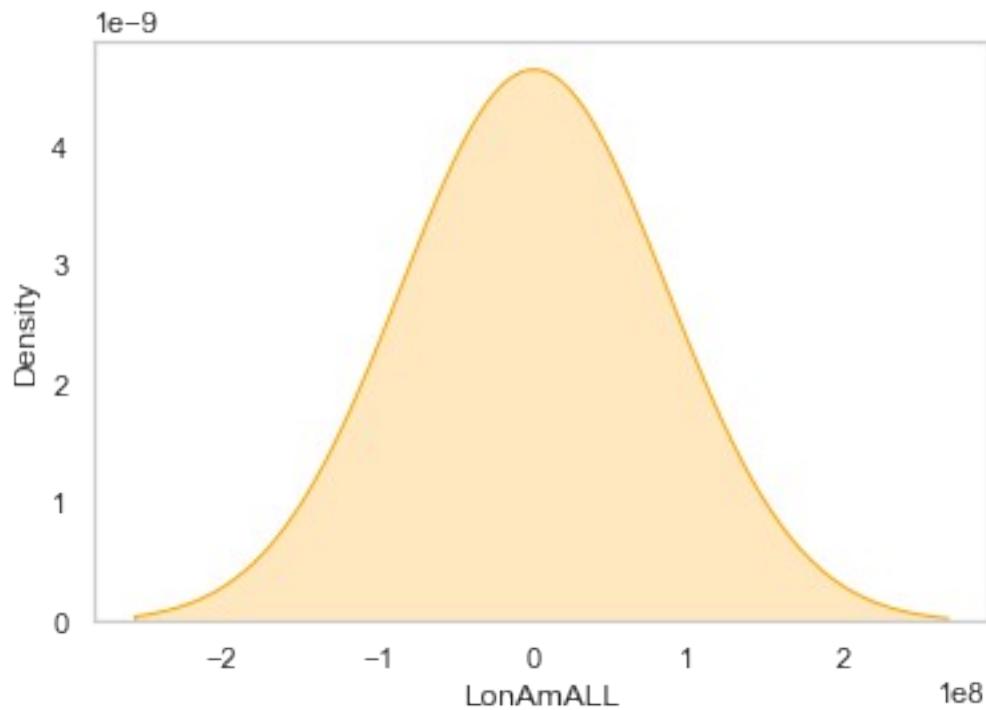
```
sns.kdeplot(CIA_Explore['Total households'], shade=True,  
bw_method=100, color="blue")  
plt.show()
```



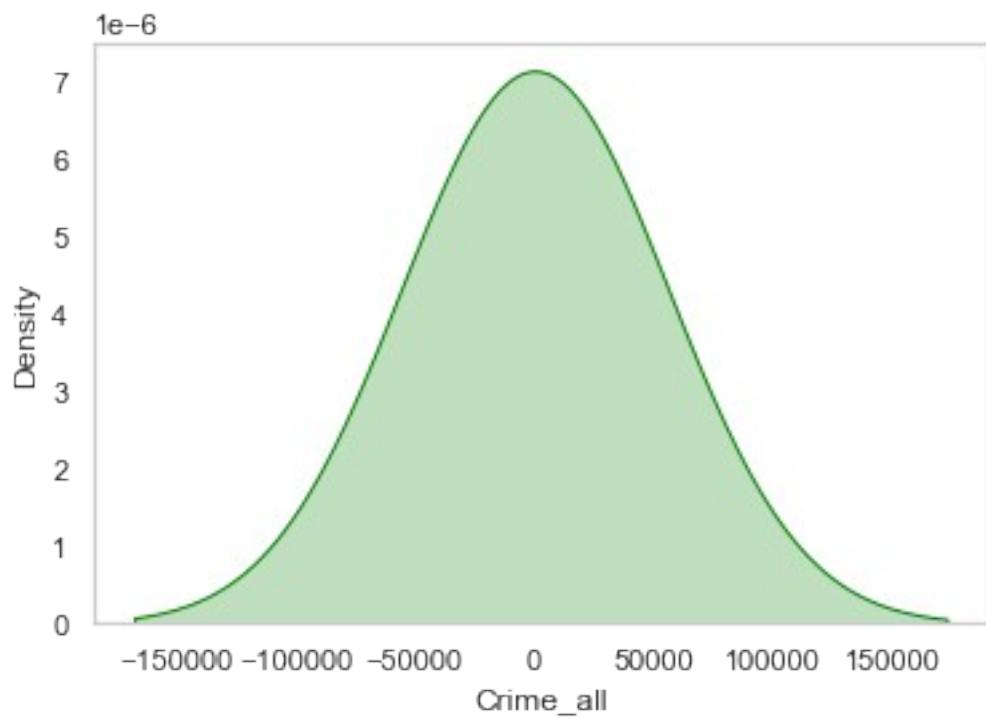
```
sns.kdeplot(CIA_Explore['Mean Income'], shade=True, bw_method=100,  
color="salmon")  
plt.show()
```



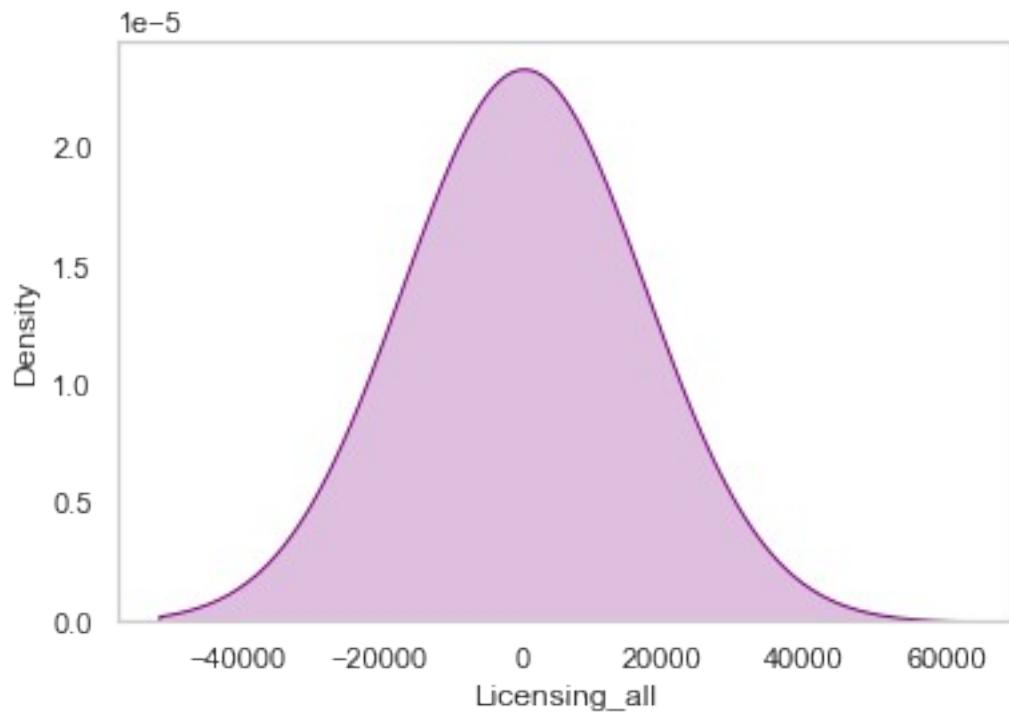
```
sns.kdeplot(CIA_Explore['LonAmALL'], shade=True, bw_method=100,  
color="orange")  
plt.show()
```



