

EDA

September 6, 2019

0.1 Capstone #1

0.1.1 *File Descriptions*

- DATA_ELEMENT_DESCRIPTION.csv defines each data element and indicates where its description is found in Data Sources, Definitions, and Notes.
- DEFINED_DATA_VALUE.csv defines the meaning of specific values (such as missing or suppressed data).
- DEMOGRAPHICS.csv identifies the data elements and values in the Demographics indicator domain.
- HEALTHY_PEOPLE_2010.csv identifies the Healthy People 2010 Targets and the U.S. Percentages or Rates.
- LEADING_CAUSES_OF_DEATH.csv identifies the data elements and values in the Leading Causes of Death indicator domain.
- MEASURES_OF_BIRTH_AND_DEATH.csv identifies the data elements and values in the Measures of Birth and Death indicator domain.
- PREVENTIVE_SERVICES_USE.csv identifies the data elements and values in the Preventive Services indicator domain.
- RELATIVE_HEALTH_IMPORTANCE.csv identifies the data elements and values in the Relative Health Importance indicator domain.
- RISK_FACTORS_AND_ACCESS_TO_CARE.csv identifies the data elements and values in the Risk Factors and Access to Care indicator domain.
- SUMMARY_MEASURES_OF_HEALTH.csv identifies the data elements and values in the Summary Measures of Health indicator domain.
- VULNERABLE_POPS_AND_ENV_HEALTH.csv identifies the data elements and values in the Vulnerable Populations and Environmental Health indicator domain.

Data source can be found [here](#)

```
[1]: import glob
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib as mpl
import matplotlib.cm as cm
from matplotlib.pyplot import figaspect
from mpl_toolkits.axes_grid1 import make_axes_locatable
import geopandas as gpd
import seaborn as sns
from scipy.stats.stats import pearsonr
```

```

mpl.rcParams.update({'font.size': 14})

[2]: #Reading all 11 csv files
files = sorted(glob.glob('../CHSI_dataset/*.csv'))

```

0.1.2 File Initialization

```

[3]: DATA_ELEMENT_DESCRIPTION = pd.read_csv(files[0])
DEFINED_DATA_VALUE = pd.read_csv(files[1])
DEMOGRAPHICS = pd.read_csv(files[2])
HEALTHY_PEOPLE_2010 = pd.read_csv(files[3])
LEADING_CAUSES_OF_DEATH = pd.read_csv(files[4])
MEASURES_OF_BIRTH_AND_DEATH = pd.read_csv(files[5])
PREVENTIVE_SERVICES_USE = pd.read_csv(files[6])
RELATIVE_HEALTH_IMPORTANCE = pd.read_csv(files[7])
RISK_FACTORS_AND_ACCESS_TO_CARE = pd.read_csv(files[8])
SUMMARY_MEASURES_OF_HEALTH = pd.read_csv(files[9])
VULNERABLE_POPS_AND_ENV_HEALTH = pd.read_csv(files[10])

```

```

[4]: #Auxiliary files
DATA_ELEMENT_DESCRIPTION
DEFINED_DATA_VALUE
HEALTHY_PEOPLE_2010

```

	Categories	Elements \
0	Birth Measures	Low Birth Wt. (<2500 g)
1	Birth Measures	Very Low Birth Wt. (<1500 g)
2	Birth Measures	Premature Births (<37 weeks)
3	Birth Measures	Births to Women under 18
4	Birth Measures	Births to Women over 40
5	Birth Measures	Births to Unmarried Women
6	Birth Measures	No Care in First Trimester
7	Infant Mortality	Infant Mortality
8	Infant Mortality	White non Hispanic Infant Mortality
9	Infant Mortality	Black non Hispanic Infant Mortality
10	Infant Mortality	Hispanic Infant Mortality
11	Infant Mortality	Neonatal Infant Mortality
12	Infant Mortality	Post-neonatal Infant Mortality
13	Death Measures	Breast Cancer (Female)
14	Death Measures	Colon Cancer
15	Death Measures	Coronary Heart Disease
16	Death Measures	Homicide
17	Death Measures	Lung Cancer
18	Death Measures	Motor Vehicle Injuries
19	Death Measures	Stroke
20	Death Measures	Suicide
21	Death Measures	Unintentional Injury

	US_Pct_or_Rate_2003	Healthy_People_2010_Target
0	7.9	5.0
1	1.4	0.9
2	12.3	7.6
3	3.4	-9998.9
4	2.6	-9998.9
5	34.6	-9998.9
6	16.0	10.0
7	6.8	4.5
8	5.7	4.5
9	13.6	4.5
10	5.6	4.5
11	4.6	2.9
12	2.2	1.2
13	25.3	21.3
14	19.1	13.7
15	172.0	162.0
16	6.0	2.8
17	54.1	43.3
18	14.8	8.0
19	53.0	50.0
20	10.8	4.8
21	37.3	17.1

[5]: LEADING_CAUSES_OF_DEATH.head()

	State_FIPS_Code	County_FIPS_Code	CHSI_County_Name	CHSI_State_Name	\
0	1	1	Autauga	Alabama	
1	1	3	Baldwin	Alabama	
2	1	5	Barbour	Alabama	
3	1	7	Bibb	Alabama	
4	1	9	Blount	Alabama	

	CHSI_State_Abbr	Strata_ID_Number	A_Wh_Comp	CI_Min_A_Wh_Comp	\
0	AL	29	-1111	-1111	
1	AL	16	57	39	
2	AL	51	-1111	-1111	
3	AL	42	-1111	-1111	
4	AL	28	34	17	

	CI_Max_A_Wh_Comp	A_Bl_Comp	...	F_Bl_Cancer	CI_Min_F_Bl_Cancer	\
0	-1111	-1111	...	19	14	
1	75	-1111	...	20	15	
2	-1111	-1111	...	26	22	
3	-1111	-1111	...	20	14	
4	52	-1111	...	28	10	

	CI_Max_F_Bl_Cancer	F_Ot_Cancer	CI_Min_F_Ot_Cancer	CI_Max_F_Ot_Cancer	\
--	--------------------	-------------	--------------------	--------------------	---

```

0          23      -1111      -1111      -1111
1          25      -1111      -1111      -1111
2          31      -1111      -1111      -1111
3          25      -1111      -1111      -1111
4          46      -1111      -1111      -1111

```

	F_Hi_Cancer	CI_Min_F_Hi_Cancer	CI_Max_F_Hi_Cancer	LCD_Time_Span
0	-1111	-1111	-1111	1999-2003
1	-1111	-1111	-1111	2001-2003
2	-1111	-1111	-1111	1999-2003
3	-1111	-1111	-1111	1994-2003
4	-1111	-1111	-1111	1999-2003

[5 rows x 235 columns]

```

[6]: #Outlier column name
DATA_ELEMENT_DESCRIPTION.update(
    DATA_ELEMENT_DESCRIPTION.replace('C_Ot_homicide','C_Ot_Homicide'))
LEADING_CAUSES_OF_DEATH.rename(columns={'C_Ot_homicide':'C_Ot_Homicide'},u
→inplace=True)

#Functions to describe acronyms
def description(param):
    if param in list(DATA_ELEMENT_DESCRIPTION.COLUMN_NAME):
        description_value = DATA_ELEMENT_DESCRIPTION[DATA_ELEMENT_DESCRIPTION.
                                                       COLUMN_NAME==param].DESCRIPTION.tolist()[0]
    else:
        description_value = ''
    return description_value

def short_description(param):
    list_of_removing = ['County data,', 'death measures,', 'birth measures,',u
→', '']
    result = description(param)
    for i in list_of_removing:
        if result.__contains__(i):
            result = result.replace(i,'')
    return result

def short_race_description(param):
    list_of_removing = ['Black', 'Hispanic','White', 'other',
                        'County data,', 'death measures,', 'birth measures,',u
→', '']
    result = description(param)
    for i in list_of_removing:
        if result.__contains__(i):
            result = result.replace(i,'')

```

```

    return result

[7]: #Common columns in all worksheets
county_info = ['State_FIPS_Code', 'County_FIPS_Code', 'CHSI_County_Name',
               'CHSI_State_Name', 'CHSI_State_Abbr', 'Strata_ID_Number']

[8]: #Joining files
worksheets = [DEMOGRAPHICS,
              LEADING_CAUSES_OF_DEATH,
              MEASURES_OF_BIRTH_AND_DEATH,
              PREVENTIVE_SERVICES_USE,
              RELATIVE_HEALTH_IMPORTANCE,
              RISK_FACTORS_AND_ACCESS_TO_CARE,
              SUMMARY_MEASURES_OF_HEALTH,
              VULNERABLE_POPS_AND_ENV_HEALTH]

[9]: #Replacing not available/reported data by zeros
nan_values = [-1111, -1111.1, -1, -9999, -2222, -2222.2, -2]
for worksheet in worksheets:
    nda = []
    for i,nan_value in enumerate(nan_values):
        nda.append(worksheet.loc[:,:]!=nan_value)
    worksheet.update(worksheet.where(ndar[i]).fillna(0))

[10]: #Time dependent data should be identified and normalized
time_dependent_worksheets = [LEADING_CAUSES_OF_DEATH,
                             MEASURES_OF_BIRTH_AND_DEATH,
                             PREVENTIVE_SERVICES_USE,
                             VULNERABLE_POPS_AND_ENV_HEALTH]

time_spans = ['1994-2003', '1999-2003', '2001-2003']
time_span_convert = [7,4,2]
for worksheet in time_dependent_worksheets:
    for i in list(worksheet.columns):
        if i.__contains__('Time_Span'):
            worksheet[i].replace(time_spans, time_span_convert, inplace=True)
            worksheet.rename(columns={i: 'Time'}, inplace=True)

for worksheet in time_dependent_worksheets:
    for i in list(worksheet.columns):
        if worksheet.columns.get_loc(i) < worksheet.columns.get_loc('Time') and
           i not in county_info:
            worksheet[i]=worksheet[i]/worksheet['Time']

[11]: #Merging all clean data files
df = worksheets[0]
for name in worksheets[1:]:

```

```
df = df.merge(name, on=county_info.append('Time'), how='outer', sort=True).  
      ↪fillna(0)
```

[12]: df.head()

```
[12]:   State_FIPS_Code  County_FIPS_Code  CHSI_County_Name  CHSI_State_Name  \  
0           1              1          Autauga        Alabama  
1           1              3          Baldwin        Alabama  
2           1              5         Barbour        Alabama  
3           1              7          Bibb        Alabama  
4           1              9         Blount        Alabama  
  
    CHSI_State_Abbr  Strata_ID_Number  \  
0            AL             29  
1            AL             16  
2            AL             51  
3            AL             42  
4            AL             28  
  
    Strata_Determining_Factors  Number_Counties  \  
0  frontier status, population size, poverty, age            37  
1  frontier status, population size, poverty, age            27  
2  frontier status, population size, poverty, age...          33  
3  frontier status, population size, poverty, age            53  
4  frontier status, population size, poverty, age            39  
  
    Population_Size  Min_Population_Size  ...  Shig_Rpt  Shig_Rpt_Ind  \  
0        48612                28447  ...  1.000000  0.750000  
1       162586                118395  ...  20.500000 2.000000  
2        28414                 27269  ...  0.250000  0.750000  
3        21516                  8134  ...  0.428571  0.428571  
4        55725                 29009  ...  2.750000 1.000000  
  
    Shig_Exp  Toxic_Chem  Carbon_Monoxide_Ind  Nitrogen_Dioxide_Ind  \  
0  2.750000  720799.250000            0.250000            0.250000  
1  6.500000  17832.000000            0.500000            0.500000  
2  4.000000  12468.500000            0.250000            0.250000  
3  2.285714  1043.142857            0.142857            0.142857  
4  1.250000  222255.000000            0.250000            0.250000  
  
    Sulfur_Dioxide_Ind  Ozone_Ind  Particulate_Matter_Ind  Lead_Ind  
0        0.250000  0.250000            0.250000  0.250000  
1        0.500000  1.000000            0.500000  0.500000  
2        0.250000  0.250000            0.250000  0.250000  
3        0.142857  0.142857            0.142857  0.142857  
4        0.250000  0.250000            0.250000  0.250000
```

[5 rows x 533 columns]

0.1.3 Redundant columns

```
[13]: observation = list(df.columns)
description_list = [description(i) for i in observation]
def observ_keyword(variable):
    results = []
    for i, j in enumerate(description_list):
        if variable in str(j):
            results.append(observation[i])
    return results

[14]: filter_percentile = list(description(i) for i in
                           →list(observ_keyword('percentile')))
filter_CI = list(description(i) for i in list(observ_keyword('Confidence'
                           →interval')))
filter_fav = list(description(i) for i in list(observ_keyword('Favorable'
                           →indicator')))

filters = list(observ_keyword('Favorable indicator')
              + observ_keyword('Confidence interval')
              + observ_keyword('percentile'))
df = df.drop(columns=filters)

[15]: #Neutral columns
for i in list(df.columns):
    if len(np.unique(df[i]))==1 and i!='D_Ot_HIV':
        df=df.drop(columns=i)
df.head()

[15]:   State_FIPS_Code  County_FIPS_Code  CHSI_County_Name  CHSI_State_Name \
0                  1                  1      Autauga      Alabama
1                  1                  3      Baldwin      Alabama
2                  1                  5     Barbour      Alabama
3                  1                  7       Bibb      Alabama
4                  1                  9     Blount      Alabama

  CHSI_State_Abbr  Strata_ID_Number \
0          AL             29
1          AL             16
2          AL             51
3          AL             42
4          AL             28

  Strata_Determining_Factors  Number_Counties \
0  frontier status, population size, poverty, age           37
1  frontier status, population size, poverty, age           27
2  frontier status, population size, poverty, age...         33
3  frontier status, population size, poverty, age           53
4  frontier status, population size, poverty, age           39
```

```

Population_Size Population_Density ... Salm_Exp Shig_Rpt Shig_Exp \
0 48612 82.0 ... 7.750000 1.000000 2.750000
1 162586 102.0 ... 33.500000 20.500000 6.500000
2 28414 32.0 ... 7.250000 0.250000 4.000000
3 21516 35.0 ... 4.571429 0.428571 2.285714
4 55725 86.0 ... 7.750000 2.750000 1.250000

Toxic_Chem Carbon_Monoxide_Ind Nitrogen_Dioxide_Ind \
0 720799.250000 0.250000 0.250000
1 17832.000000 0.500000 0.500000
2 12468.500000 0.250000 0.250000
3 1043.142857 0.142857 0.142857
4 222255.000000 0.250000 0.250000

Sulfur_Dioxide_Ind Ozone_Ind Particulate_Matter_Ind Lead_Ind
0 0.250000 0.250000 0.250000 0.250000
1 0.500000 1.000000 0.500000 0.500000
2 0.250000 0.250000 0.250000 0.250000
3 0.142857 0.142857 0.142857 0.142857
4 0.250000 0.250000 0.250000 0.250000