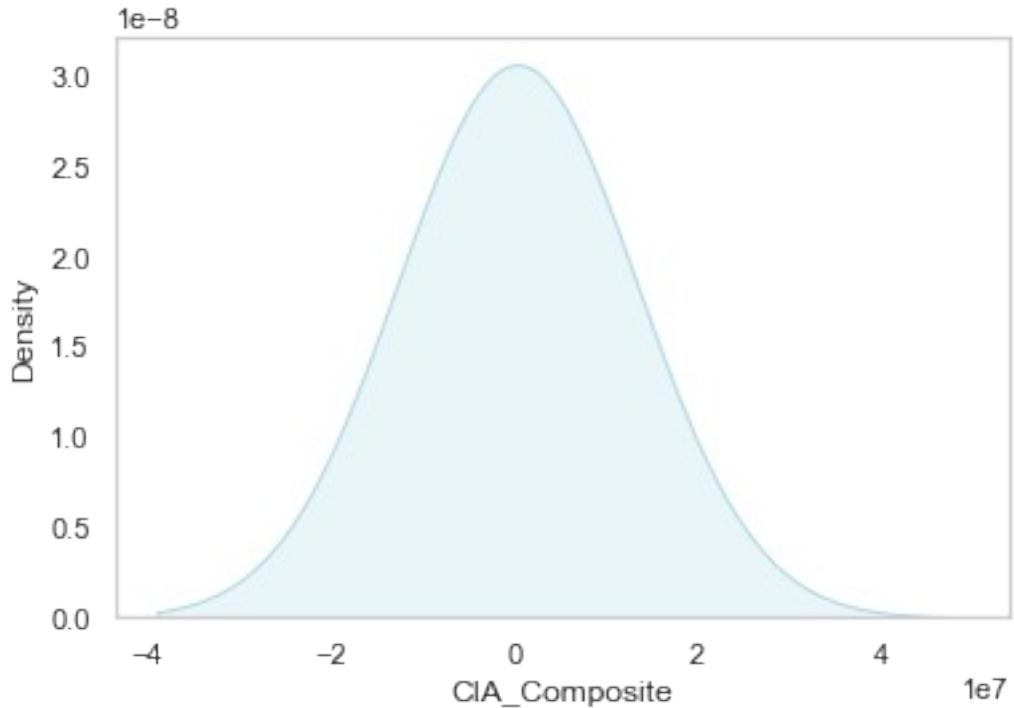
```
sns.kdeplot(CIA_Explore['Crime_all'], shade=True, bw_method=100,  
color="green")  
plt.show()
```



```
sns.kdeplot(CIA_Explore['Licensing_all'], shade=True, bw_method=15,  
color="purple")  
plt.show()
```



```
sns.kdeplot(CIA_Explore['CIA_Composite'], shade=True, bw_method=15,  
color="lightblue")  
plt.show()
```



```
import statsmodels.formula.api as smf
import statsmodels.api as sm

CIA_Grid =
CIA_Explore.filter(['CIA_Composite','Licensing_all','Crime_all','LonAm
ALL', 'Mean Income', 'Total households', 'Noise_IncidentALL'], axis=1)

CIA_Grid.info()

CIA_group_corr = CIA_Grid.corr()

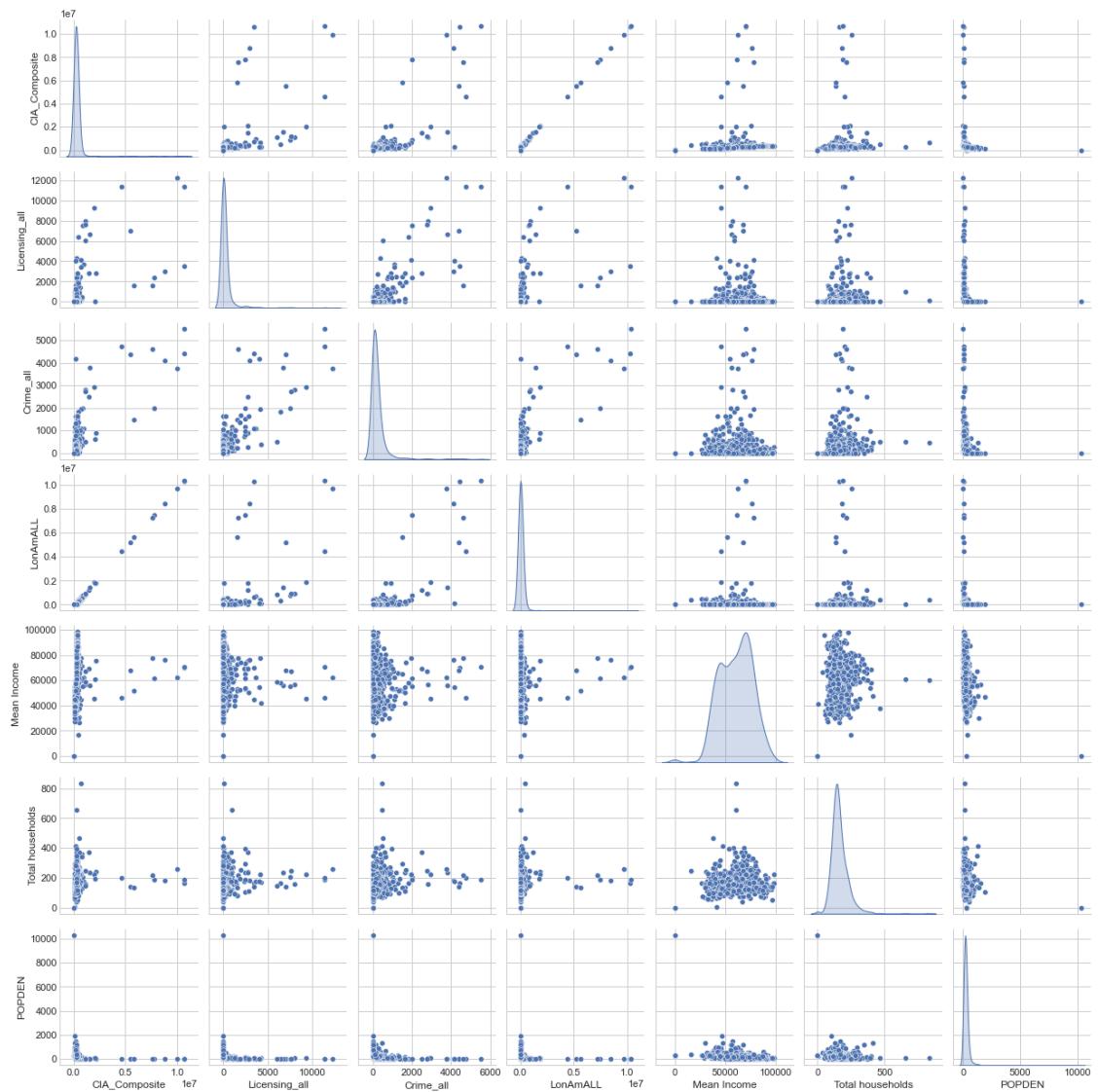
plt.figure(figsize=(50,50))
sns.set(font_scale=2)
sns.heatmap(CIA_group_corr, vmax=1, square=True, annot=False,
annot_kws={"size": 20}, cmap='RdPu')

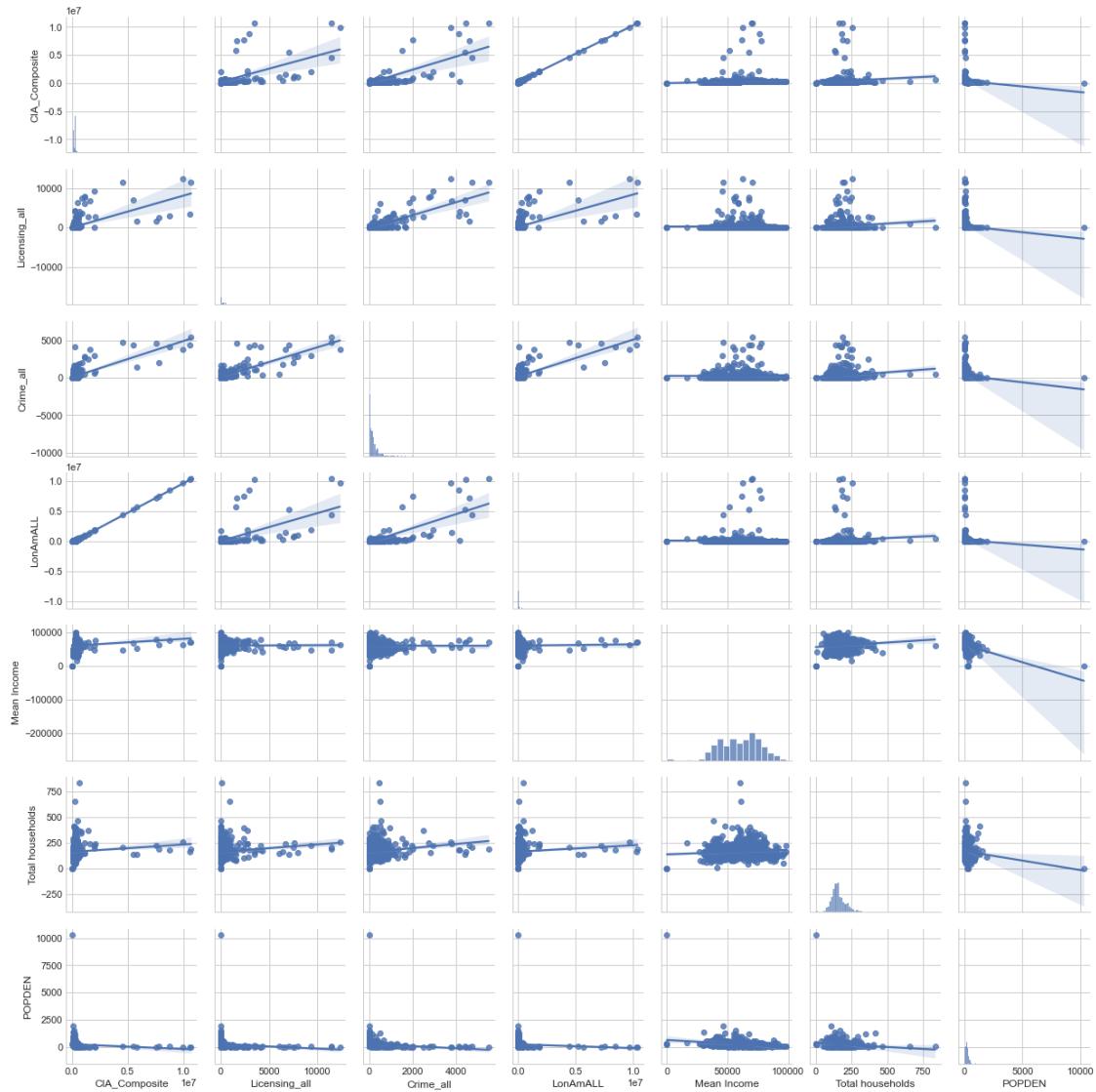
plt.title('Correlation among CIA variables')

# natural log of chosen grid
CIA_Grid_log = np.log(CIA_Grid)

CIA_Grid_log10 = np.log10(CIA_Grid)

plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid, kind="reg")
plt.show()
```