```

[5 rows x 198 columns]

[16]: df.describe().transpose()

	count	mean	std	min	\
State_FIPS_Code	3141.0	30.304680	15.134423	1.000000	
County_FIPS_Code	3141.0	103.716651	107.999484	1.000000	
Strata_ID_Number	3141.0	44.696275	25.118434	1.000000	
Number_Counties	3141.0	38.486151	10.290195	15.000000	
Population_Size	3141.0	94368.164279	306431.655763	62.000000	
...	
Nitrogen_Dioxide_Ind	3141.0	0.235275	0.125723	0.142857	
Sulfur_Dioxide_Ind	3141.0	0.235275	0.125723	0.142857	
Ozone_Ind	3141.0	0.263565	0.202474	0.142857	
Particulate_Matter_Ind	3141.0	0.237595	0.134062	0.142857	
Lead_Ind	3141.0	0.235435	0.126373	0.142857	
		25%	50%	75%	max
State_FIPS_Code		18.000000	29.000000	45.00	56.0
County_FIPS_Code		35.000000	79.000000	133.00	840.0
Strata_ID_Number		23.000000	44.000000	66.00	88.0
Number_Counties		32.000000	37.000000	45.00	62.0
Population_Size		11211.000000	25235.000000	64040.00	9935475.0
...		
Nitrogen_Dioxide_Ind		0.142857	0.142857	0.25	0.5
Sulfur_Dioxide_Ind		0.142857	0.142857	0.25	0.5

Ozone_Ind	0.142857	0.142857	0.25	1.0
Particulate_Matter_Ind	0.142857	0.142857	0.25	1.0
Lead_Ind	0.142857	0.142857	0.25	1.0

[194 rows x 8 columns]

0.1.4 Demographic Map

To visualize the health indices throughout the country, I merge the map shapefile and data to us_merge dataframes. Because Alaska and Hawaii are further away and out of proportion I merged them separately. US_plot function creates the US map with any numeric variables in the data –default color is blue.

```
[17]: us_map = gpd.read_file('../US-map/UScounties.shp')
us_map_land = us_map[ (us_map['STATE_NAME']!='Alaska') &(us_map['STATE_NAME']!='Hawaii')]
us_map_Alaska = us_map[us_map['STATE_NAME']=='Alaska']
us_map_Hawaii = us_map[us_map['STATE_NAME']=='Hawaii']

#Merging map and data:
df_land = us_map_land.set_index('NAME').join(df.set_index('CHSI_County_Name'))
df_Alaska = us_map_Alaska.set_index('NAME').join(df.set_index('CHSI_County_Name'))
df_Hawaii = us_map_Hawaii.set_index('NAME').join(df.set_index('CHSI_County_Name'))
```

```
[18]: def min_max_col(variable):
    minimum = min(df_land[variable].min(),
                  df_Alaska[variable].min(), df_Hawaii[variable].min())
    maximum = max(df_land[variable].max(),
                  df_Alaska[variable].max(), df_Hawaii[variable].max())
    return minimum, maximum

def US_plot(variable, color='Blues'):
    h, w = figaspect(1.)
    mn, mx = min_max_col(variable)
    fig, ax1 = plt.subplots(1, figsize=(w*10, h*10))
    ax1.axis('off')
    ax1.set_title(description(variable), fontsize=40)
    divider = make_axes_locatable(ax1)
    cax = divider.append_axes('right', size='2%', pad=0.1)
    cax.tick_params(labelsize=25)
    df_land.plot(column=variable, cmap=color,
                 linewidth=0.8, ax=ax1,
                 edgecolor='0.8', vmin=mn ,vmax=mx,
                 legend=True, cax=cax)
```

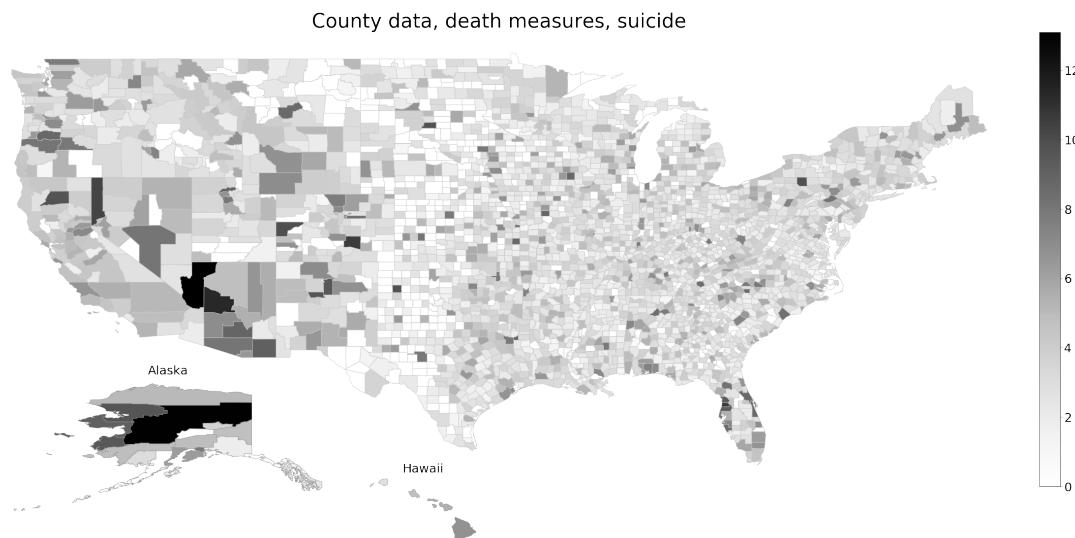
```

left, bottom, width, height = [0.15, 0.22, 0.24, 0.3]
ax2 = fig.add_axes([left, bottom, width, height])
ax2.axis('off')
ax2.set_title('Alaska', fontsize=25)
df_Alaska.plot(column=variable, cmap=color, vmin=mn ,vmax=mx,
                linewidth=0.8, ax=ax2, edgecolor='0.6')

left, bottom, width, height = [0.35, 0.3, 0.2, 0.05]
ax3 = fig.add_axes([left, bottom, width, height])
ax3.axis('off')
ax3.set_title('Hawaii', fontsize=25)
df_Hawaii.plot(column =variable, cmap=color, vmin=mn ,vmax=mx,
                linewidth=0.8, ax=ax3, edgecolor='0.6')

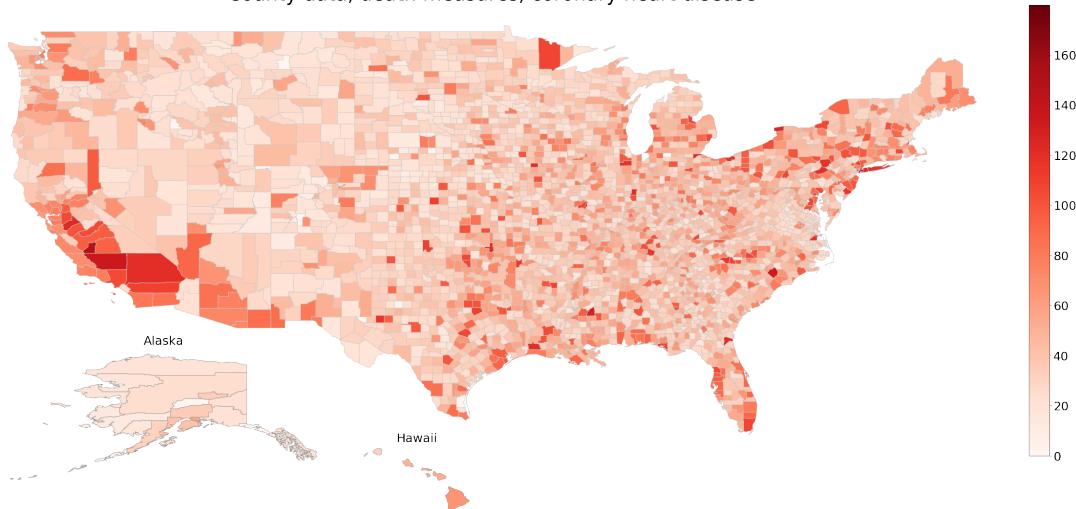
```

[19]: US_plot('Suicide', 'Greys')



[20]: US_plot('CHD', 'Reds')

County data, death measures, coronary heart disease



0.1.5 Measures of Birth and Death

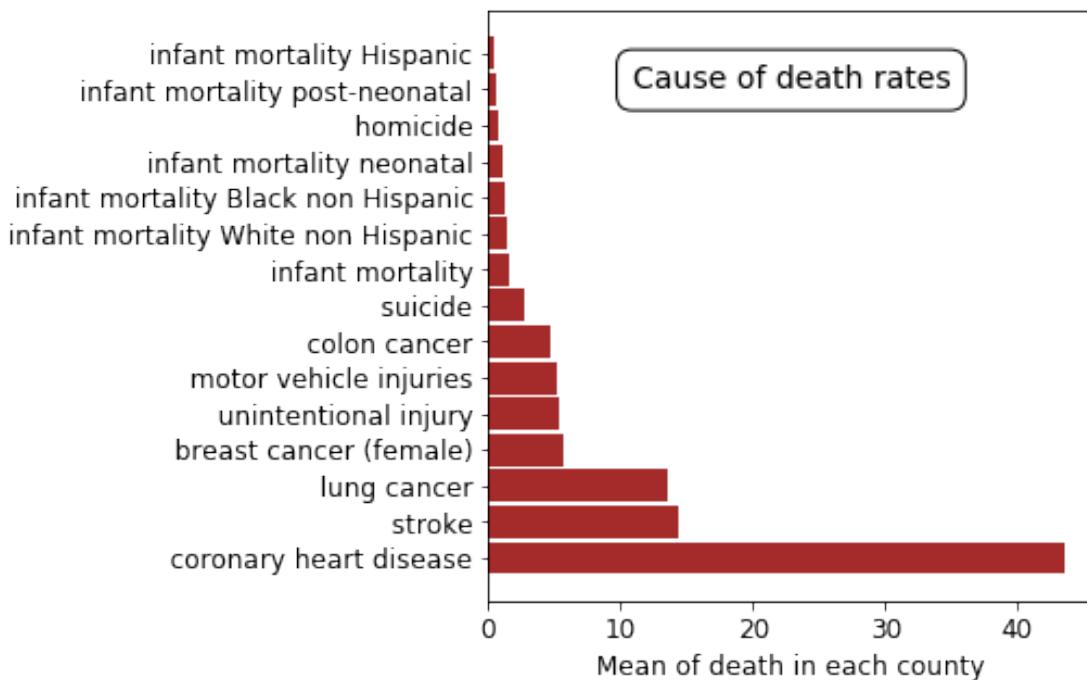
```
[21]: Birth_Death_list = list(np.intersect1d(df.columns, MEASURES_OF_BIRTH_AND_DEATH.
                                         →columns))
Birth = []
Death = []
for i in Birth_Death_list:
    if i not in county_info:
        if description(i).__contains__('birth'):
            Birth.append(i)
        else:
            Death.append(i)

[22]: Death_Mean = {'Cause_of_Death':Death, 'Mean_Death':[np.mean(df[i]) for i in
                                         →Death]}
Birth_Mean = {'Birth':Birth, 'Mean_Birth':[np.mean(df[i]) for i in Birth]}

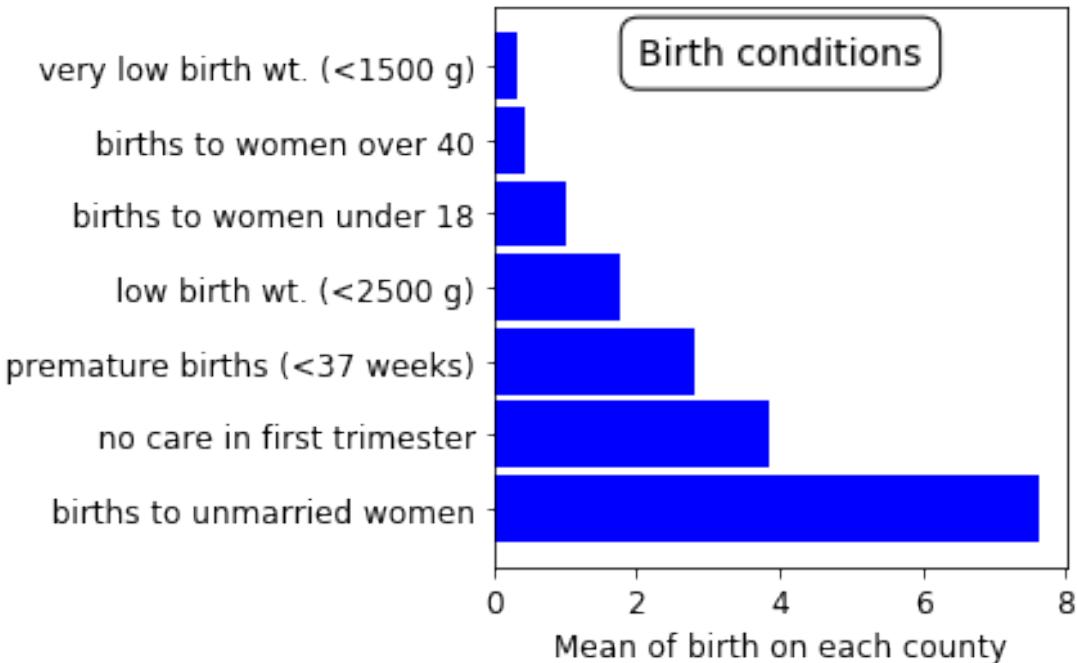
df_death_mean = pd.DataFrame(Death_Mean)
df_death_mean = df_death_mean.
    →drop(df_death_mean[df_death_mean['Cause_of_Death'] == 'Total_Deaths'].index, ↴
          axis=0)
df_death_mean = df_death_mean.sort_values(by=['Mean_Death'], ascending=False)

df_birth_mean = pd.DataFrame(Birth_Mean)
df_birth_mean = df_birth_mean.drop(df_birth_mean[df_birth_mean['Birth'] ↴
    →== 'Total_Births'].index, axis=0)
df_birth_mean = df_birth_mean.sort_values(by=['Mean_Birth'], ascending=False)
```

```
[23]: fig, ax = plt.subplots(1, figsize=(5, 5))
labels=list(short_description(i) for i in df_death_mean.Cause_of_Death)
plt.barh(labels, df_death_mean.Mean_Death, color='brown', height=0.9)
plt.xlabel('Mean of death in each county', fontsize=12)
plt.title('Cause of death rates', y=0.845, fontsize=14,
           bbox=dict(facecolor='none', edgecolor='k', boxstyle='round, pad=0.5'))
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```