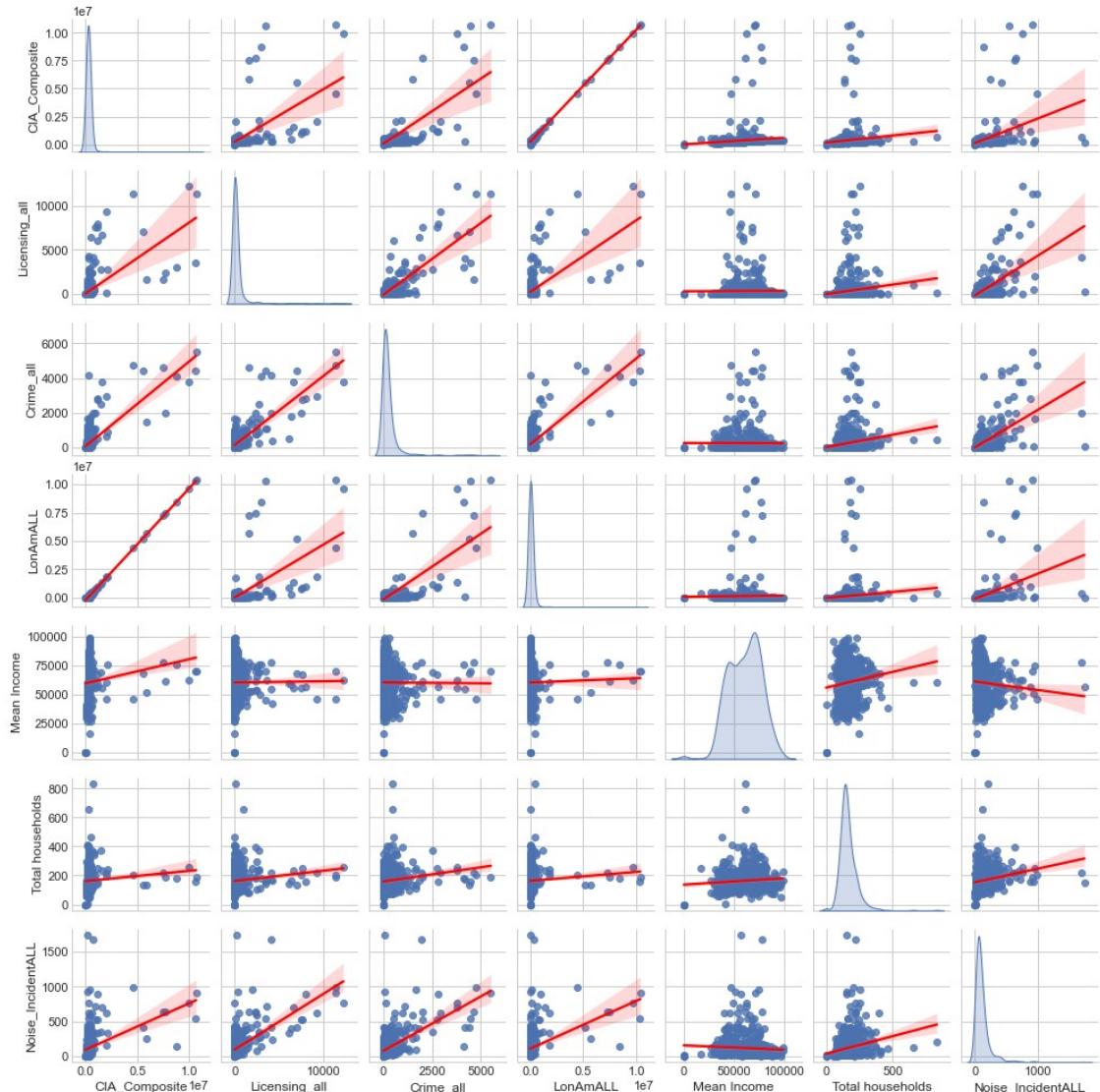




```

sns.set(style="ticks")
plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid, kind='reg', diag_kind='kde', height=2,
             plot_kws={'line_kws': {'color': 'red'}})
plt.show()