```
[24]: fig, ax = plt.subplots(1, figsize=(4, 4))
labels=list(short_description(i) for i in df_birth_mean.Birth)
plt.barh(labels, df_birth_mean.Mean_Birth, color='b', height=0.9)
plt.xlabel('Mean of birth on each county', fontsize=12)
plt.title('Birth conditions', y=0.872, fontsize=14,
           bbox=dict(facecolor='none', edgecolor='k', boxstyle='round, pad=0.5'))
plt.xticks(fontsize=12)
plt.yticks(fontsize=12)
plt.show()
```



```
[25]: Death_race_list = list(np.intersect1d(df.columns, LEADING_CAUSES_OF_DEATH.
                                         →columns))
Black = []
Hispanic = []
White = []
other = []
for i in Death_race_list:
    if i not in county_info:
        if description(i).__contains__('Black'):
            Black.append(i)
        elif description(i).__contains__('Hispanic'):
            Hispanic.append(i)
        elif description(i).__contains__('White'):
            White.append(i)
        else:
            other.append(i)
```

```
[26]: Black_up_24=[]
Black_25=[]
Hispanic_up_24=[]
Hispanic_25=[]
White_up_24=[]
White_25=[]
other_up_24=[]
other_25=[]
```

```

for i in Black:
    if description(i).__contains__('25-44') or description(i).
    →__contains__('45-64') or description(i).__contains__('65+'):
        Black_25.append(i)
    else:
        Black_up_24.append(i)
for i in Hispanic:
    if description(i).__contains__('25-44') or description(i).
    →__contains__('45-64') or description(i).__contains__('65+'):
        Hispanic_25.append(i)
    else:
        Hispanic_up_24.append(i)
for i in White:
    if description(i).__contains__('25-44') or description(i).
    →__contains__('45-64') or description(i).__contains__('65+'):
        White_25.append(i)
    else:
        White_up_24.append(i)
for i in other:
    if description(i).__contains__('25-44') or description(i).
    →__contains__('45-64') or description(i).__contains__('65+'):
        other_25.append(i)
    else:
        other_up_24.append(i)

```

[27]:

```

fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(2,2, figsize=(25, 25), sharey=True)
fig.subplots_adjust(hspace=-0.1)
cs=cm.Pastel1(np.arange(100))
mpl.rcParams['font.size'] = 15
fig.suptitle('Cause of Death, age under 25: Different Races', y=0.95, u
→fontsize=30)
ax1.set_title('Black', fontsize=25)
labels=list(short_race_description(i) for i in Black_up_24)
ax1.pie(list(np.mean(df[i]) for i in Black_up_24),
       labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

ax2.set_title('Hispanic', fontsize=25)
labels=list(short_race_description(i) for i in Hispanic_up_24)
ax2.pie(list(np.mean(df[i]) for i in Hispanic_up_24),
       labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

ax3.set_title('White', fontsize=25)
labels=list(short_race_description(i) for i in White_up_24)
ax3.pie(list(np.mean(df[i]) for i in White_up_24),
       labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

ax4.set_title('Other', fontsize=25)

```

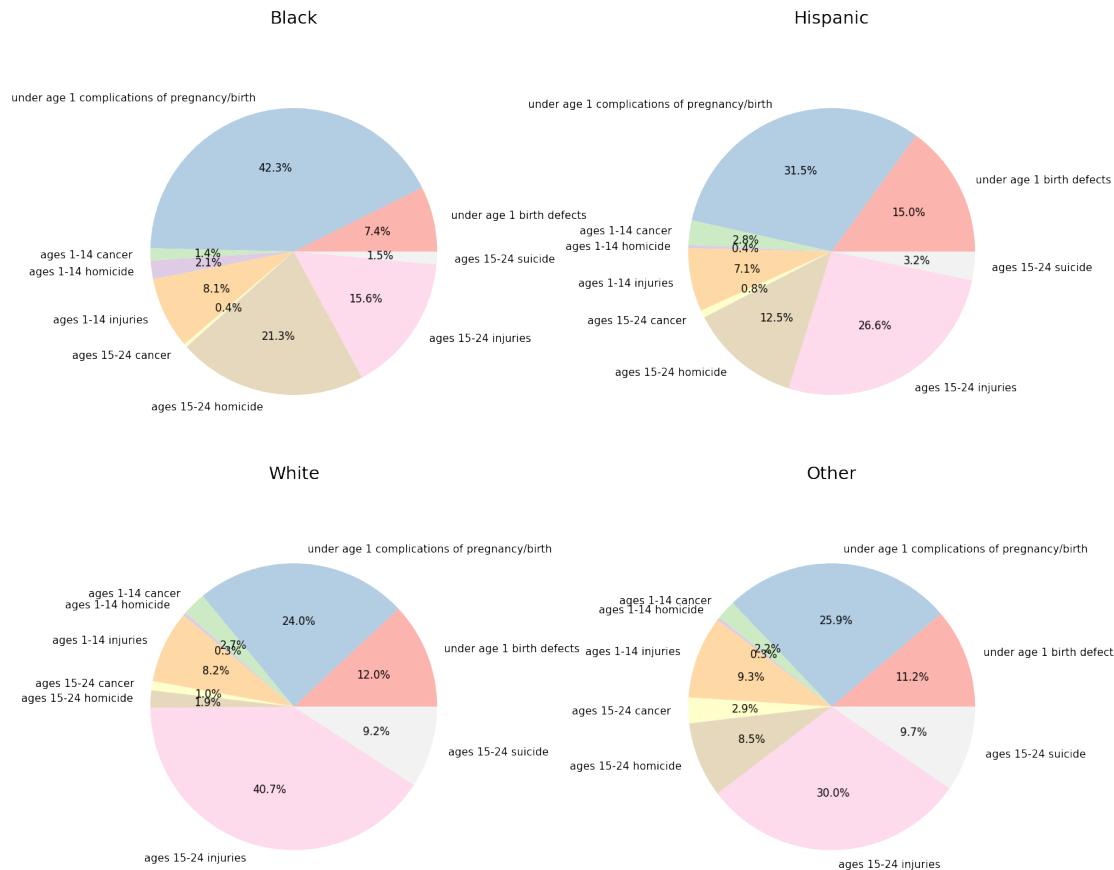
```

labels=list(short_race_description(i) for i in other_up_24)
ax4.pie(list(np.mean(df[i])*2 for i in other_up_24),
        labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

plt.show()

```

Cause of Death, age under 25: Different Races



```

[28]: fig, ((ax1, ax2), (ax3, ax4)) = plt.subplots(2,2, figsize=(25, 25), sharey=True)
fig.subplots_adjust(hspace=-0.1)
cs=cm.Set3(np.arange(100))
mpl.rcParams['font.size'] = 15
fig.suptitle('Cause of Death, age 25+: Different Races', y=0.95, fontsize=30)
ax1.set_title('Black', fontsize=25)
labels=list(short_race_description(i) for i in Black_25)
ax1.pie(list(np.mean(df[i]) for i in Black_25),
        labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

```

```

ax2.set_title('Hispanic', fontsize=25)
labels=list(short_race_description(i) for i in Hispanic_25)
ax2.pie(list(np.mean(df[i]) for i in Hispanic_25),
        labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

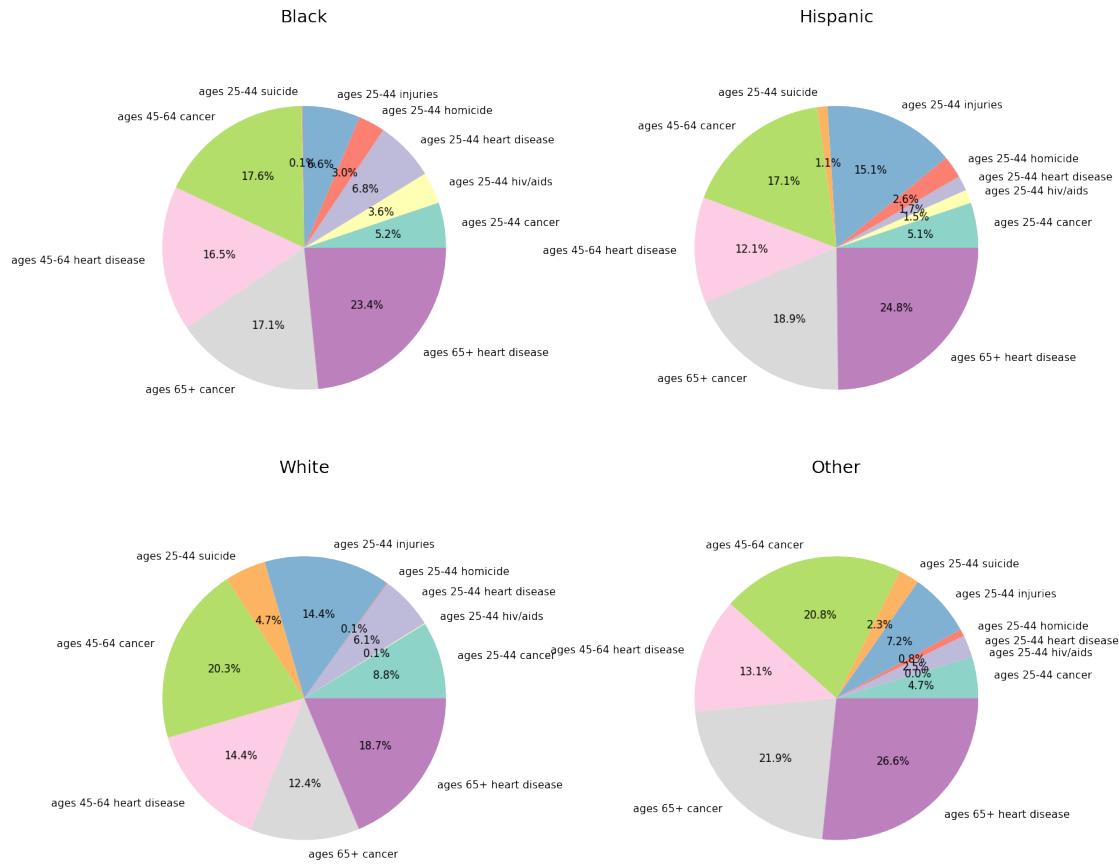
ax3.set_title('White', fontsize=25)
labels=list(short_race_description(i) for i in White_25)
ax3.pie(list(np.mean(df[i]) for i in White_25),
        labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

ax4.set_title('Other', fontsize=25)
labels=list(short_race_description(i) for i in other_25)
ax4.pie(list(np.mean(df[i]) for i in other_25),
        labels=labels, colors=cs, autopct='%.1f%%', radius=0.8)

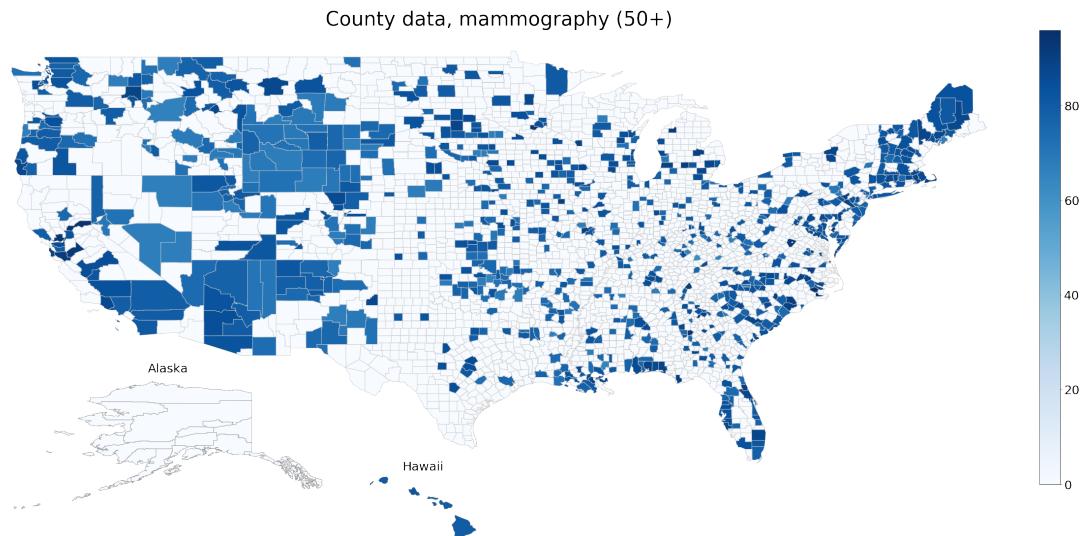
plt.show()

```

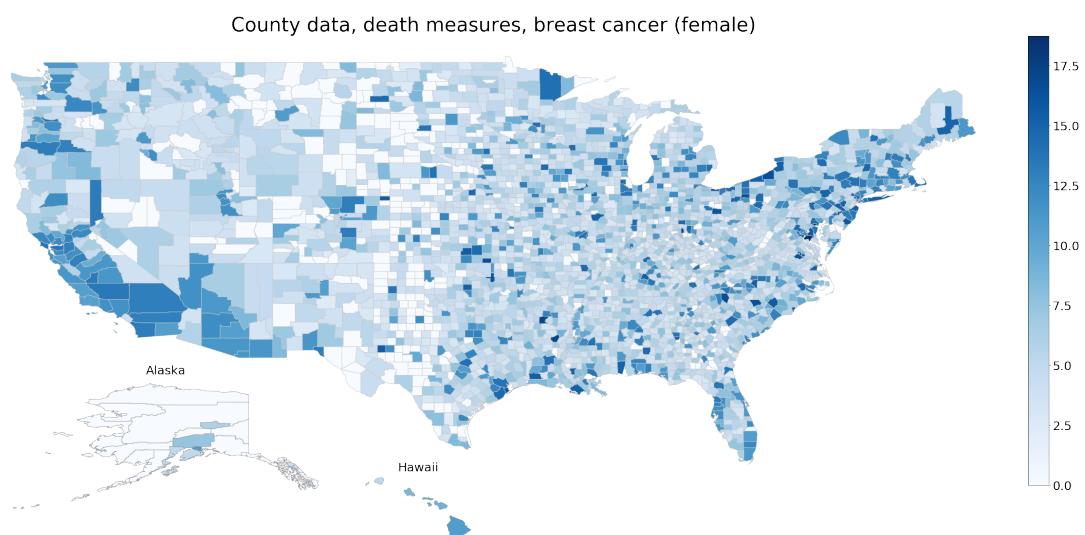
Cause of Death, age 25+: Different Races



```
[29]: df.Mammogram  
US_plot('Mammogram')
```



```
[30]: US_plot('Brst_Cancer')
```



0.1.6 Correlations between Variables

The following table shows the Pearson correlation between variables:

```
[31]: df.corr(method = 'pearson')
```

[31]:

	State_FIPS_Code	County_FIPS_Code	Strata_ID_Number	\		
State_FIPS_Code	1.000000	0.166480	0.000187			
County_FIPS_Code	0.166480	1.000000	0.044329			
Strata_ID_Number	0.000187	0.044329	1.000000			
Number_Counties	0.027089	0.028094	-0.016999			
Population_Size	-0.057695	-0.051829	-0.385595			
...		
Nitrogen_Dioxide_Ind	-0.014068	-0.075417	-0.795967			
Sulfur_Dioxide_Ind	-0.014068	-0.075417	-0.795967			
Ozone_Ind	-0.043496	-0.078794	-0.683131			
Particulate_Matter_Ind	-0.027528	-0.073277	-0.770920			
Lead_Ind	-0.014104	-0.075084	-0.793512			
	Number_Counties	Population_Size	Population_Density	\		
State_FIPS_Code	0.027089	-0.057695	0.023598			
County_FIPS_Code	0.028094	-0.051829	0.052212			
Strata_ID_Number	-0.016999	-0.385595	-0.185758			
Number_Counties	1.000000	-0.085950	-0.031292			
Population_Size	-0.085950	1.000000	0.335231			
...		
Nitrogen_Dioxide_Ind	-0.129497	0.477760	0.222360			
Sulfur_Dioxide_Ind	-0.129497	0.477760	0.222360			
Ozone_Ind	-0.104967	0.522135	0.195464			
Particulate_Matter_Ind	-0.129573	0.509329	0.213169			
Lead_Ind	-0.126564	0.475792	0.221272			
	Poverty	Age_19_Under	Age_19_64	Age_65_84	...	\
State_FIPS_Code	-0.020754	-0.077999	-0.037598	0.098458	...	
County_FIPS_Code	0.140420	0.127726	-0.110678	-0.004368	...	
Strata_ID_Number	0.276217	-0.147028	-0.329400	0.388108	...	
Number_Counties	-0.108006	-0.073129	-0.075331	0.105265	...	
Population_Size	-0.055041	0.126784	0.104946	-0.193847	...	
...
Nitrogen_Dioxide_Ind	-0.189415	0.185081	0.249407	-0.354018	...	
Sulfur_Dioxide_Ind	-0.189415	0.185081	0.249407	-0.354018	...	
Ozone_Ind	-0.169929	0.181667	0.224395	-0.331683	...	
Particulate_Matter_Ind	-0.166007	0.197109	0.233078	-0.350170	...	
Lead_Ind	-0.189819	0.184625	0.249517	-0.353629	...	
	Salm_Exp	Shig_Rpt	Shig_Exp	Toxic_Chem	\	
State_FIPS_Code	-0.063681	-0.006557	-0.061807	-0.013879		
County_FIPS_Code	-0.055910	0.029384	-0.034715	-0.019483		
Strata_ID_Number	-0.465205	-0.297500	-0.419904	-0.155351		
Number_Counties	-0.107958	-0.062619	-0.088583	-0.068168		
Population_Size	0.978261	0.523775	0.901652	0.204323		
...	
Nitrogen_Dioxide_Ind	0.583461	0.376931	0.532349	0.217413		

Sulfur_Dioxide_Ind	0.583461	0.376931	0.532349	0.217413	
Ozone_Ind	0.613932	0.401853	0.563673	0.249636	
Particulate_Matter_Ind	0.604673	0.385331	0.559581	0.222776	
Lead_Ind	0.581096	0.375404	0.529744	0.219943	
		Carbon_Monoxide_Ind	Nitrogen_Dioxide_Ind	\	
State_FIPS_Code		-0.016436	-0.014068		
County_FIPS_Code		-0.075387	-0.075417		
Strata_ID_Number		-0.793963	-0.795967		
Number_Counties		-0.128768	-0.129497		
Population_Size		0.477616	0.477760		
...			
Nitrogen_Dioxide_Ind		0.997508	1.000000		
Sulfur_Dioxide_Ind		0.997508	1.000000		
Ozone_Ind		0.874168	0.874082		
Particulate_Matter_Ind		0.967427	0.969951		
Lead_Ind		0.995015	0.997508		
		Sulfur_Dioxide_Ind	Ozone_Ind	Particulate_Matter_Ind	\
State_FIPS_Code		-0.014068	-0.043496	-0.027528	
County_FIPS_Code		-0.075417	-0.078794	-0.073277	
Strata_ID_Number		-0.795967	-0.683131	-0.770920	
Number_Counties		-0.129497	-0.104967	-0.129573	
Population_Size		0.477760	0.522135	0.509329	
...		
Nitrogen_Dioxide_Ind		1.000000	0.874082	0.969951	
Sulfur_Dioxide_Ind		1.000000	0.874082	0.969951	
Ozone_Ind		0.874082	1.000000	0.866830	
Particulate_Matter_Ind		0.969951	0.866830	1.000000	
Lead_Ind		0.997508	0.871056	0.967427	
		Lead_Ind			
State_FIPS_Code		-0.014104			
County_FIPS_Code		-0.075084			
Strata_ID_Number		-0.793512			
Number_Counties		-0.126564			
Population_Size		0.475792			
...		...			
Nitrogen_Dioxide_Ind		0.997508			
Sulfur_Dioxide_Ind		0.997508			
Ozone_Ind		0.871056			
Particulate_Matter_Ind		0.967427			
Lead_Ind		1.000000			

[194 rows x 194 columns]

Well, this is too much information about our big dataframe! To know about the important correlated variables we need more cleaning;

I'll make another small dataframe with 3 columns: column one and two→ correlated pairs and column 3 the magnitude of their correlations. To make it easier to see the highly correlated parameters I sort them. I also defined a threshold=0.7 to cut low-correlated ones.

```
[32]: not_helping_columns = ['Sulfur_Dioxide_Ind',
                           'Nitrogen_Dioxide_Ind', 'Lead_Ind', ↳
                           'Carbon_Monoxide_Ind', 'Particulate_Matter_Ind', 'Time']

#The function of making dataframes with different thresholds of correlations
def func_df_corr(threshold):
    threshold = threshold
    attrs = df.drop(columns=not_helping_columns).corr()
    high_corrs = (attrs[abs(attrs) > threshold][attrs != 1.0]).unstack().dropna().to_dict()
    df_corrs = pd.DataFrame(list((sorted(key)[0], sorted(key)[1], ↳
                                   high_corrs[key]) for key in high_corrs),
                            columns=['attribute_1', 'attribute_2', ↳
                                     'correlation'])
    df_corrs = df_corrs.iloc[abs(df_corrs['correlation']).argsort()[:-1]].drop_duplicates().reset_index(drop=True)
    return df_corrs

df_corrs = func_df_corr(0.6)
df_corrs.head(20)
```

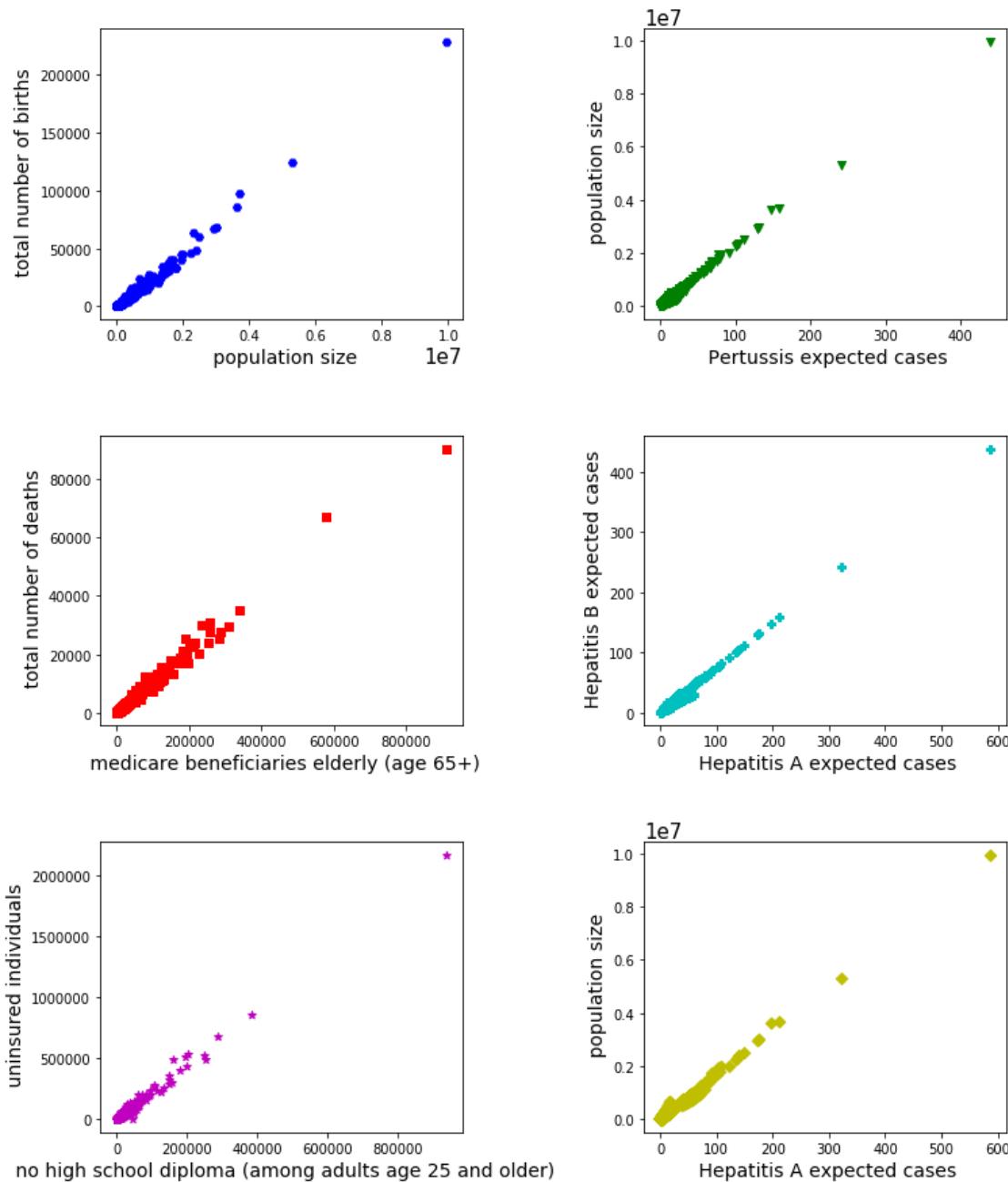
	attribute_1	attribute_2	correlation
0	Major_Depression	Population_Size	0.993877
1	Population_Size	Total_Births	0.993762
2	Pert_Exp	Population_Size	0.993672
3	Elderly_Medicare	Total_Deaths	0.993192
4	HepA_Exp	HepB_Exp	0.992540
5	No_HS_Diploma	Uninsured	0.991927
6	HepA_Exp	Population_Size	0.989902
7	Major_Depression	Pert_Exp	0.989281
8	Population_Size	Recent_Drug_Use	0.986504
9	Pert_Exp	Total_Births	0.986449
10	HepA_Exp	Total_Births	0.986186
11	HepA_Exp	Pert_Exp	0.985803
12	HepA_Exp	Major_Depression	0.984434
13	Population_Size	Unemployed	0.984176
14	Major_Depression	Total_Births	0.984092
15	Total_Births	Unemployed	0.984065
16	HepB_Exp	Population_Size	0.983862
17	Disabled_Medicare	Total_Deaths	0.983111
18	Ecol_Exp	Population_Size	0.982927
19	HepB_Exp	Syphilis_Exp	0.982537

Alright! It looks better!