```



```

sns.set(style="ticks")
plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid_log, kind='reg', diag_kind='kde', height=2,
             plot_kws={'line_kws': {'color': 'red'}})
plt.show()

```

```

/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply
    y *= step

```

```
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
    y += start
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply
    y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
    y += start
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply
    y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
    y += start
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply
    y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
    y += start
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply
    y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
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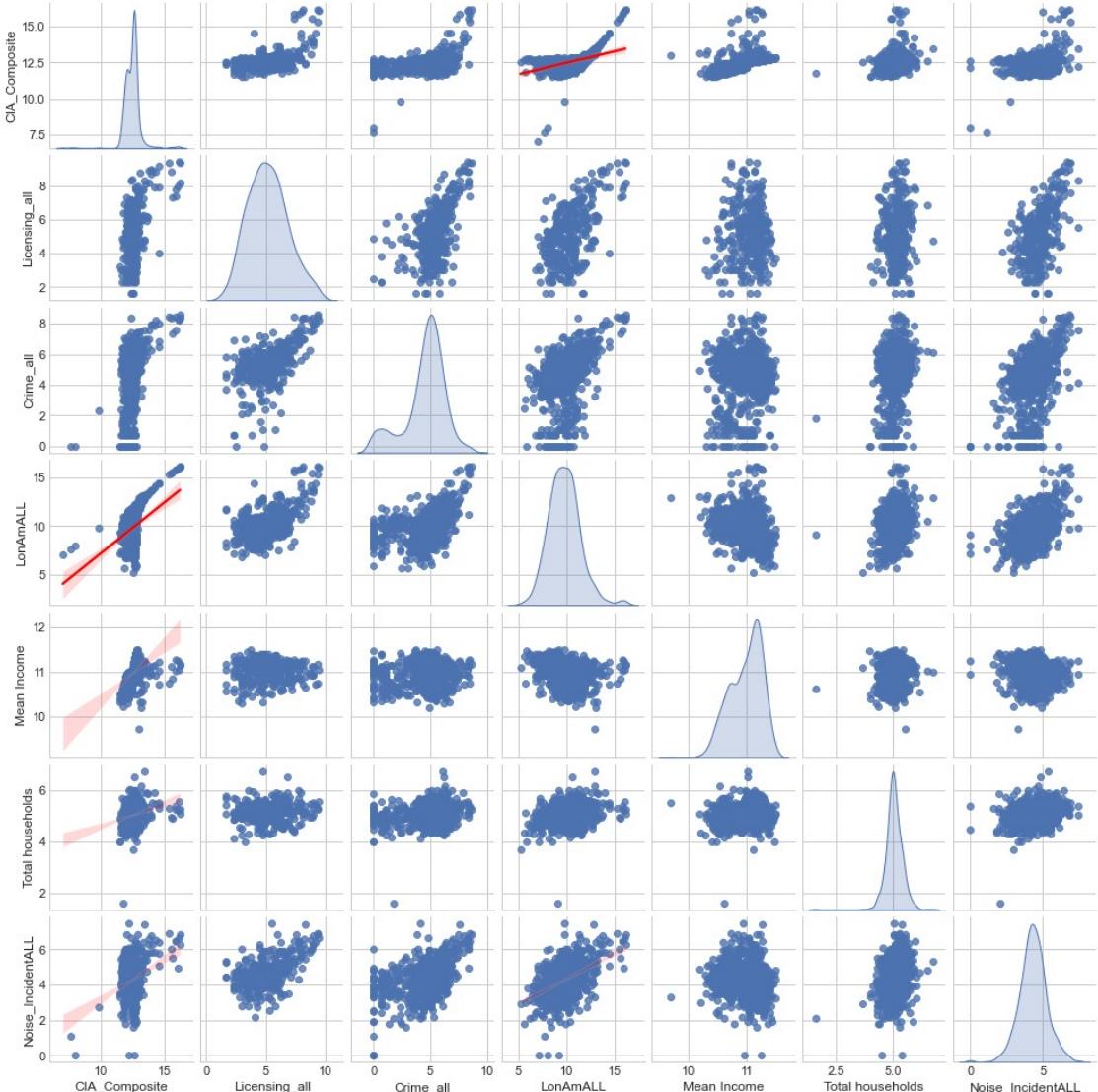
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```



```

sns.set(style="ticks")
plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid_log10, kind='reg', diag_kind='kde', height=2,
             plot_kws={'line_kws': {'color': 'red'}})
plt.show()

/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
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    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
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in multiply
```

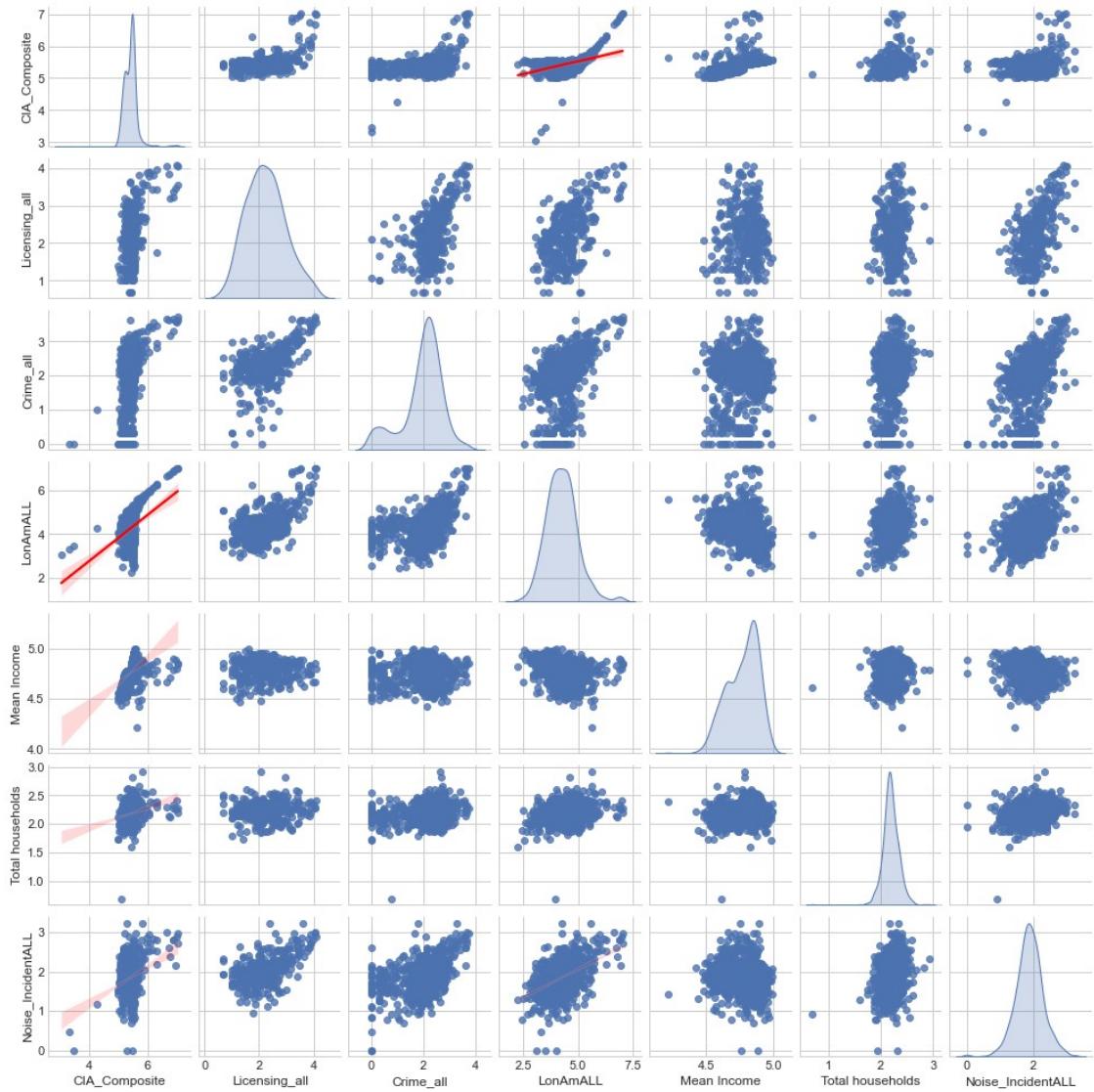
```
y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
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```