```
[33]: # If we want to make a df with tuples of correlated pairs:  
# df_corrs = pd.DataFrame(list(set([(tuple(sorted(key)), high_corrs [key])  
#                                     for key in high_corrs])),  
#                         columns=['attribute_pair', 'correlation']))
```

```
[34]: #Here we plot the top 6 most correlated parameters:  
colors = ['b', 'g', 'r', 'c', 'm', 'y']  
markers = ['H', 'v', 's', 'P', '*', 'D']  
fig, axs = plt.subplots(3,2, figsize=(12,15), facecolor='w', edgecolor='k')  
fig.subplots_adjust(hspace=0.4, wspace=0.5)  
fig.suptitle('Plots of highly-correlated parameters', y=0.97, fontsize=30)  
axs = axs.ravel()  
  
for i in range(6):  
    axs[i].scatter(df[df_corrs.loc[i+1,'attribute_1']], df[df_corrs.  
→loc[i+1,'attribute_2']],  
                    marker=markers[i], color=colors[i])  
    axs[i].set_xlabel(short_description(df_corrs.loc[i+1,'attribute_1']),  
→fontsize=14)  
    axs[i].set_ylabel(short_description(df_corrs.loc[i+1,'attribute_2']),  
→fontsize=14)  
    axs[i].tick_params(axis='x', labelsize=10)  
    axs[i].tick_params(axis='y', labelsize=10)
```

Plots of highly-correlated parameters



```
[35]: for i in Death:
    print(df_corrs[df_corrs['attribute_1']==i].head(10))
```

	attribute_1	attribute_2	correlation
162	Brst_Cancer	E_Wh_Cancer	0.886133

175	Brst_Cancer	F_Wh_Cancer	0.880687
179	Brst_Cancer	Col_Cancer	0.876601
190	Brst_Cancer	Premature	0.871133
194	Brst_Cancer	LBW	0.866469
195	Brst_Cancer	Lung_Cancer	0.865634
199	Brst_Cancer	F_Wh_HeartDis	0.863822
207	Brst_Cancer	E_Wh_HeartDis	0.859256
237	Brst_Cancer	VLBW	0.831433
238	Brst_Cancer	Stroke	0.831162
	attribute_1	attribute_2	correlation
110	CHD	F_Wh_HeartDis	0.935667
142	CHD	E_Wh_HeartDis	0.899126
171	CHD	Lung_Cancer	0.883059
183	CHD	Premature	0.875345
204	CHD	LBW	0.859882
224	CHD	Col_Cancer	0.843544
230	CHD	F_Wh_Cancer	0.835635
252	CHD	Unmarried	0.820675
255	CHD	E_Wh_Cancer	0.818792
264	CHD	VLBW	0.812496
	attribute_1	attribute_2	correlation
170	Col_Cancer	Lung_Cancer	0.883116
177	Col_Cancer	E_Wh_Cancer	0.876780
184	Col_Cancer	F_Wh_Cancer	0.873506
192	Col_Cancer	E_Wh_HeartDis	0.868112
205	Col_Cancer	F_Wh_HeartDis	0.859775
208	Col_Cancer	Premature	0.858899
218	Col_Cancer	LBW	0.850530
233	Col_Cancer	Stroke	0.833689
258	Col_Cancer	VLBW	0.816654
273	Col_Cancer	Unmarried	0.803242
	attribute_1	attribute_2	correlation
479	Homicide	Unmarried	0.724589
484	Homicide	RHI_Homicide_Ind	0.723311
554	Homicide	VLBW	0.697721
594	Homicide	Under_18	0.684708
602	Homicide	LBW	0.682850
712	Homicide	Premature	0.652485
720	Homicide	Infant_Mortality	0.650414
867	Homicide	IM_Neonatal	0.610523
919	Homicide	IM_B1_Non_Hisp	0.603218
925	Homicide	IM_Postneonatal	0.602134
	attribute_1	attribute_2	correlation
229	IM_B1_Non_Hisp	RHI_IM_B1_Non_Hisp_Ind	0.836600
451	IM_B1_Non_Hisp	VLBW	0.732362
500	IM_B1_Non_Hisp	Infant_Mortality	0.717898
503	IM_B1_Non_Hisp	LBW	0.716869
509	IM_B1_Non_Hisp	IM_Neonatal	0.715536

581	IM_B1_Non_Hisp	Premature	0.688660
624	IM_B1_Non_Hisp	Unmarried	0.678101
810	IM_B1_Non_Hisp	Lung_Cancer	0.622090
928	IM_B1_Non_Hisp	Stroke	0.601380
	attribute_1	attribute_2	correlation
240	IM_Hisp	RHI_IM_Hisp_Ind	0.830289
	attribute_1	attribute_2	correlation
83	IM_Neonatal	Infant_Mortality	0.957536
167	IM_Neonatal	VLBW	0.884262
214	IM_Neonatal	LBW	0.854181
225	IM_Neonatal	IM_Wh_Non_Hisp	0.839856
241	IM_Neonatal	Premature	0.830115
262	IM_Neonatal	Unmarried	0.814709
287	IM_Neonatal	Lung_Cancer	0.791710
333	IM_Neonatal	Stroke	0.772439
535	IM_Neonatal	IM_Postneonatal	0.704508
598	IM_Neonatal	Injury	0.683374
	attribute_1	attribute_2	correlation
202	IM_Postneonatal	Infant_Mortality	0.861712
335	IM_Postneonatal	IM_Wh_Non_Hisp	0.771664
355	IM_Postneonatal	Unmarried	0.762027
400	IM_Postneonatal	LBW	0.748177
402	IM_Postneonatal	Premature	0.747661
405	IM_Postneonatal	VLBW	0.746402
481	IM_Postneonatal	Lung_Cancer	0.724177
574	IM_Postneonatal	Stroke	0.691351
591	IM_Postneonatal	Under_18	0.685518
634	IM_Postneonatal	Injury	0.674898
	attribute_1	attribute_2	correlation
176	IM_Wh_Non_Hisp	Infant_Mortality	0.878677
286	IM_Wh_Non_Hisp	Lung_Cancer	0.793334
338	IM_Wh_Non_Hisp	Premature	0.770844
342	IM_Wh_Non_Hisp	LBW	0.769292
366	IM_Wh_Non_Hisp	VLBW	0.757914
389	IM_Wh_Non_Hisp	Stroke	0.750930
464	IM_Wh_Non_Hisp	Unmarried	0.728337
561	IM_Wh_Non_Hisp	Injury	0.695708
566	IM_Wh_Non_Hisp	Strata_ID_Number	-0.693857
568	IM_Wh_Non_Hisp	Suicide	0.693612
	attribute_1	attribute_2	correlation
146	Infant_Mortality	VLBW	0.897124
182	Infant_Mortality	LBW	0.875407
209	Infant_Mortality	Premature	0.858678
213	Infant_Mortality	Unmarried	0.854232
251	Infant_Mortality	Lung_Cancer	0.820784
285	Infant_Mortality	Stroke	0.795222
459	Infant_Mortality	Injury	0.729428
527	Infant_Mortality	Under_18	0.707677

	attribute_1	attribute_2	correlation
603	Infant_Mortality	Ozone_Ind	0.682789
652	Infant_Mortality	Strata_ID_Number	-0.669357
	attribute_1	attribute_2	correlation
300	Injury	Premature	0.785381
305	Injury	Lung_Cancer	0.782913
328	Injury	LBW	0.773255
343	Injury	Suicide	0.767469
345	Injury	Unmarried	0.766347
427	Injury	Stroke	0.739471
492	Injury	VLBW	0.720905
647	Injury	Ozone_Ind	0.670945
781	Injury	Strata_ID_Number	-0.629603
790	Injury	Under_18	0.628107
	attribute_1	attribute_2	correlation
144	Lung_Cancer	Premature	0.897972
187	Lung_Cancer	Stroke	0.871812
221	Lung_Cancer	VLBW	0.847087
227	Lung_Cancer	Unmarried	0.838080
350	Lung_Cancer	Ozone_Ind	0.764632
384	Lung_Cancer	Strata_ID_Number	-0.753092
414	Lung_Cancer	Suicide	0.743307
681	Lung_Cancer	Under_18	0.659504
794	Lung_Cancer	Over_40	0.627460
	attribute_1	attribute_2	correlation
691	MVA	RHI_MVA_Ind	0.658178
855	MVA	Under_18	0.612438
	attribute_1	attribute_2	correlation
249	Stroke	VLBW	0.821874
281	Stroke	Unmarried	0.798352
556	Stroke	Suicide	0.697454
752	Stroke	Under_18	0.638731
	attribute_1	attribute_2	correlation
587	Suicide	Unmarried	0.687304
769	Suicide	VLBW	0.632481
	attribute_1	attribute_2	correlation
56	Total_Deaths	Unemployed	0.967528
126	Total_Deaths	Uninsured	0.917039

[36]: *#Now the most correlated parameters with heart disease:*

```

num_plots = 16
colors = cm.tab20(np.linspace(0, 1, num_plots))
fig, axs = plt.subplots(int(num_plots/2),2, figsize=(12,40), facecolor='w',  

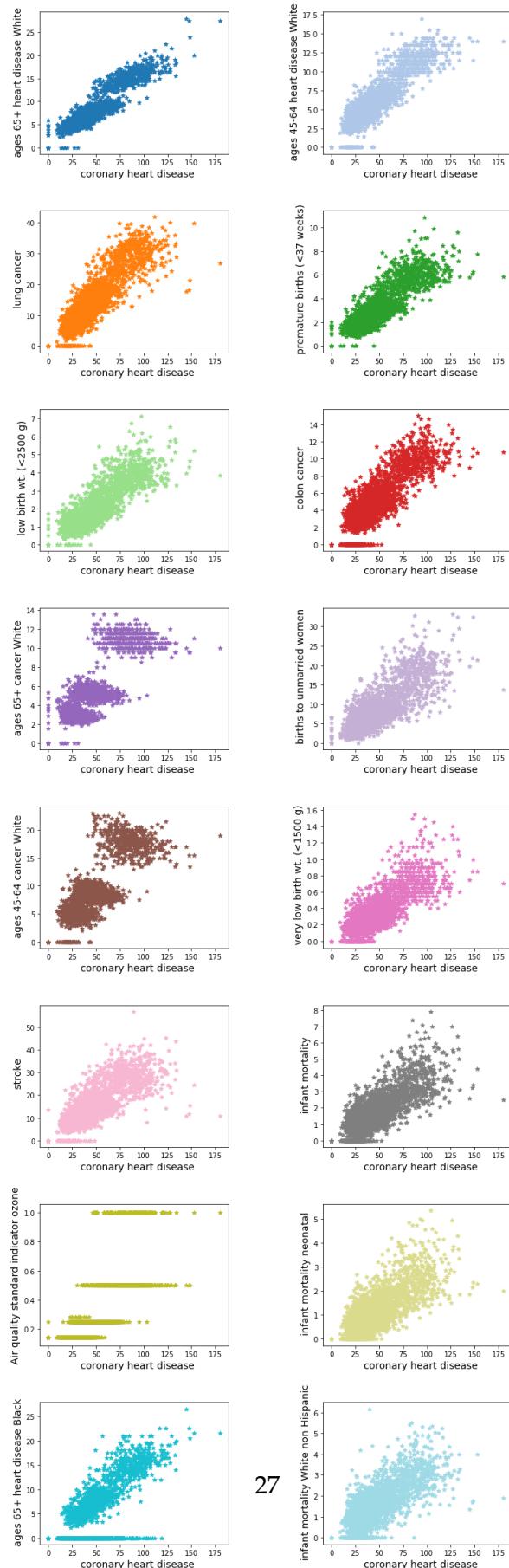
    ↪edgecolor='k')
fig.subplots_adjust(hspace=0.4, wspace=0.5)
fig.suptitle('Plots of most correlated parameters with heart disease', y=0.92,  

    ↪fontsize=30)
axs = axs.ravel()

```

```
corr_params = list(df_corrs[df_corrs['attribute_1']=='CHD']['attribute_2'])
for i in range(num_plots):
    axs[i].scatter(df['CHD'], df[corr_params[i]],
                   marker='*', color=colors[i])
    axs[i].set_xlabel(short_description('CHD'), fontsize=14)
    axs[i].set_ylabel(short_description(corr_params[i]), fontsize=14)
    axs[i].tick_params(axis='x', labelsize=10)
    axs[i].tick_params(axis='y', labelsize=10)
```

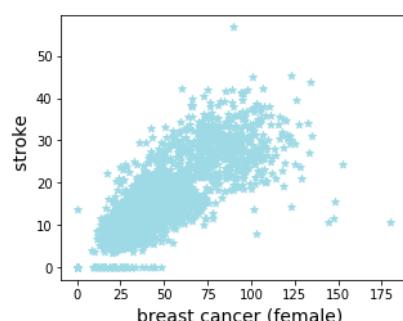
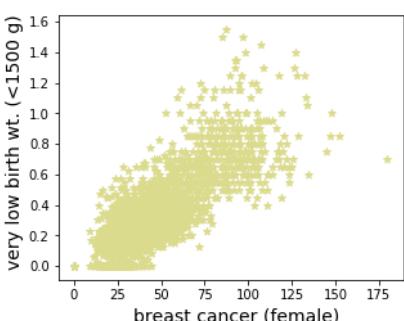
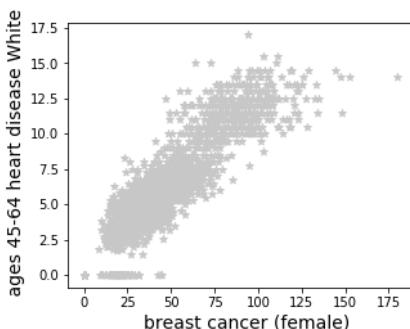
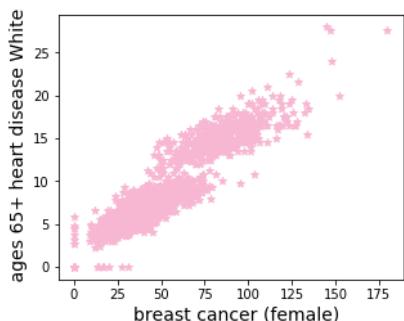
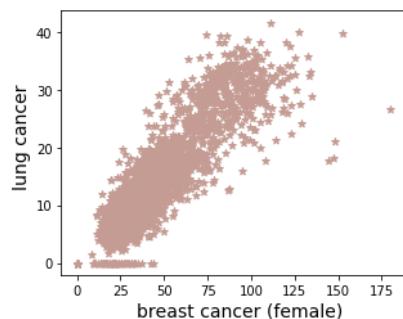
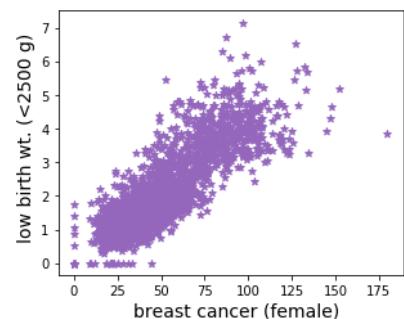
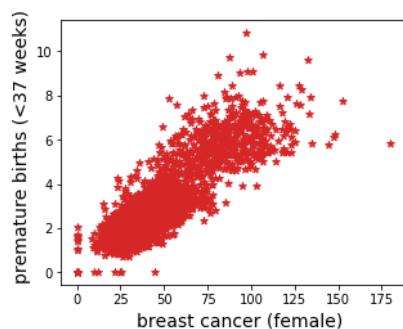
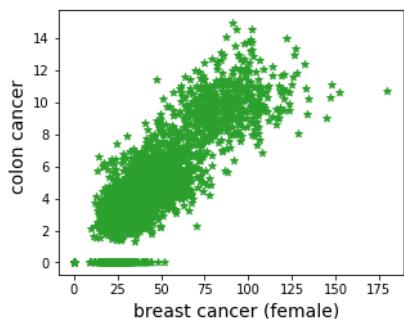
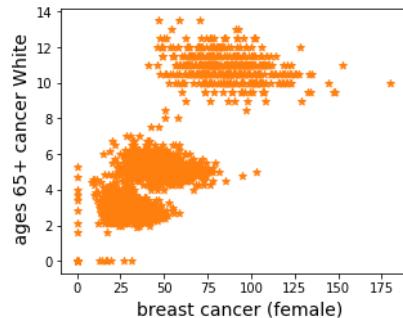
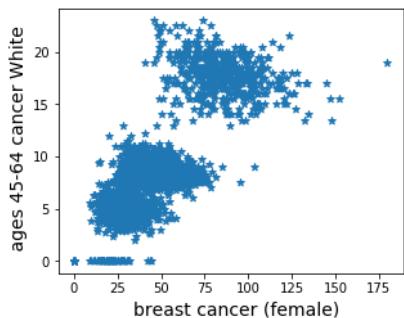
Plots of most correlated parameters with heart disease



```
[37]: #Now the most correlated parameters with breast cancer:
num_plots = 10
colors = cm.tab20(np.linspace(0, 1, num_plots))
fig, axs = plt.subplots(int(num_plots/2),2, figsize=(12,25), facecolor='w', edgecolor='k')
fig.subplots_adjust(hspace=0.4, wspace=0.5)
fig.suptitle('Plots of most correlated parameters with breast cancer', y=0.92, fontsize=30)
axs = axs.ravel()

corr_params = list(df_corrs[df_corrs['attribute_1']=='Brst_Cancer']['attribute_2'])
for i in range(num_plots):
    axs[i].scatter(df['CHD'], df[corr_params[i]],
                   marker='*', color=colors[i])
    axs[i].set_xlabel(short_description('Brst_Cancer'), fontsize=14)
    axs[i].set_ylabel(short_description(corr_params[i]), fontsize=14)
    axs[i].tick_params(axis='x', labelsize=10)
    axs[i].tick_params(axis='y', labelsize=10)
```

Plots of most correlated parameters with breast cancer



Okk! Correlated parameters are great and can be discussed in statistical inference section.
Now how about looking at the data from States point of view:

[38]: #A new dataframe based on States:

```
df_state = df.groupby('CHSI_State_Abbr').sum().reset_index()  
df_state.head()
```

[38]:

	CHSI_State_Abbr	State_FIPS_Code	County_FIPS_Code	Strata_ID_Number	\
0	AK	54	4162	1957	
1	AL	67	4489	2745	
2	AR	375	5625	3993	
3	AZ	60	208	513	
4	CA	348	3364	1201	

	Number_Counties	Population_Size	Population_Density	Poverty	\
0	946	663661	213.0	327.9	
1	2489	4557808	5736.0	1144.7	
2	2753	2779154	3877.0	1334.5	
3	491	5939292	714.0	252.6	
4	2174	36132147	36531.0	746.4	

	Age_19_Under	Age_19_64	...	Salm_Exp	Shig_Rpt	Shig_Exp	\
0	795.1	1718.6	...	118.857143	26.821429	61.107143	
1	1689.5	4063.9	...	971.142857	609.821429	555.357143	
2	1866.1	4469.7	...	589.821429	359.500000	269.000000	
3	422.2	847.8	...	945.000000	869.000000	645.071429	
4	1505.6	3564.9	...	5618.250000	0.000000	3304.464286	

	Toxic_Chem	Carbon_Monoxide_Ind	Nitrogen_Dioxide_Ind	\
0	8.371644e+07	4.642857	4.642857	
1	4.291972e+07	16.857143	16.357143	
2	1.140120e+07	14.500000	14.500000	
3	1.833658e+07	5.285714	5.285714	
4	2.311464e+07	22.285714	22.285714	

	Sulfur_Dioxide_Ind	Ozone_Ind	Particulate_Matter_Ind	Lead_Ind
0	4.642857	4.642857	4.642857	4.642857
1	16.357143	18.357143	16.357143	16.357143
2	14.500000	15.250000	14.500000	14.500000
3	5.285714	6.535714	6.535714	5.285714
4	22.285714	35.821429	25.571429	22.285714

[5 rows x 195 columns]

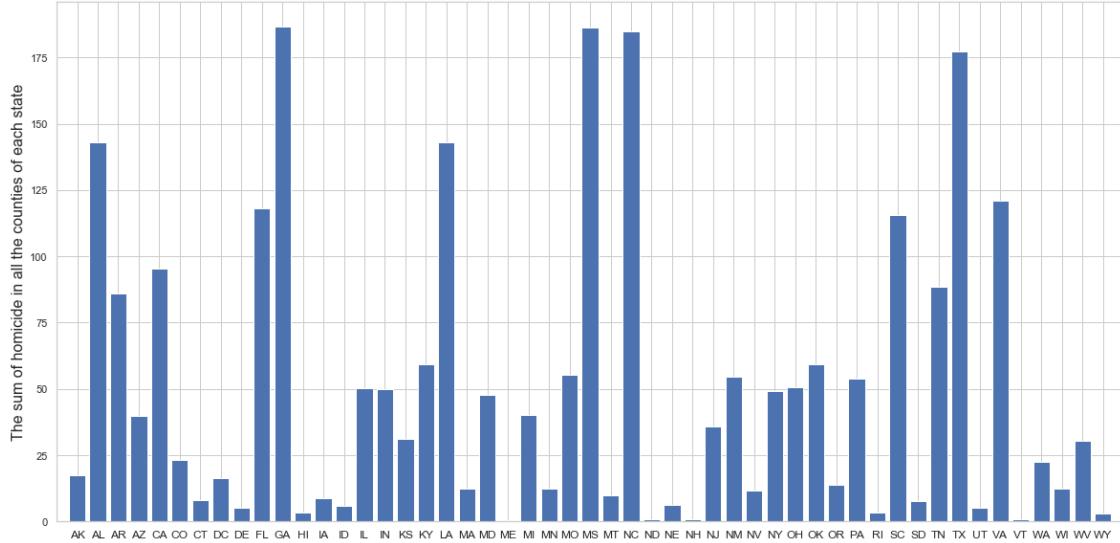
[39]: sns.set(style='whitegrid')

```
fig, ax = plt.subplots(1, figsize=(20, 10))  
plt.bar(df_state['CHSI_State_Abbr'], df_state['Homicide'], color='b')
```

```

plt.xlim(-1, len(df_state.index))
plt.ylabel('The sum of homicide in all the counties of each state', fontsize=16)
plt.xticks(fontsize=12)
plt.show()

```



```

[40]: sns.reset_defaults()
us_state = gpd.read_file('../US-States/states.shp')
us_state_land = us_state[ (us_state['STATE_NAME']!='Alaska') &(us_state['STATE_NAME']!='Hawaii')]
us_state_Alaska = us_state[us_state['STATE_NAME']=='Alaska']
us_state_Hawaii = us_state[us_state['STATE_NAME']=='Hawaii']
us_state.head()

#Merging map and data:

df_state_land = us_state_land.set_index('STATE_ABBR').join(df_state.set_index('CHSI_State_Abbr'))
df_state_Alaska = us_state_Alaska.set_index('STATE_ABBR').join(df_state.set_index('CHSI_State_Abbr'))
df_state_Hawaii = us_state_Hawaii.set_index('STATE_ABBR').join(df_state.set_index('CHSI_State_Abbr'))

def min_max_col2(variable):
    minimum = min(df_state_land[variable].min(),
                  df_state_Alaska[variable].min(), df_state_Hawaii[variable].min())
    maximum = max(df_state_land[variable].max(),
                  df_state_Alaska[variable].max(), df_state_Hawaii[variable].max())
    return minimum, maximum

def US_state_plot(variable, color='Blues'):

```

```

h, w = figaspect(1.)
mn, mx = min_max_col2(variable)
fig, ax1 = plt.subplots(1, figsize=(w*10, h*10))
ax1.axis('off')
ax1.set_title(short_description(variable), fontsize=40)
divider = make_axes_locatable(ax1)
cax = divider.append_axes('right', size='2%', pad=0.1)
cax.tick_params(labelsize=25)
df_state_land.plot(column=variable, cmap=color,
                    linewidth=0.8, ax=ax1,
                    edgecolor='0.8', vmin=mn ,vmax=mx,
                    legend=True, cax=cax)

left, bottom, width, height = [0.15, 0.22, 0.24, 0.3]
ax2 = fig.add_axes([left, bottom, width, height])
ax2.axis('off')
ax2.set_title('Alaska', fontsize=25)
df_state_Alaska.plot(column=variable, cmap=color, vmin=mn ,vmax=mx,
                      linewidth=0.8, ax=ax2, edgecolor='0.6')

left, bottom, width, height = [0.35, 0.3, 0.2, 0.05]
ax3 = fig.add_axes([left, bottom, width, height])
ax3.axis('off')
ax3.set_title('Hawaii', fontsize=25)
df_state_Hawaii.plot(column =variable, cmap=color, vmin=mn ,vmax=mx,
                      linewidth=0.8, ax=ax3, edgecolor='0.6')

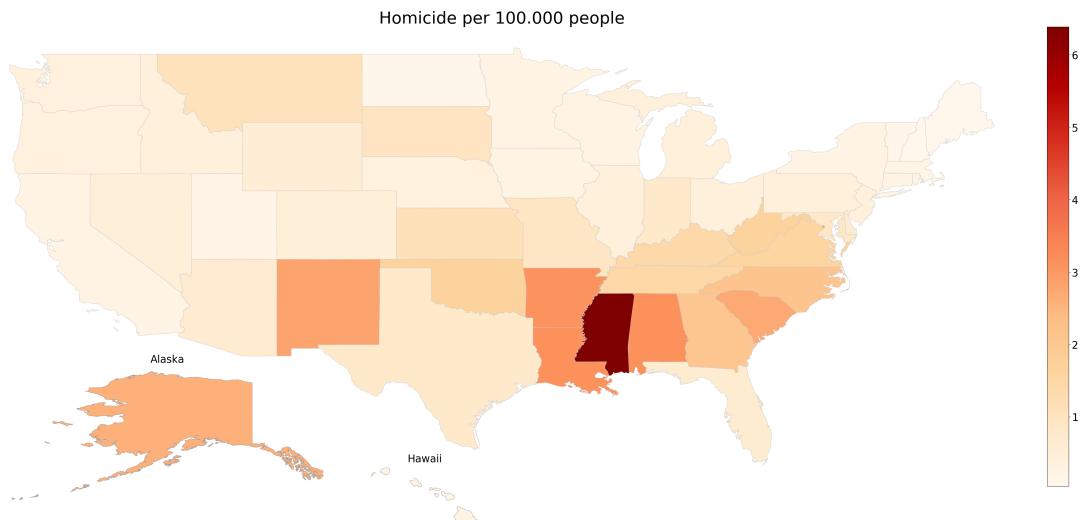
```

```

[41]: df_state_land['Homicide_per_capita'] = df_state_land['Homicide'] .
      →div(df_state_land['Population_Size'])*100000
df_state_Alaska['Homicide_per_capita'] = df_state_Alaska['Homicide'] .
      →div(df_state_Alaska['Population_Size'])*100000
df_state_Hawaii['Homicide_per_capita'] = df_state_Hawaii['Homicide'] .
      →div(df_state_Hawaii['Population_Size'])*100000
new_item = pd.DataFrame({'COLUMN_NAME': ['Homicide_per_capita'], 'DESCRIPTION':
      →['Homicide per 100.000 people']})
DATA_ELEMENT_DESCRIPTION = DATA_ELEMENT_DESCRIPTION.append(new_item, sort=False)