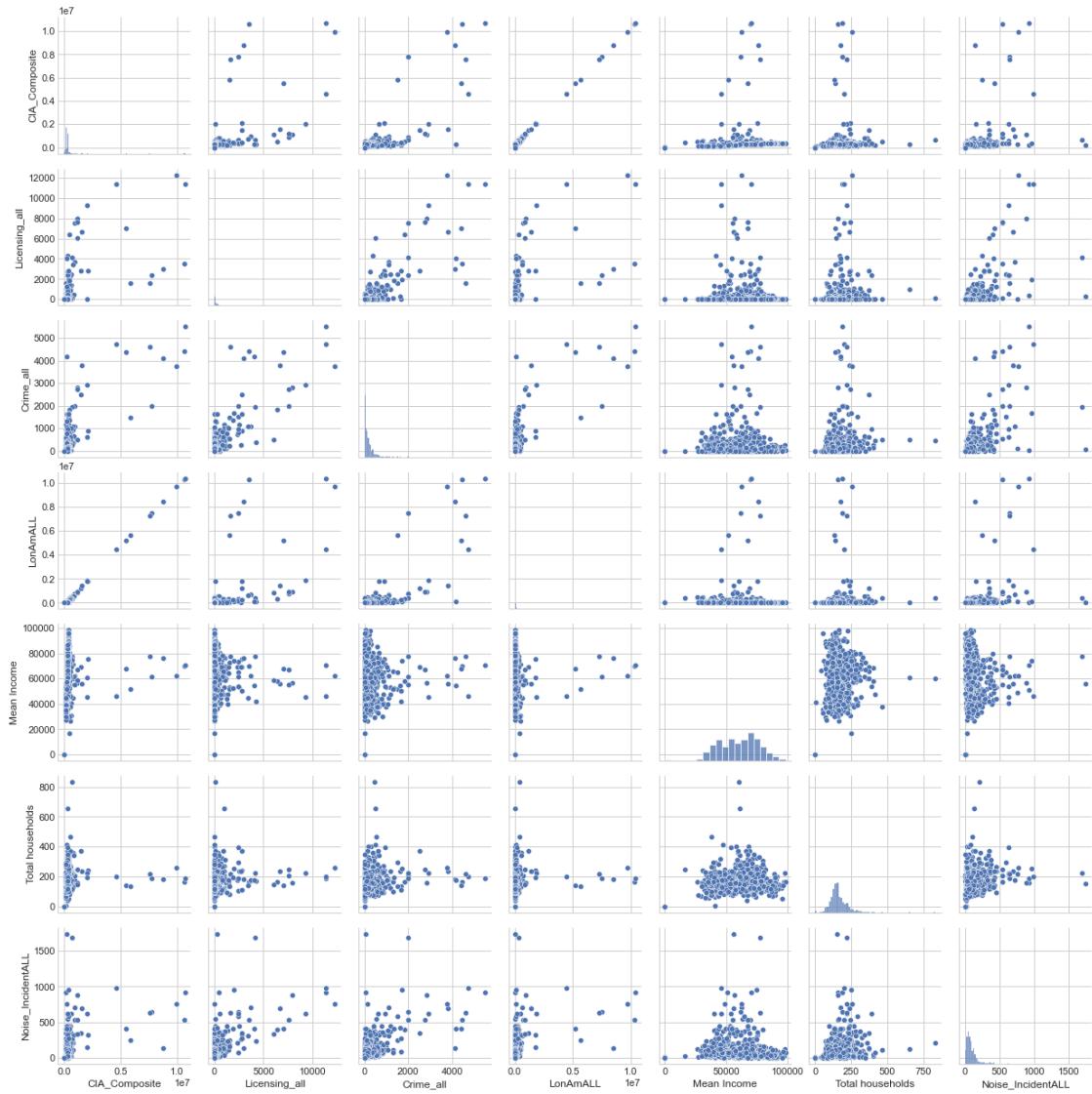
```
y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
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lib/nanfunctions.py:1395: RuntimeWarning: All-NaN slice encountered
    result = np.apply_along_axis(_nanquantile_1d, axis, a, q,
```



```

plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid, kind="scatter")
plt.show()

```



```

# sns.color_palette("YlOrBr", as_cmap=True)
sns.set(style="ticks", color_codes=True)

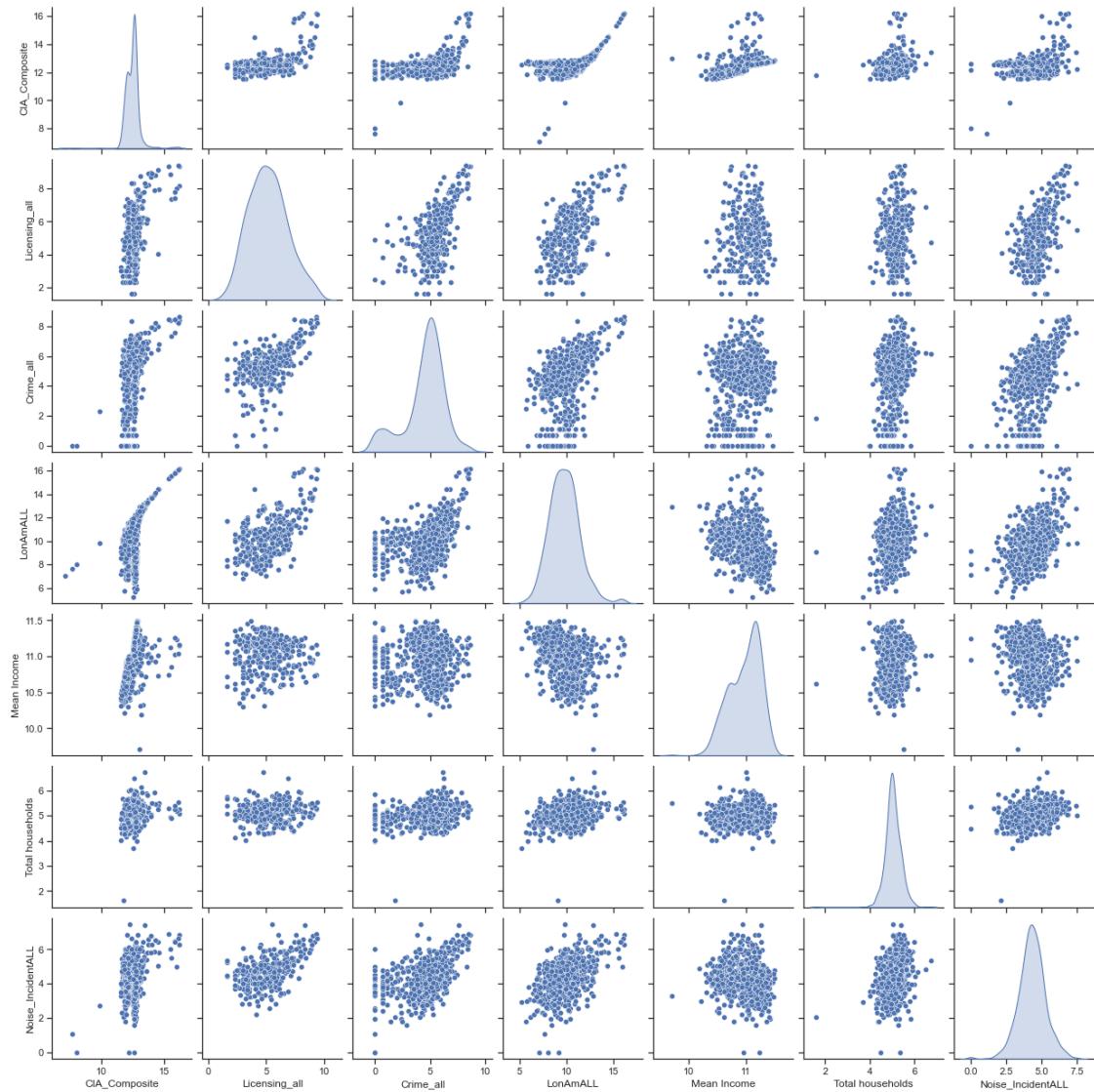
# Density
sns.pairplot(CIA_Grid_log, diag_kind="kde")
#sns.pairplot(CIA_Grid_log, diag_kind="kde", corner=True)

# Histogram
# sns.pairplot(CIA_Grid, diag_kind="hist")

# You can custom it as a density plot or histogram so see the related
# sections
# sns.pairplot(CIA_Grid, diag_kind="kde", diag_kws=dict(shade=True,
# bw_adjust=.05, vertical=False) )

plt.show()