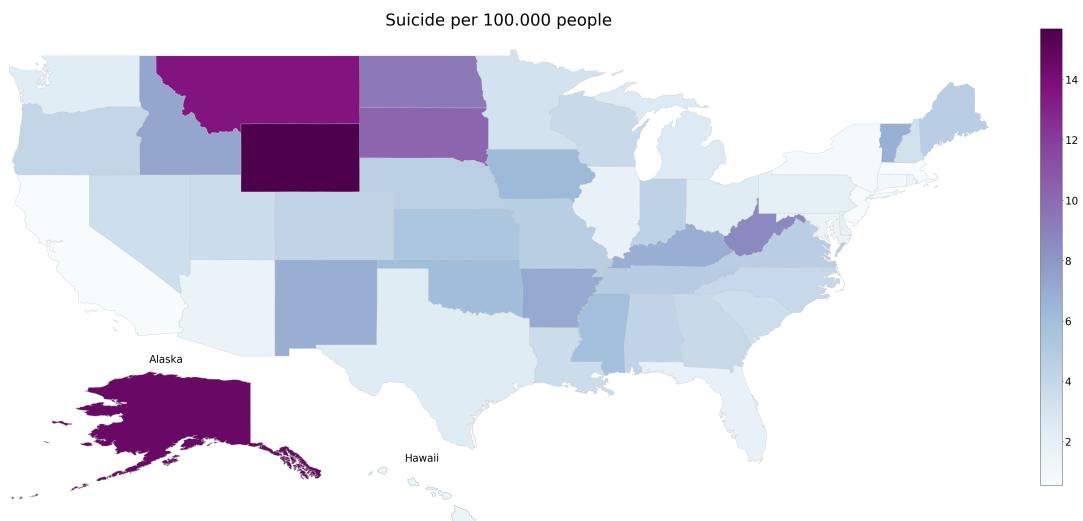
US_state_plot('Homicide_per_capita', 'OrRd')

```



```
[42]: df_state_land['Suicide_per_capita'] = df_state_land['Suicide']/
    →df_state_land['Population_Size']*100000
df_state_Alaska['Suicide_per_capita'] = df_state_Alaska['Suicide']/
    →df_state_Alaska['Population_Size']*100000
df_state_Hawaii['Suicide_per_capita'] = df_state_Hawaii['Suicide']/
    →df_state_Hawaii['Population_Size']*100000
new_item = pd.DataFrame({'COLUMN_NAME': ['Suicide_per_capita'], 'DESCRIPTION':
    →['Suicide per 100.000 people']})
DATA_ELEMENT_DESCRIPTION = DATA_ELEMENT_DESCRIPTION.append(new_item, sort=False)

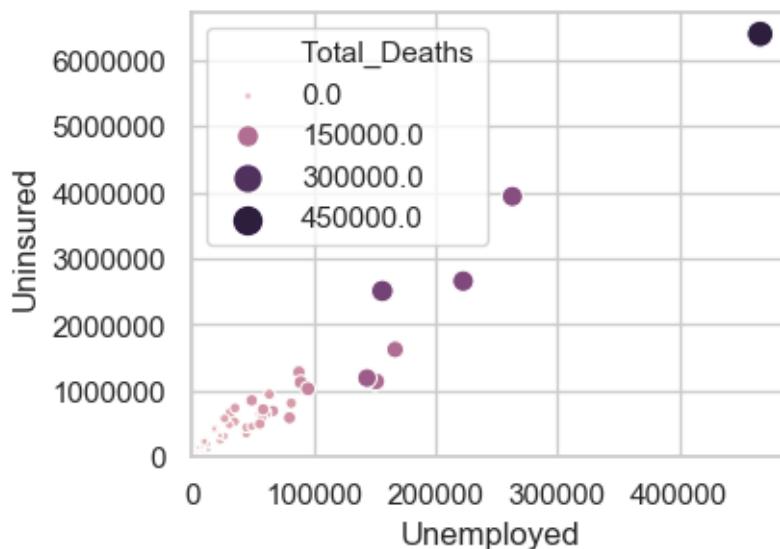
US_state_plot('Suicide_per_capita', 'BuPu')
```



```
[43]: #Relationship between total death, being unmarried and being uninsured:
sns.set(style='whitegrid')
fig, ax = plt.subplots(1, figsize=(4, 3))
cmap = sns.cubehelix_palette(light=0.8, as_cmap=True)
ax = sns.scatterplot(x='Unemployed', y='Uninsured', size='Total_Deaths',  

                     hue='Total_Deaths',
                     sizes=(1, 100), palette=cmap, data=df_state)
ax.set_xlim(0)
ax.set_ylim(0)
```

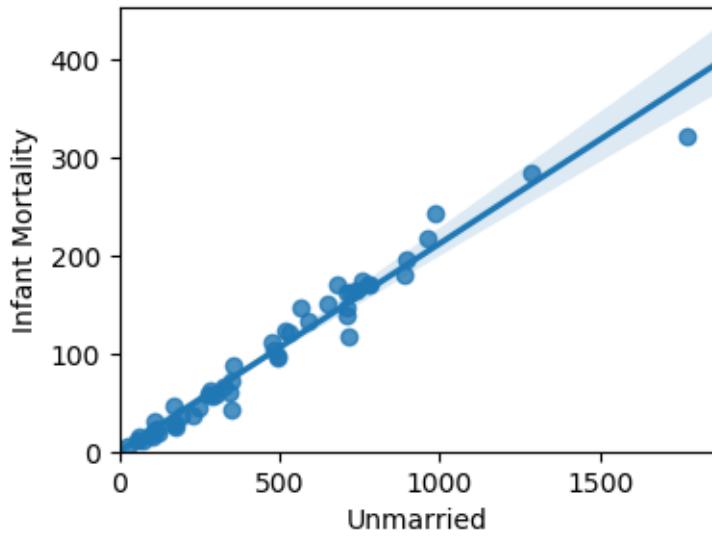
[43]: (0, 6709031.725179751)



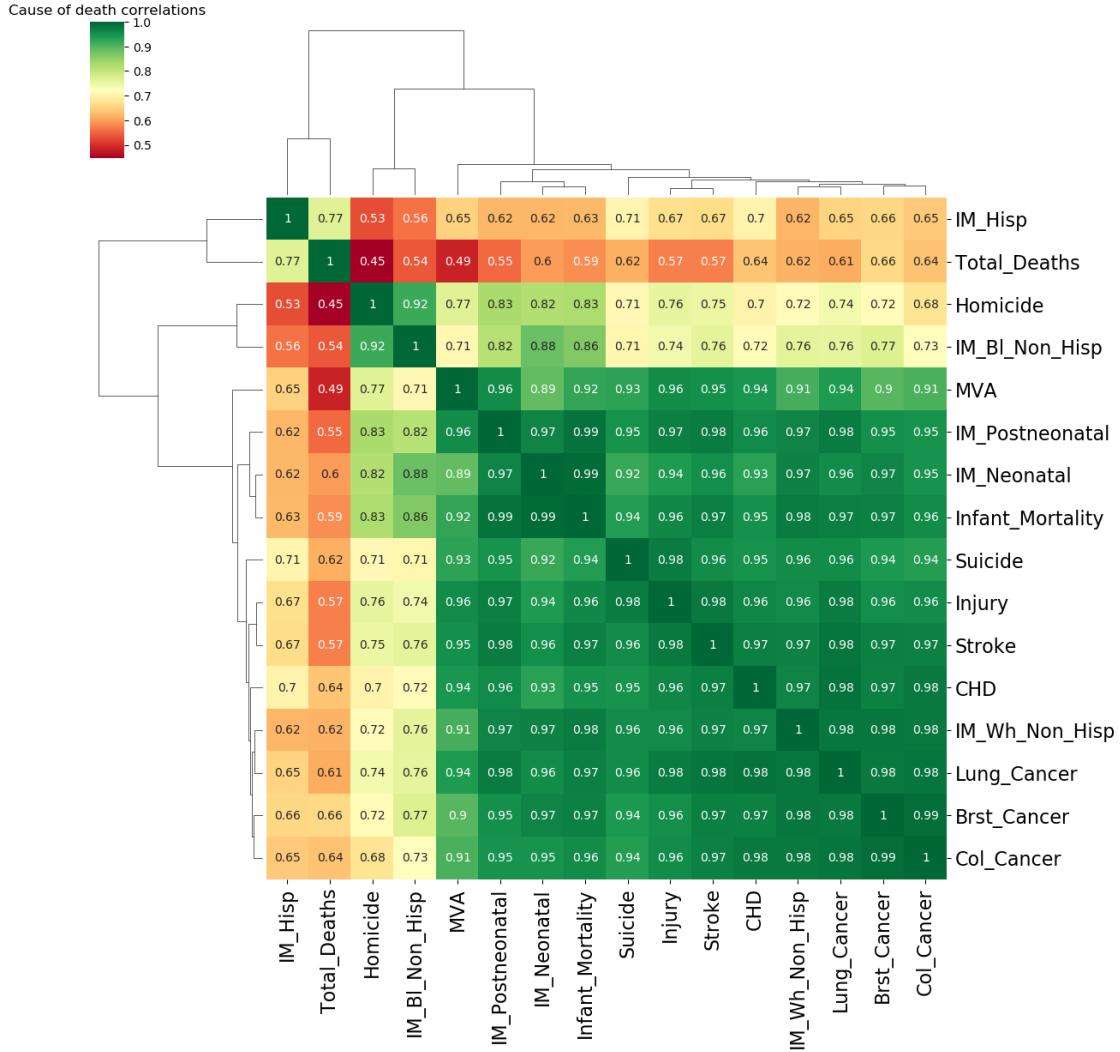
```
[53]: sns.reset_orig()
```

```
[45]: f, ax = plt.subplots(figsize=(4, 3))
ax = sns.regplot(x='Unmarried', y='Infant_Mortality', data=df_state)
ax.set(ylim=(0, None))
ax.set(xlim=(0, None))
ax.set_ylabel('Infant Mortality')
```

[45]: Text(0, 0.5, 'Infant Mortality')



```
[46]: g = sns.clustermap(df_state[Death].corr(method='pearson'), cmap='RdYlGn',
    annot=True, annot_kws={'size': 10}, figsize=(5,5))
g.ax_heatmap.set_xticklabels(g.ax_heatmap.get_xmajorticklabels(), fontsize = 16)
g.ax_heatmap.set_yticklabels(g.ax_heatmap.get_ymajorticklabels(), fontsize = 16)
plt.subplots_adjust(left=0, bottom=-1, right=2, top=1, wspace=0, hspace=0)
plt.title('Cause of death correlations')
plt.show()
```

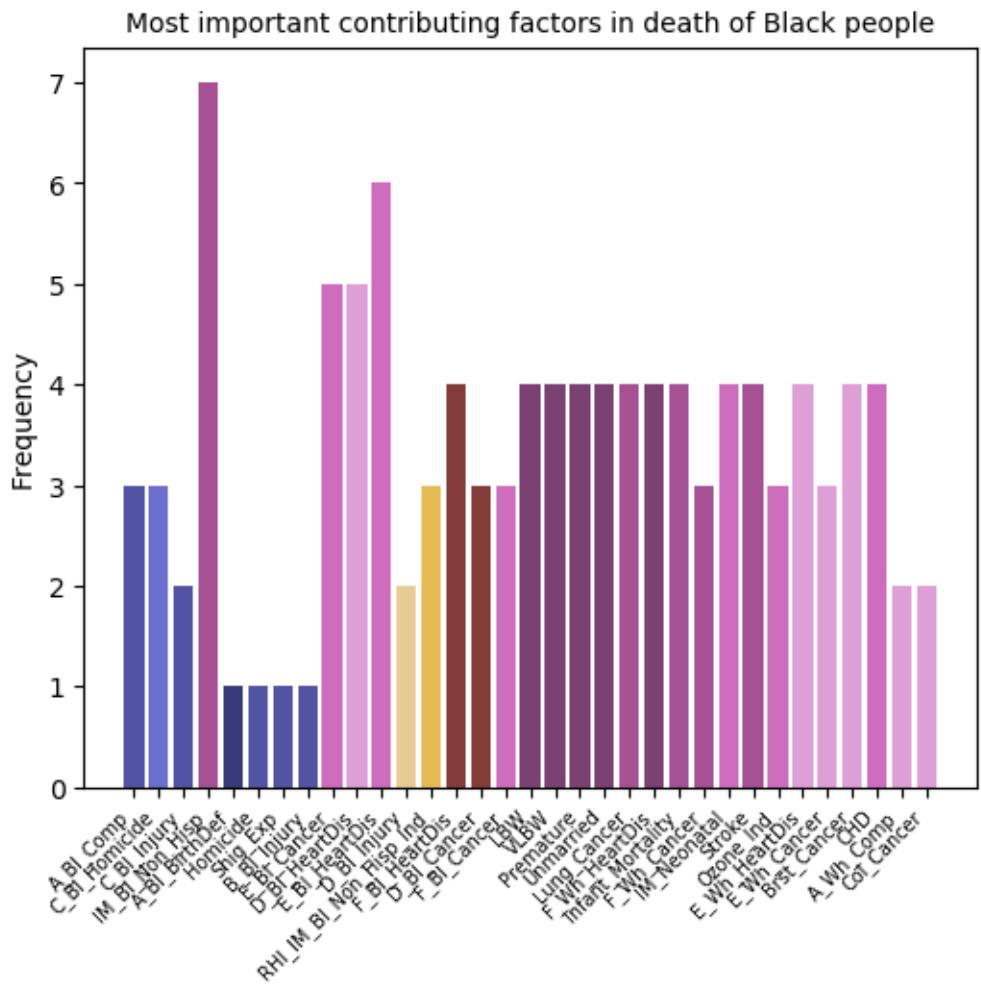