```



```

# sns.color_palette("YlOrBr", as_cmap=True)
sns.set(style="ticks", color_codes=True)

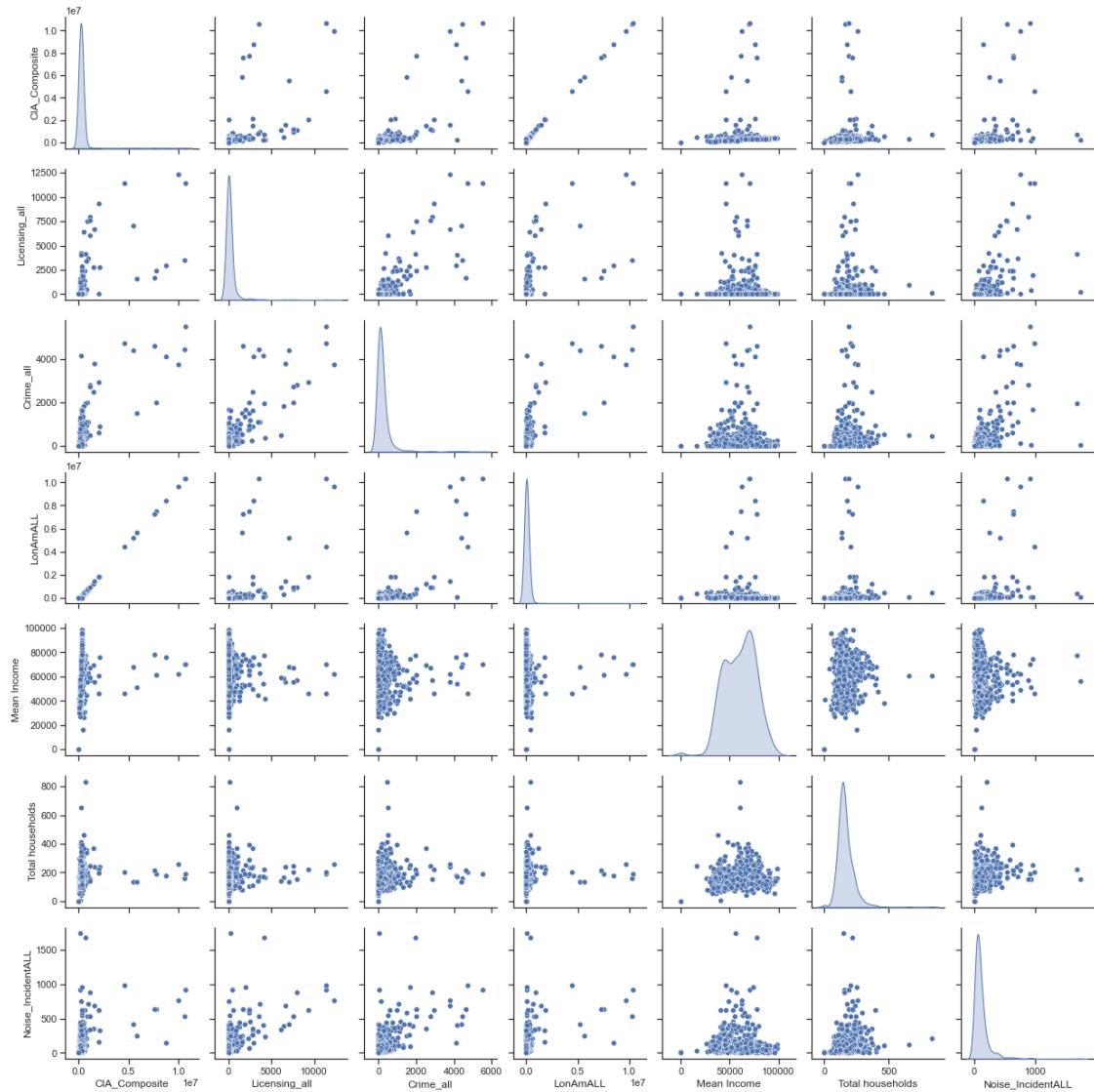
# Density
sns.pairplot(CIA_Grid, diag_kind="kde")
#sns.pairplot(CIA_Grid_log, diag_kind="kde", corner=True)

# Histogram
# sns.pairplot(CIA_Grid, diag_kind="hist")

# You can custom it as a density plot or histogram so see the related
# sections
# sns.pairplot(CIA_Grid, diag_kind="kde", diag_kws=dict(shade=True,
# bw_adjust=.05, vertical=False) )

plt.show()

```



`CIA_Grid.describe()`

	CIA_Composite	Licensing_all	Crime_all	LonAmALL	Mean
Income \ count	7.830000e+02 783.000000	783.000000	783.000000	7.830000e+02	
mean	3.640467e+05 60295.836704	290.918263	260.546616	1.448521e+05	
std	8.648052e+05 15976.633204	1135.877790	558.495639	8.555769e+05	
min	1.152000e+03 0.000000	0.000000	0.000000	1.820000e+02	
25%	1.805046e+05 47067.067383	0.000000	33.500000	5.740000e+03	
50%	2.799658e+05 61585.777778	0.000000	121.000000	1.619200e+04	
75%	3.150380e+05	100.000000	260.500000	4.631400e+04	

```
72149.912008
max      1.068965e+07    12298.000000   5511.000000   1.037115e+07
98293.209877
```

```
      Total households  Noise_IncidentALL
count      783.000000      783.000000
mean      163.338442     114.925926
std       64.987283     150.481171
min       0.000000      0.000000
25%      126.500000     42.000000
50%      152.000000     73.000000
75%      188.500000     128.000000
max      833.000000    1739.000000
```

```
CIA_Grid_log.describe()
```

```
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
lib/function_base.py:4009: RuntimeWarning: invalid value encountered
in subtract
    diff_b_a = subtract(b, a)
```

```
      CIA_Composite  Licensing_all  Crime_all  LonAmALL  Mean
Income \
count      783.000000      783.000000  783.000000  783.000000
783.000000
mean      12.446594          -inf          -inf      9.771711  -
inf
std       0.641167          NaN          NaN      1.653430
NaN
min       7.049255          -inf          -inf      5.204007  -
inf
25%      12.103512          NaN      3.511434      8.655214
10.759329
50%      12.542423          NaN      4.795791      9.692273
11.028186
75%      12.660448          4.605170      5.562601     10.743192
11.186501
max      16.184787          9.417192      8.614501     16.154538
11.495710
```

```
      Total households  Noise_IncidentALL
count      783.000000      783.000000
mean          -inf          -inf
std           NaN          NaN
min          -inf          -inf
25%      4.840234      3.737670
50%      5.023881      4.290459
75%      5.239094      4.852030
max      6.725034      7.461066
```

```

CIA_Grid_Scaled =
CIA_Explore_Scaled.filter(['CIA_Composite','Licensing_all','Crime_all',
,'LonAmALL', 'Mean Income', 'Total households', 'Noise_IncidentALL'],
axis=1)

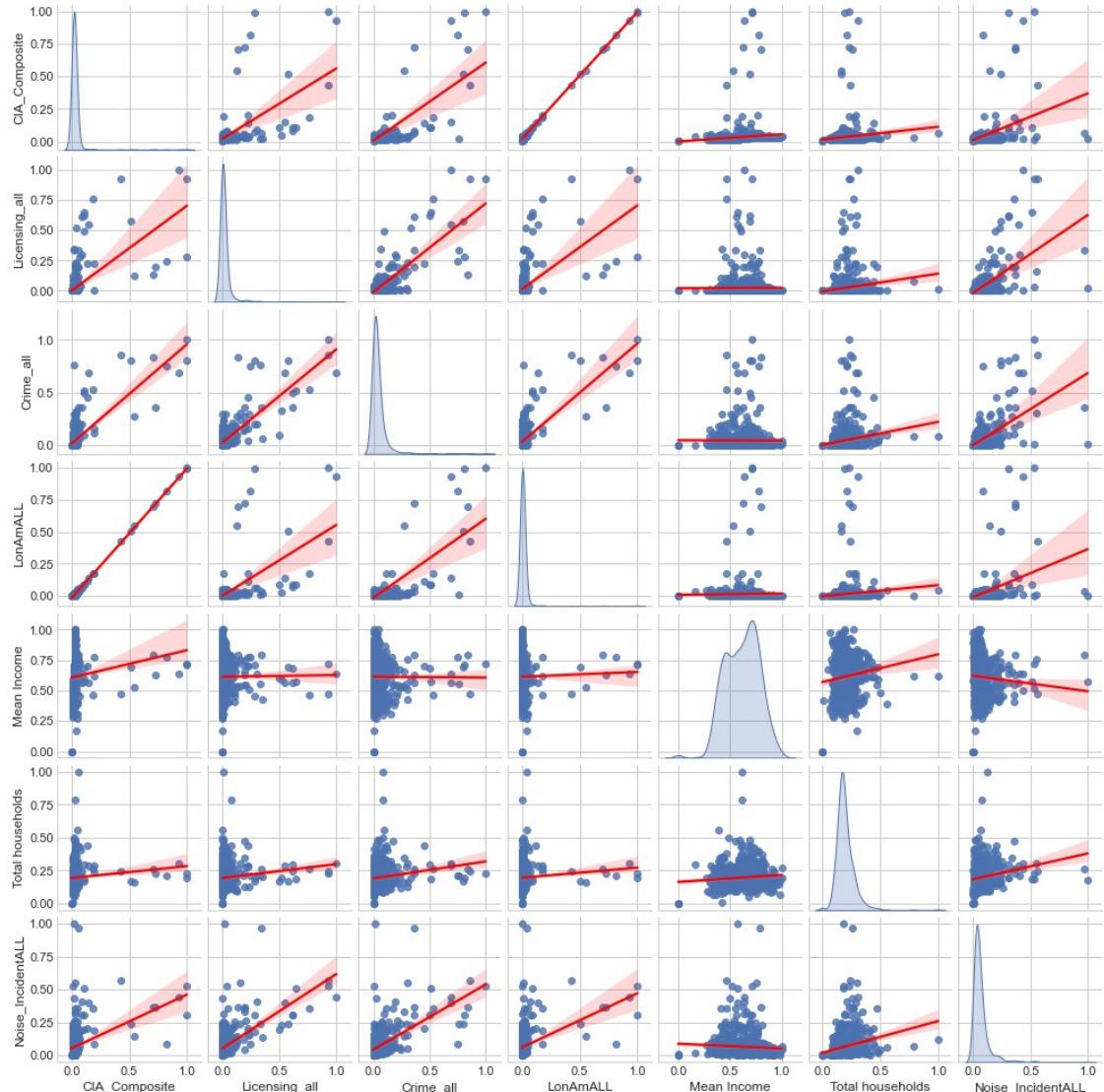
CIA_Grid_Scaled.info()

<class 'pandas.core.frame.DataFrame'>
Int64Index: 783 entries, 0 to 782
Data columns (total 7 columns):
 #   Column           Non-Null Count  Dtype  
--- 
 0   CIA_Composite    783 non-null    float64
 1   Licensing_all    783 non-null    float64
 2   Crime_all        783 non-null    float64
 3   LonAmALL         783 non-null    float64
 4   Mean Income      783 non-null    float64
 5   Total households 783 non-null    float64
 6   Noise_IncidentALL 783 non-null    float64
dtypes: float64(7)
memory usage: 48.9 KB

CIA_Grid_Scaled_log = np.log(CIA_Grid_Scaled)

sns.set(style="ticks")
plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid_Scaled, kind='reg', diag_kind='kde', height=2,
             plot_kws={'line_kws': {'color': 'red'}})
plt.show()

```



```

sns.set(style="ticks")
plt.style.use('seaborn-whitegrid')
plt.rcParams['figure.figsize'] = (15,15)
sns.pairplot(CIA_Grid_Scaled_log, kind='reg', diag_kind='kde',
height=2,
            plot_kws={'line_kws': {'color': 'red'}})
plt.show()

```

```

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/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:151: RuntimeWarning: invalid value encountered
in multiply

```

```
y *= step
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
core/function_base.py:161: RuntimeWarning: invalid value encountered
in add
    y += start
/Users/elika_sinha/opt/anaconda3/lib/python3.9/site-packages/numpy/
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in subtract
    diff_b_a = subtract(b, a)
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in subtract
    diff_b_a = subtract(b, a)
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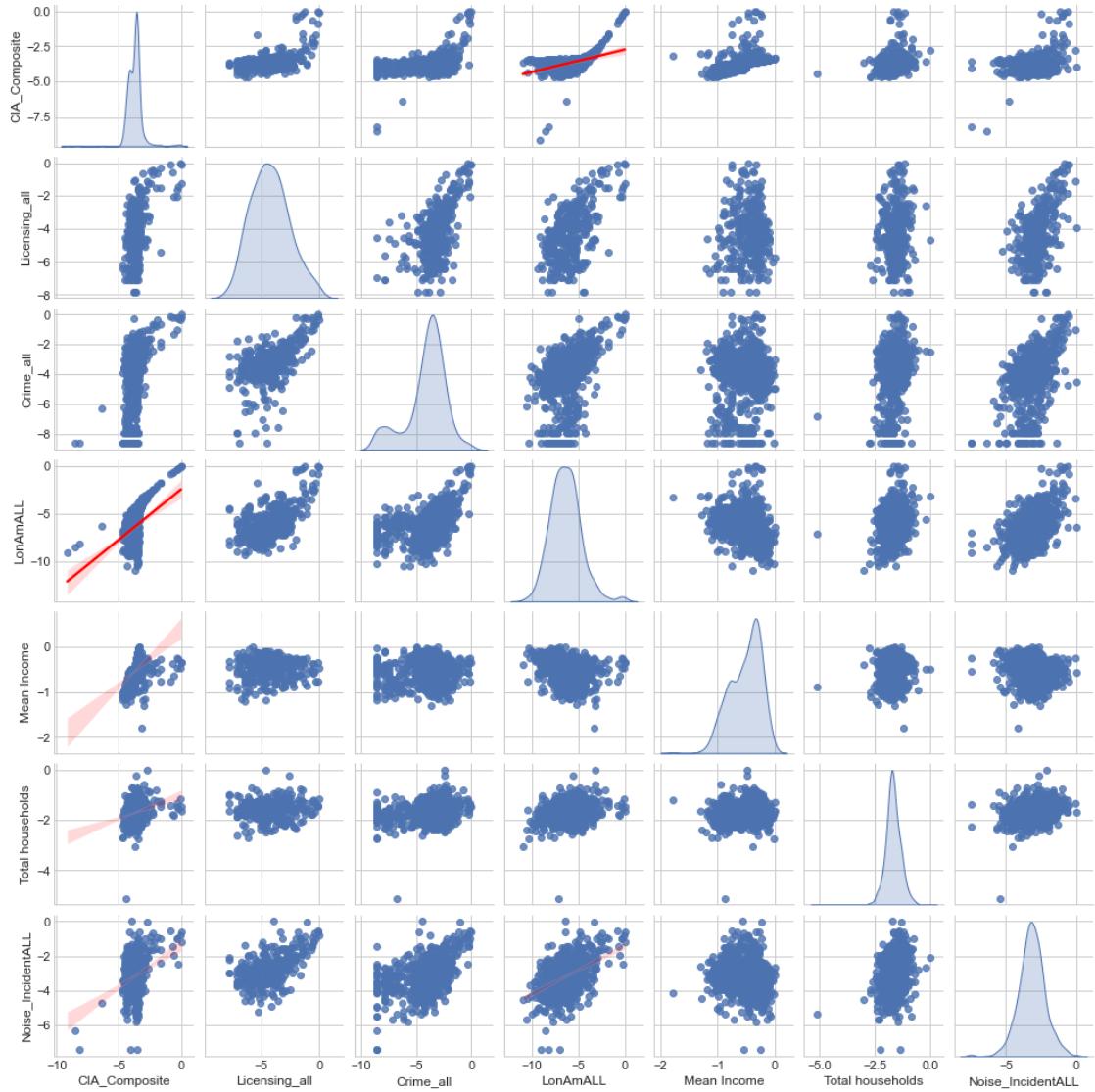
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```

# sns.color_palette("YlOrBr", as_cmap=True)
sns.set(style="ticks", color_codes=True)

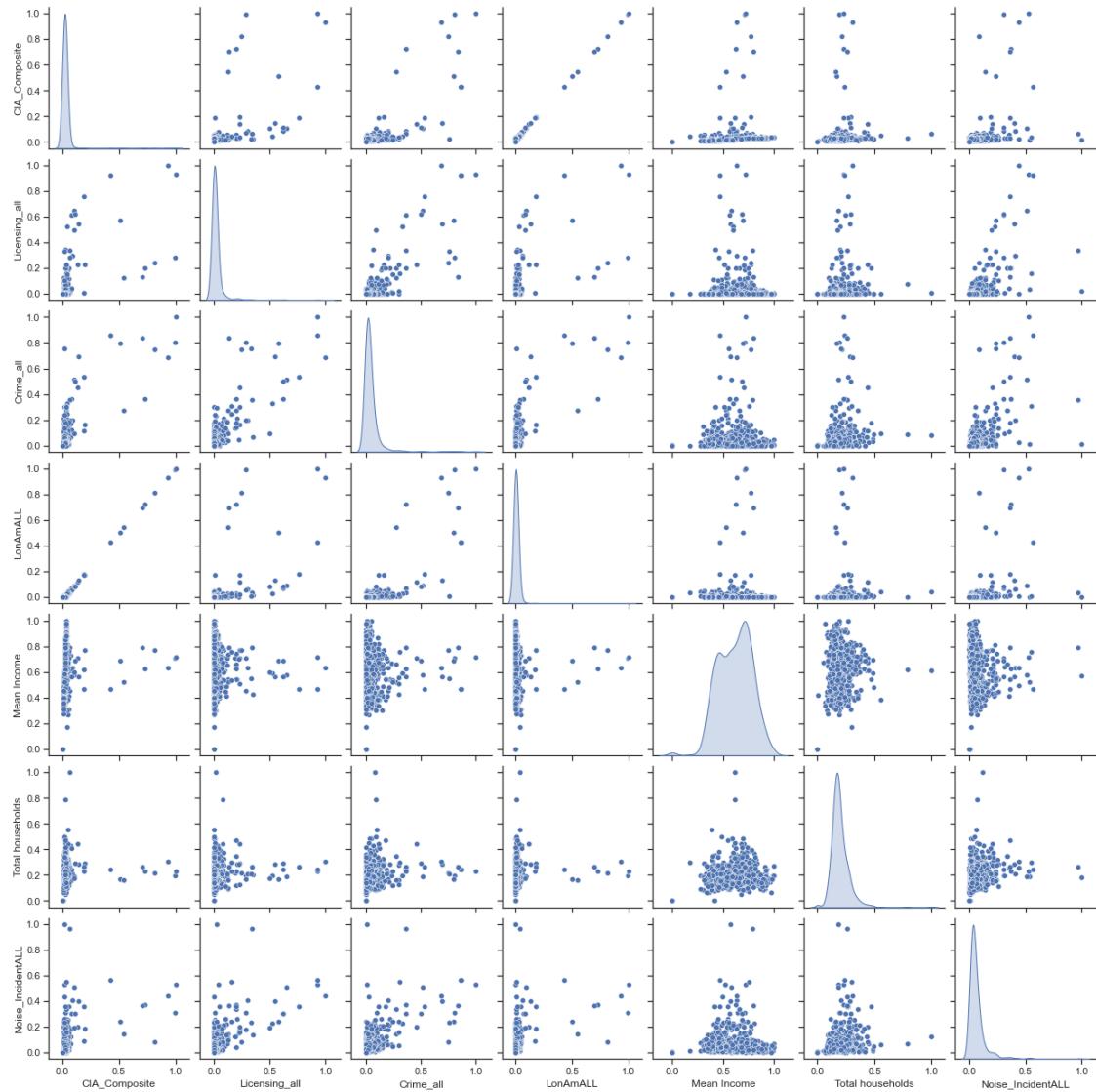
# Density
sns.pairplot(CIA_Grid_Scaled, diag_kind="kde")
#sns.pairplot(CIA_Grid_log, diag_kind="kde", corner=True)

# Histogram
# sns.pairplot(CIA_Grid, diag_kind="hist")

# You can custom it as a density plot or histogram so see the related
# sections
# sns.pairplot(CIA_Grid, diag_kind="kde", diag_kws=dict(shade=True,
# bw_adjust=.05, vertical=False) )

plt.show()

```



```

# sns.color_palette("YlOrBr", as_cmap=True)
sns.set(style="ticks", color_codes=True)

# Density
sns.pairplot(CIA_Grid_Scaled_log, diag_kind="kde")
#sns.pairplot(CIA_Grid_log, diag_kind="kde", corner=True)

# Histogram
# sns.pairplot(CIA_Grid, diag_kind="hist")

# You can custom it as a density plot or histogram so see the related
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