```
[47]: list_of_races = [Black, Hispanic, White, other]
names = ['Black', 'Hispanic', 'White', 'Other']
for n, races in enumerate(list_of_races):
    x=[]
    for i in races:
        x= [*x,
              *(func_df_corr(0.65)[func_df_corr(0.
→65)['attribute_1']==i]['attribute_2']),
              *(func_df_corr(0.65)[func_df_corr(0.
→65)['attribute_2']==i]['attribute_1'])]
    colors = iter(cm.tab20b(np.linspace(0, 1, len(x))))
    plt.subplots(1, figsize=(6, 5))
    for j in x:
        plt.bar(j, x.count(j), color=next(colors))
```

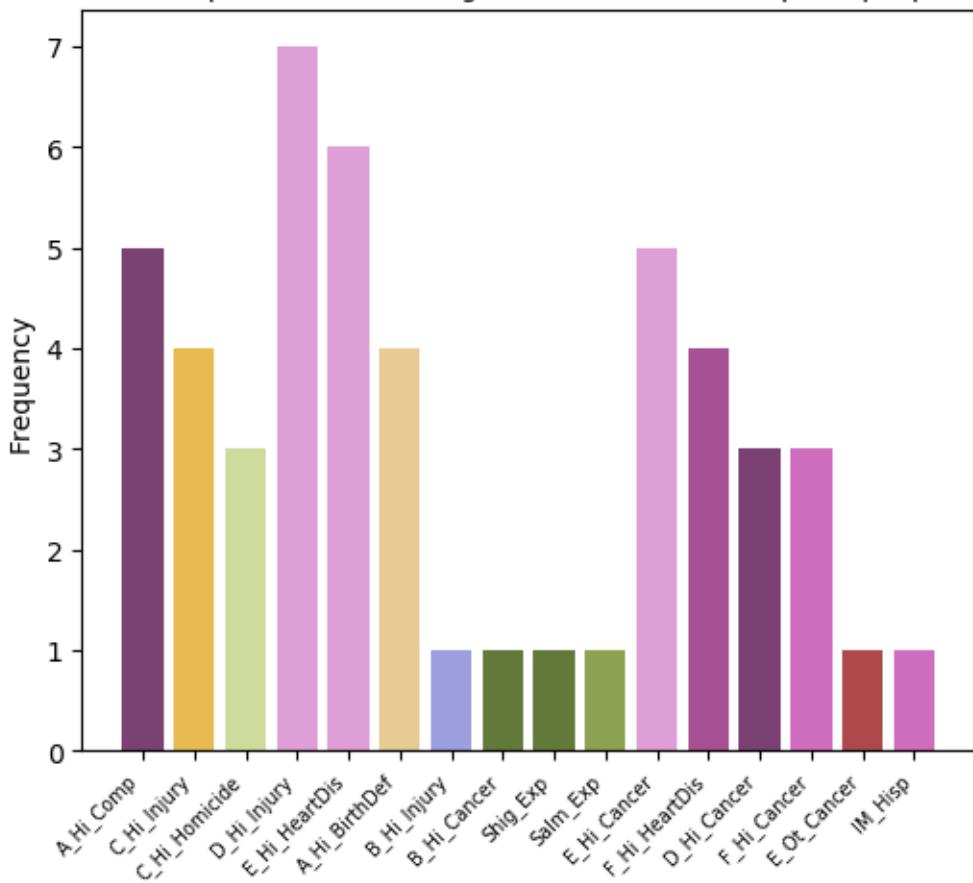
```

plt.setp(plt.gca().get_xticklabels(), fontsize=7, rotation=45, horizontalalignment='right')
plt.ylabel('Frequency')
plt.title('Most important contributing factors in death of Black people', fontweight='bold', fontsize=10)
plt.show()

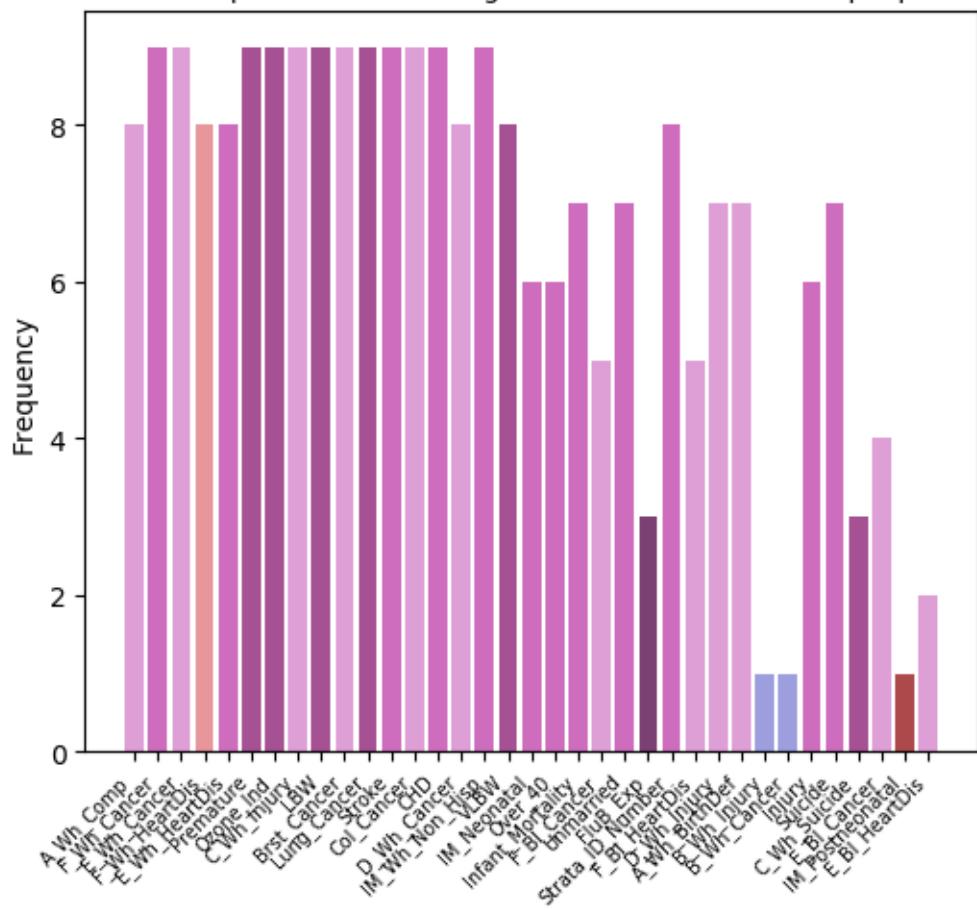
```

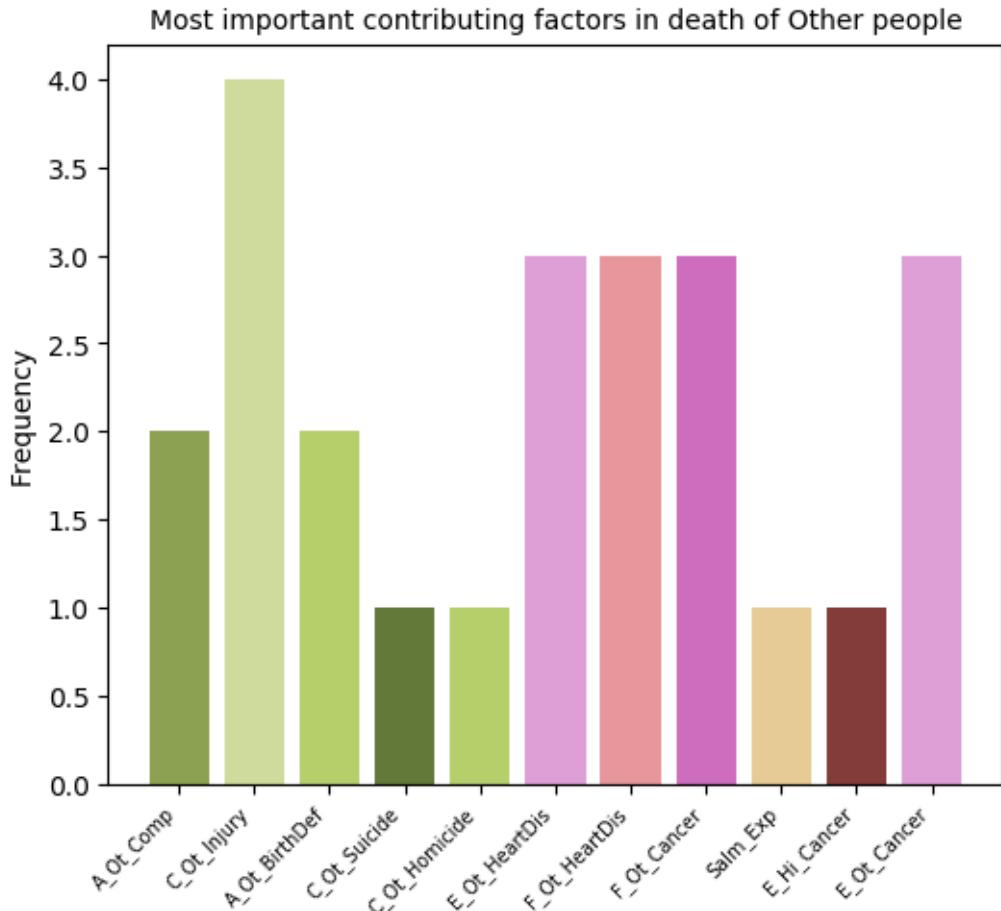


Most important contributing factors in death of Hispanic people



Most important contributing factors in death of White people





```
[48]: x=[]
for i in Death:
    x=[*x, *(func_df_corr(0.65)[func_df_corr(0.
→65)]['attribute_1']==i) ['attribute_2']],
        *(func_df_corr(0.65)[func_df_corr(0.
→65)]['attribute_2']==i) ['attribute_1'])]
```

```
[49]: test=np.unique(x)
test
```

```
[49]: array(['A_Bl_Comp', 'A_Wh_BirthDef', 'A_Wh_Comp', 'Brst_Cancer', 'CHD',
       'C_Bl_Homicide', 'C_Wh_Injury', 'Col_Cancer', 'D_Bl_Cancer',
       'D_Bl_HeartDis', 'D_Wh_Cancer', 'D_Wh_Injury', 'D_Wh_Suicide',
       'Disabled_Medicare', 'E_Bl_Cancer', 'E_Bl_HeartDis', 'E_Wh_Cancer',
       'E_Wh_HeartDis', 'Ecol_Exp', 'Elderly_Medicare', 'F_Bl_Cancer',
       'F_Bl_HeartDis', 'F_Hi_HeartDis', 'F_Wh_Cancer', 'F_Wh_HeartDis',
       'FluB_Rpt', 'HepA_Exp', 'HepA_Rpt', 'HepB_Exp', 'HepB_Rpt',
       'Homicide', 'IM_Bl_Non_Hisp', 'IM_Neonatal', 'IM_Postneonatal',
       'IM_Wh_Non_Hisp', 'Infant_Mortality', 'Injury', 'LBW',
```

```
'Lung_Cancer', 'Major_Depression', 'No_HS_Diploma', 'Over_40',
'Ozone_Ind', 'Pert_Exp', 'Population_Size', 'Premature',
'RHI_Homicide_Ind', 'RHI_IM_B1_Non_Hisp_Ind', 'RHI_IM_Hisp_Ind',
'RHI_IM_Wh_Non_Hisp_Ind', 'RHI_MVA_Ind', 'RHI_Suicide_Ind',
'Recent_Drug_Use', 'Salm_Exp', 'Salm_Rpt', 'Shig_Exp',
'Strata_ID_Number', 'Stroke', 'Suicide', 'Syphilis_Exp',
'Syphilis_Rpt', 'Total_Births', 'Under_18', 'Unemployed',
'Uninsured', 'Unmarried', 'VLBW'], dtype='<U22')
```

[50]: cc=filter(Death, test)

```
list_of_columns=[*county_info, *test, *Death]
```

[51]: test_dataframe = pd.DataFrame(df[list_of_columns])

[52]: test_dataframe.head()

	State_FIPS_Code	County_FIPS_Code	CHSI_County_Name	CHSI_State_Name					
0	1	1	Autauga	Alabama					
1	1	3	Baldwin	Alabama					
2	1	5	Barbour	Alabama					
3	1	7	Bibb	Alabama					
4	1	9	Blount	Alabama					
	CHSI_State_Abbr	Strata_ID_Number	Time	Time	Time	Time	...	IM_Neonatal	
0	AL	29	4	4	4	4	...	0.750000	
1	AL	16	2	2	2	2	...	2.850000	
2	AL	51	4	4	4	4	...	1.350000	
3	AL	42	7	7	7	7	...	1.014286	
4	AL	28	4	4	4	4	...	1.350000	
	IM_Postneonatal	IM_Wh_Non_Hisp	Infant_Mortality	Injury	Lung_Cancer				
0	0.750000	1.050000	1.475	5.750000	16.325000				
1	0.750000	2.850000	3.550	15.050000	31.050000				
2	0.400000	1.375000	1.775	7.400000	17.650000				
3	0.385714	1.314286	1.400	4.285714	9.228571				
4	0.900000	1.875000	2.250	6.100000	17.925000				
	MVA	Stroke	Suicide	Total_Deaths					
0	6.825000	18.475000	4.150000	466.750000					
1	12.550000	24.350000	7.150000	2194.000000					
2	6.550000	21.125000	2.575000	384.500000					
3	5.057143	20.657143	2.114286	287.428571					
4	6.850000	11.825000	3.600000	613.250000					

[5 rows x 96 columns]

[]: