lab_04

October 22, 2015

1 Data mapping

In [1]:
```
%matplotlib inline

import seaborn as sns
import pandas as pd
import pysal as ps
import geopandas as gpd
import numpy as np
import matplotlib.pyplot as plt
```

1.1 Dataset

For this tutorial, we will use the recently released Index of Multiple Deprivation from 2015.

- How to download it (link).
- Download background from the course website (link).

In [2]:
```
# This will be different on your computer and will depend on where
# you have downloaded the files
imd_shp = '../../../../data/E08000012_IMD/shapefiles/E08000012.shp'
bkg_path = 'figs/lab04_liverpool_color.tif'
data_path = '../../../../data/Liverpool/'
```

Load the IMD data:

In [3]:
```
imd = gpd.read_file(imd_shp).set_index('LSOA11CD')
imd.info()
```

```
<class 'geopandas.geodataframe.GeoDataFrame'>
Index: 298 entries, E01006512 to E01033768
Data columns (total 12 columns):
crime         298 non-null float64
education     298 non-null float64
employment    298 non-null float64
geometry      298 non-null object
health        298 non-null float64
housing       298 non-null float64
idaci         298 non-null float64
idaopi        298 non-null float64
imd_rank      298 non-null int64
imd_score     298 non-null float64
income        298 non-null float64
living_env    298 non-null float64
dtypes: float64(10), int64(1), object(1)
memory usage: 30.3+ KB
```

Additional data:

NOTE: this part loads up data that will be used for the rest of the tutorial but loading it involves some data transformations that are a bit more advanced that what is covered in this course. Simply run them to load the data, but you are not expected to know some of the coding tricks required in this cell.

In [4]:
```
# Gender breakup
gender = pd.read_csv(data_path+'tables/QS104EW_lsoa11.csv', index_col='GeographyCode')
gender = gender.rename(columns={'QS104EW0002': 'Male', 'QS104EW0003': 'Female'})[['Male', 'Femal
maj_male = gender['Male'] > gender['Female']
gender['Gender_Majority'] = maj_male
gender.loc[gender['Gender_Majority']==True, 'Gender_Majority'] = 'Male'
gender.loc[gender['Gender_Majority']==False, 'Gender_Majority'] = 'Female'
# Status breakup
sinmar = pd.read_csv(data_path+'tables/KS103EW_lsoa11.csv', index_col='GeographyCode')
sinmar = sinmar.rename(columns={'KS103EW0002': 'Single', 'KS103EW0003': 'Married'})[['Single',
maj_sin = sinmar['Single'] > sinmar['Married']
sinmar['Status_Majority'] = maj_sin
sinmar.loc[sinmar['Status_Majority']==True, 'Status_Majority'] = 'Single'
sinmar.loc[sinmar['Status_Majority']==False, 'Status_Majority'] = 'Married'
# Join
both = imd.join(sinmar).join(gender)
both.crs = imd.crs

both.head()
```

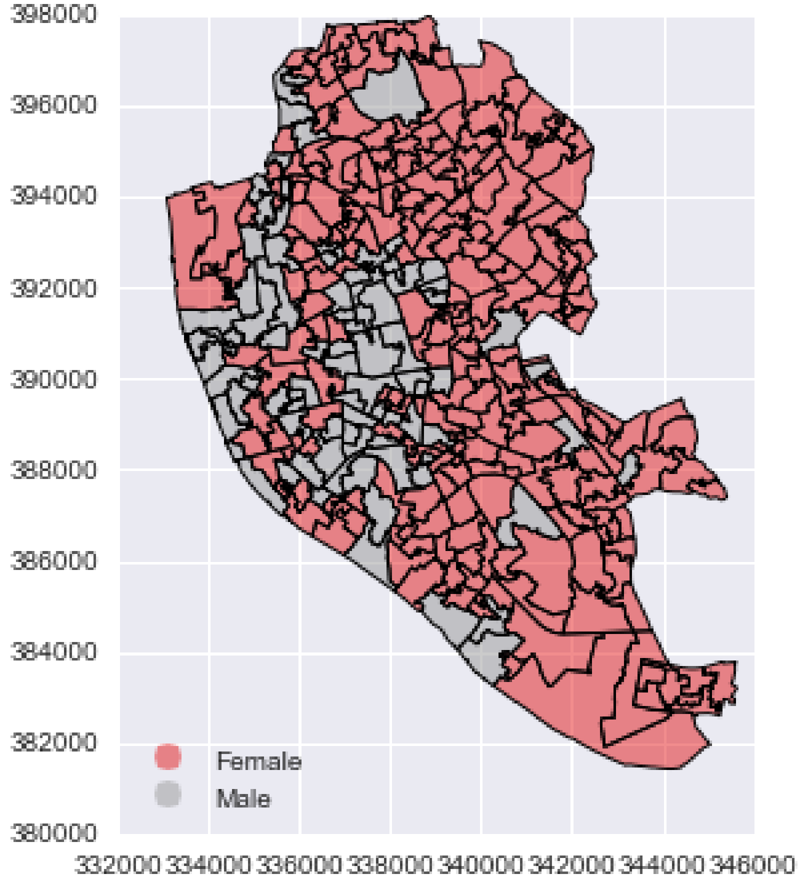
Out[4]:
```
           crime  education  employment  \
LSOA11CD
E01006512  -0.20      10.06        0.08
E01006513   1.50      20.13        0.03
E01006514   0.74      15.50        0.15
E01006515   1.16      33.51        0.30
E01006518   0.67      49.90        0.34

                                                    geometry  health  housing  \
LSOA11CD
E01006512  POLYGON ((336103.358 389628.58, 336103.416 389...    1.19    24.49
E01006513  POLYGON ((335173.781 389691.538, 335169.798 38...    0.58    25.15
E01006514  POLYGON ((335495.676 389697.267, 335495.444 38...    1.86    21.85
E01006515  POLYGON ((334953.001 389029, 334951 389035, 33...    1.90    17.40
E01006518  POLYGON ((335354.015 388601.947, 335354 388602...    2.24    15.52

           idaci  idaopi  imd_rank  imd_score  income  living_env  Single  \
LSOA11CD
E01006512   0.16    0.31     10518      25.61    0.10       68.91    1288
E01006513   0.21    0.20     10339      25.91    0.04       85.48    2613
E01006514   0.23    0.48      5247      37.64    0.19       58.90    1583
E01006515   0.46    0.76      1019      58.99    0.43       29.78     587
E01006518   0.50    0.52       662      63.37    0.43       31.03     716

           Married Status_Majority  Male  Female Gender_Majority
LSOA11CD
E01006512      287          Single  1070     810            Male
E01006513      170          Single  1461    1480          Female
E01006514      204          Single  1177     931            Male
```

```
E01006515       218          Single    595      613           Female
E01006518       363          Single    843      853           Female
```

1.2 Unique values

```
In [5]: both.plot(column='Gender_Majority', categorical=True, legend=True)
```

```
Out[5]: <matplotlib.axes._subplots.AxesSubplot at 0x10edb70d0>
```



1.3 Equal interval

```
In [6]: classi = ps.Equal_Interval(imd['imd_rank'], k=7)
        classi
```

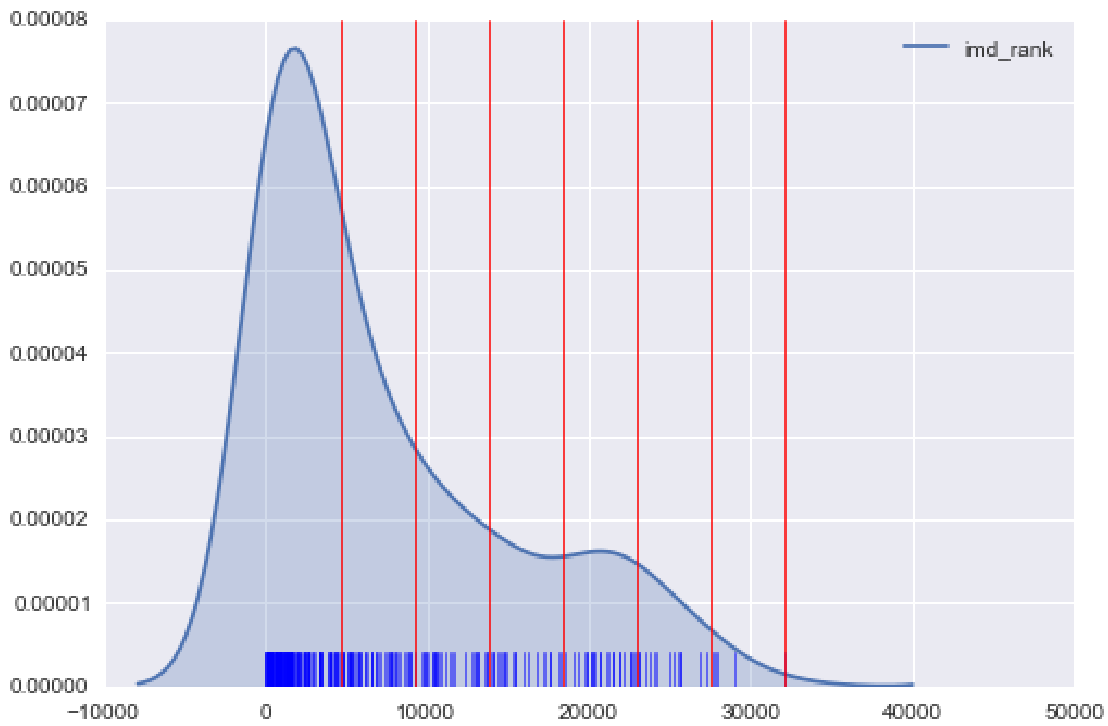
```
Out[6]:                   Equal Interval

          Lower                 Upper                 Count
         =================================================
                    x[i] <=  4604.857                   156
          4604.857 < x[i] <=  9185.714                   48
          9185.714 < x[i] <= 13766.571                   30
         13766.571 < x[i] <= 18347.429                   21
```

```
18347.429 < x[i] <= 22928.286               24
22928.286 < x[i] <= 27509.143               14
27509.143 < x[i] <= 32090.000                5
```

In [7]:
```
classi.bins
```

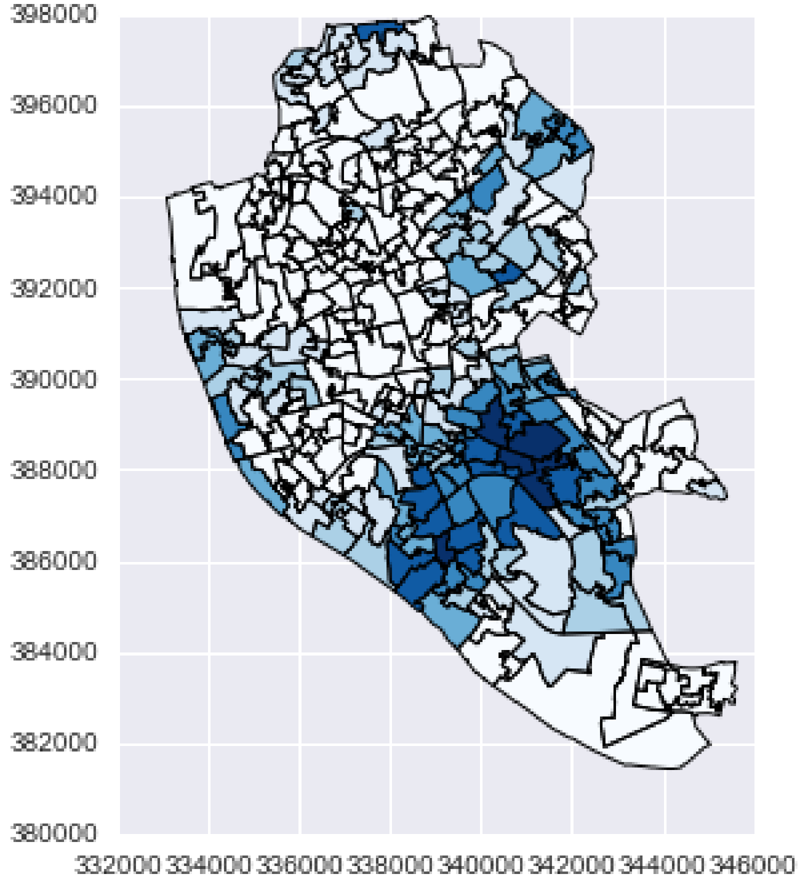
Out[7]:
```
array([  4604.85714286,   9185.71428571,  13766.57142857,  18347.42857143,
        22928.28571429,  27509.14285714,  32090.        ])
```

In [8]:
```
f, ax = plt.subplots(1)
sns.kdeplot(imd['imd_rank'], shade=True)
sns.rugplot(imd['imd_rank'], alpha=0.5)
for cut in classi.bins:
    plt.axvline(cut, color='red', linewidth=0.75)
plt.show()
```



In [9]:
```
imd.plot(column='imd_rank', scheme='equal_interval', alpha=1, k=7, colormap=plt.cm.Blues)
```

Out[9]: <matplotlib.axes._subplots.AxesSubplot at 0x1136f9150>



1.4 Quantiles

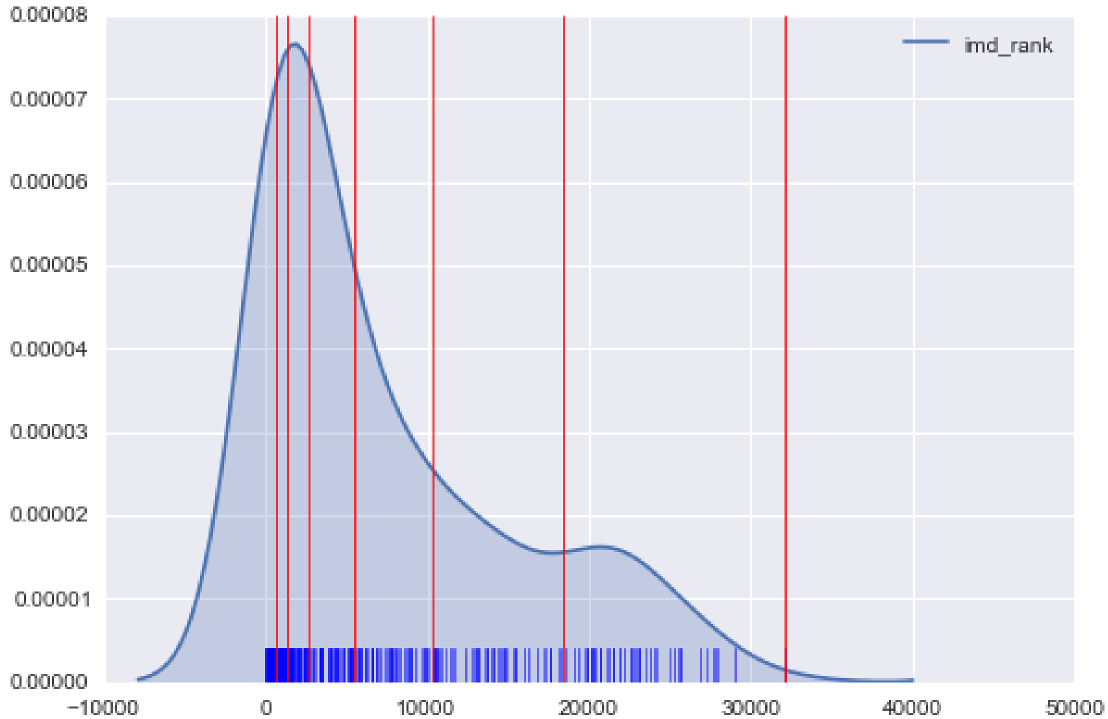
```
In [10]: classi = ps.Quantiles(imd['imd_rank'], k=7)
         classi
```

```
Out[10]:                   Quantiles

           Lower              Upper             Count
         ============================================
                     x[i] <=   633.714             43
           633.714 < x[i] <=  1335.714             42
          1335.714 < x[i] <=  2641.000             43
          2641.000 < x[i] <=  5540.143             42
          5540.143 < x[i] <= 10355.857             43
         10355.857 < x[i] <= 18401.143             42
         18401.143 < x[i] <= 32090.000             43
```

```
In [11]: classi.bins
```

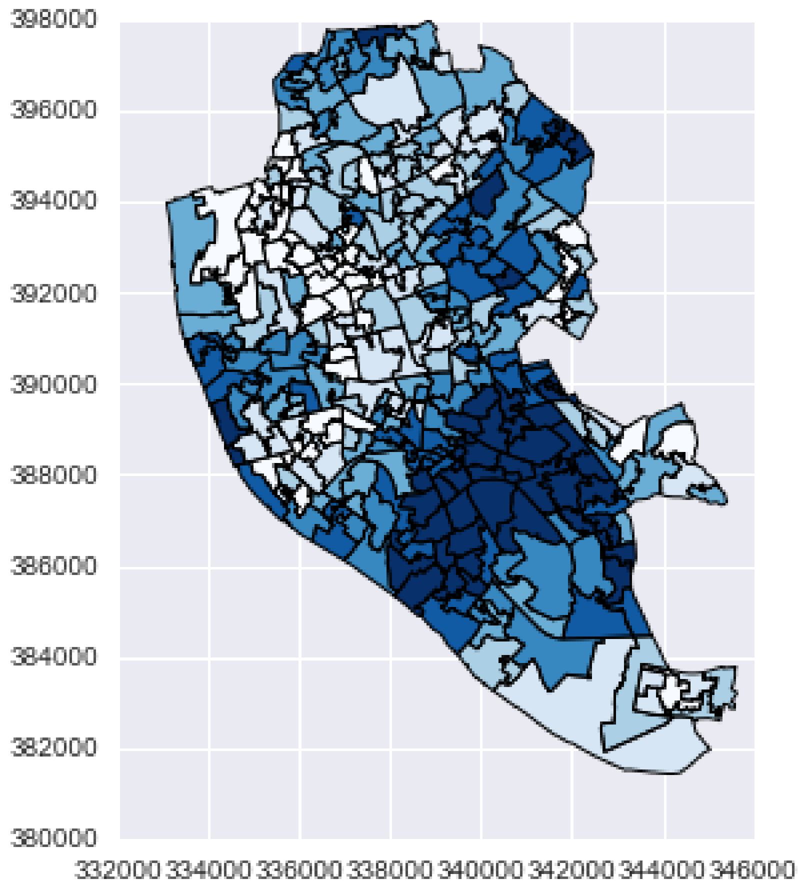
```
Out[11]: array([   633.71428571,    1335.71428571,    2641.        ,    5540.14285714,
                 10355.85714286,   18401.14285714,   32090.        ])
```

In [12]:
```
f, ax = plt.subplots(1)
sns.kdeplot(imd['imd_rank'], shade=True)
sns.rugplot(imd['imd_rank'], alpha=0.5)
for cut in classi.bins:
    plt.axvline(cut, color='red', linewidth=0.75)
plt.show()
```



In [13]:
```
imd.plot(column='imd_rank', scheme='QUANTILES', alpha=1, k=7, colormap=plt.cm.Blues)
```

Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x11473fbd0>



1.5 Fisher-Jenks

```
In [14]: classi = ps.Fisher_Jenks(imd['imd_rank'], k=7)
         classi
```

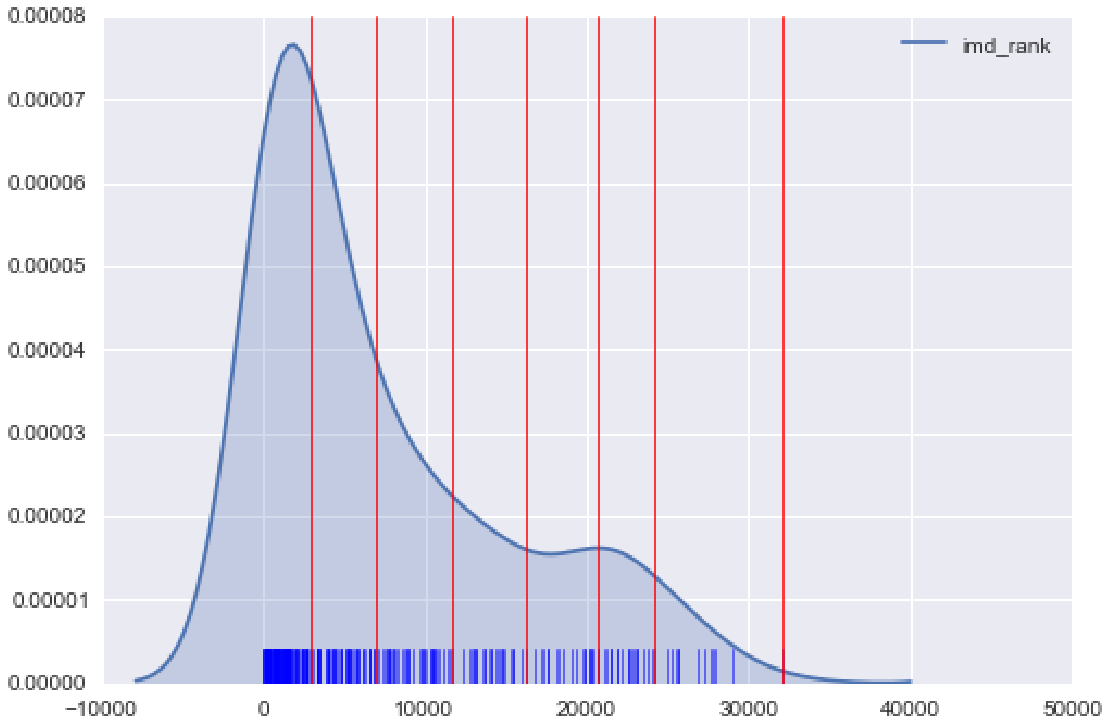
```
Out[14]:                      Fisher_Jenks

           Lower                 Upper                    Count
         ===============================================
                       x[i] <=  2930.000                   133
          2930.000 < x[i] <=  6946.000                      52
          6946.000 < x[i] <= 11656.000                      39
         11656.000 < x[i] <= 16185.000                      24
         16185.000 < x[i] <= 20719.000                      20
         20719.000 < x[i] <= 24098.000                      18
         24098.000 < x[i] <= 32090.000                      12
```

```
In [15]: classi.bins
```

```
Out[15]: array([  2930.,   6946.,  11656.,  16185.,  20719.,  24098.,  32090.])
```

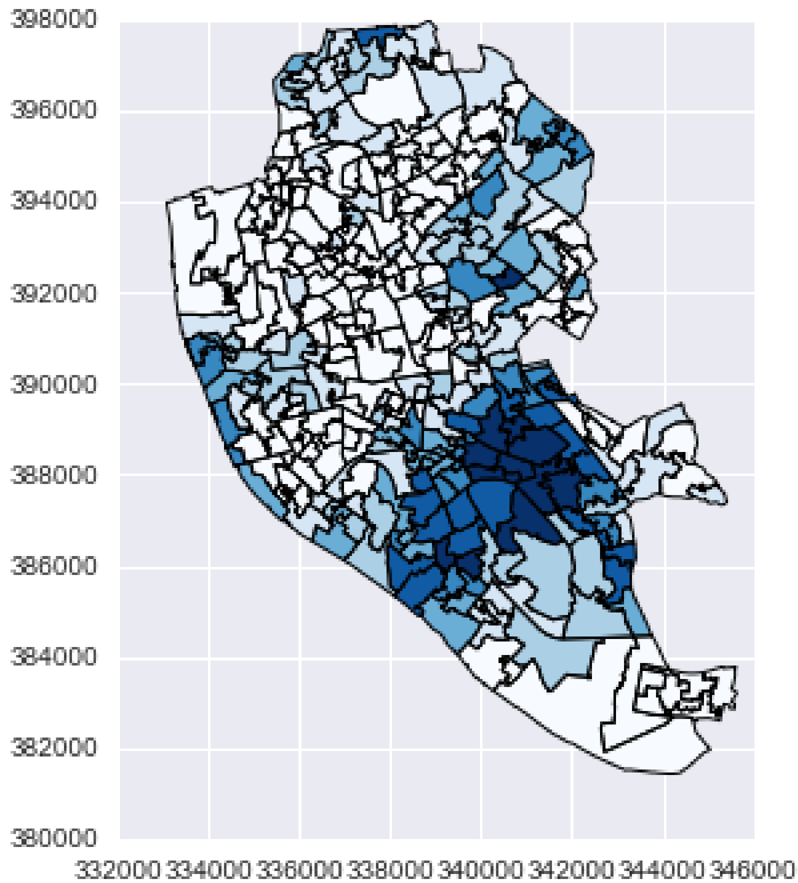
```
In [16]: f, ax = plt.subplots(1)
         sns.kdeplot(imd['imd_rank'], shade=True)
```

```
sns.rugplot(imd['imd_rank'], alpha=0.5)
for cut in classi.bins:
    plt.axvline(cut, color='red', linewidth=0.75)
plt.show()
```




```
In [17]: imd.plot(column='imd_rank', scheme='fisher_jenks', alpha=1, k=7, colormap=plt.cm.Blues)
```

```
Out[17]: <matplotlib.axes._subplots.AxesSubplot at 0x111430310>
```

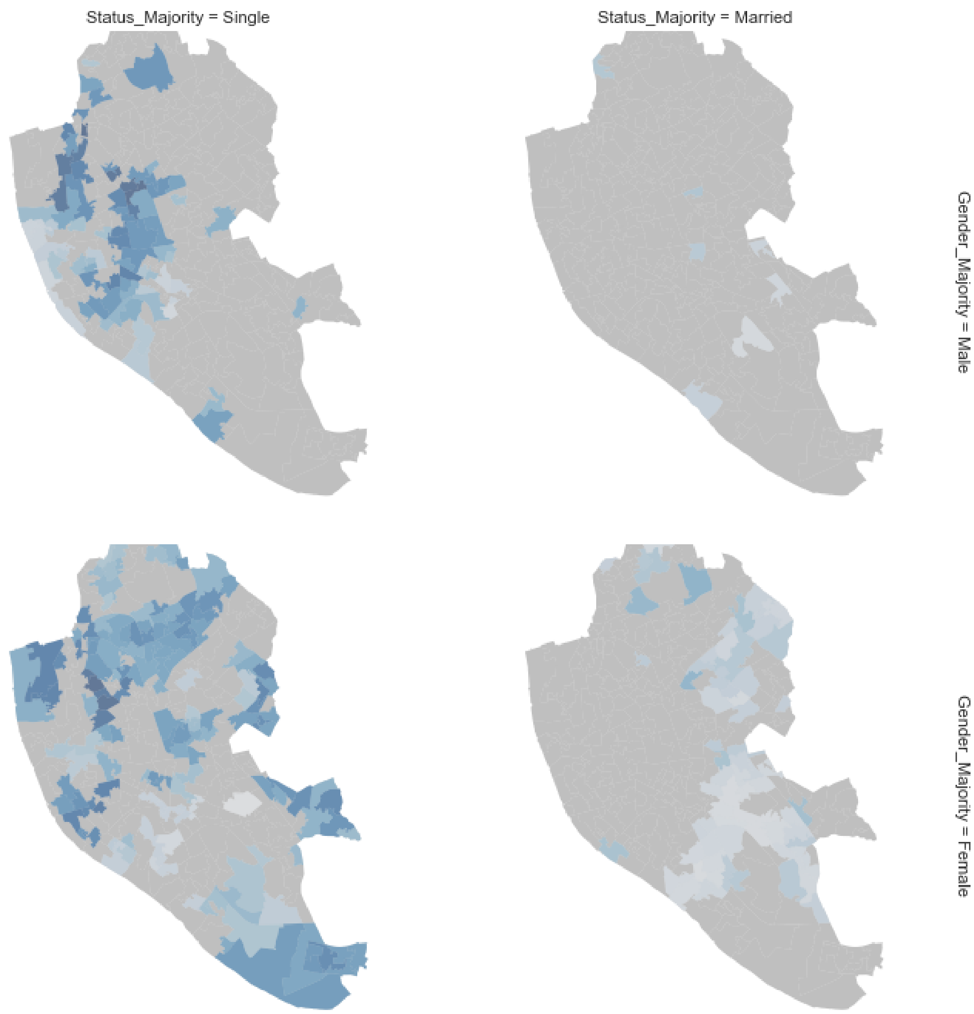


1.6 [Extension 1] Conditional maps

```
In [131]: def map_subset(vals, db, color=None, norm=True):
              '''
              Internal function to pass to `FaceGrid` to build a single map
              ...

              Arguments
              ---------
              vals      : Series
                          Values of the subplot to be mapped
              db        : GeoDataFrame
                          Table with geometries
              color     : None
              '''
              ax = plt.gca()
              for poly in db['geometry']:
                  gpd.plotting.plot_multipolygon(ax, poly, facecolor='grey', linewidth=0.)
              vari = vals.name
              if norm:
                  db.reindex(vals.index).plot(column=vari, axes=ax, colormap='Blues', linewidth=0., \
                                              vmin=db[vari].min(), vmax=db[vari].max())
```

```
            else:
                db.reindex(vals.index).plot(column=vari, axes=ax, colormap='Blues', linewidth=0.)
            ax.set_axis_off()
            plt.axis('equal')
```

```
In [146]: %%time
          g = sns.FacetGrid(both, row="Gender_Majority", col="Status_Majority", \
                            margin_titles=True, size=5)
          g.map(map_subset, "imd_score", db=both)
          plt.savefig('../lectures/figs/l04_conditional_plot.png')
          plt.tight_layout()
          plt.show()
```



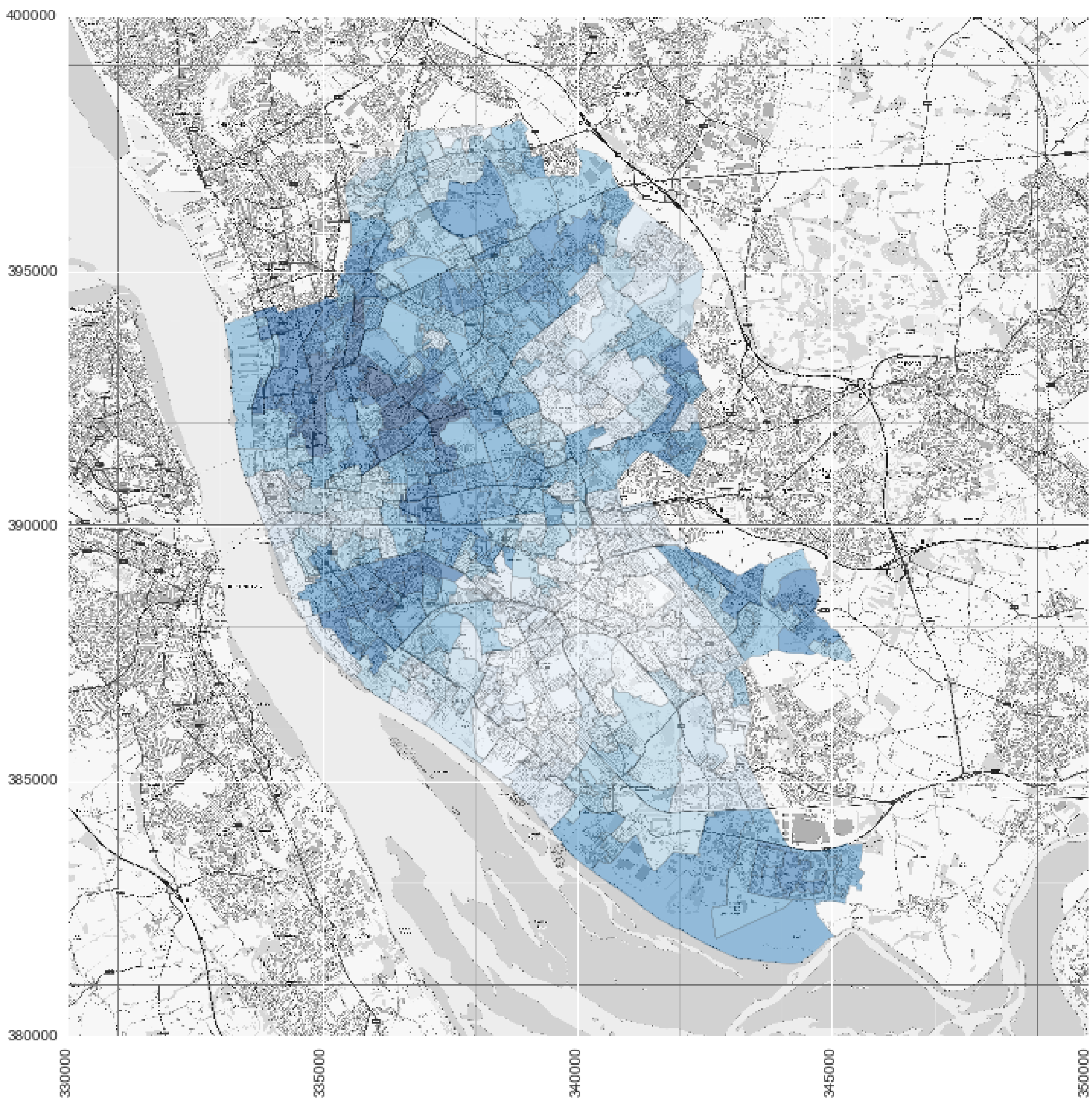

```
CPU times: user 12.4 s, sys: 46.7 ms, total: 12.4 s
Wall time: 12.4 s
```

1.7 [Extension 2] Base maps

In [18]:
```
import rasterio
liv_path = '../../../../data/liverpool.tif'
```

In [52]:
```
%%time
src = rasterio.open(liv_path)
left, bottom, right, top = src.bounds

f, ax = plt.subplots(1, figsize=(12, 12))
ax.imshow(src.read(1), cmap='gray', extent=(left, right, bottom, top))
imd.plot(column='imd_score', colormap='Blues', linewidth=0.1, axes=ax)
locs, labels = plt.xticks()
plt.setp(labels, rotation=90)
plt.axis('equal')
```

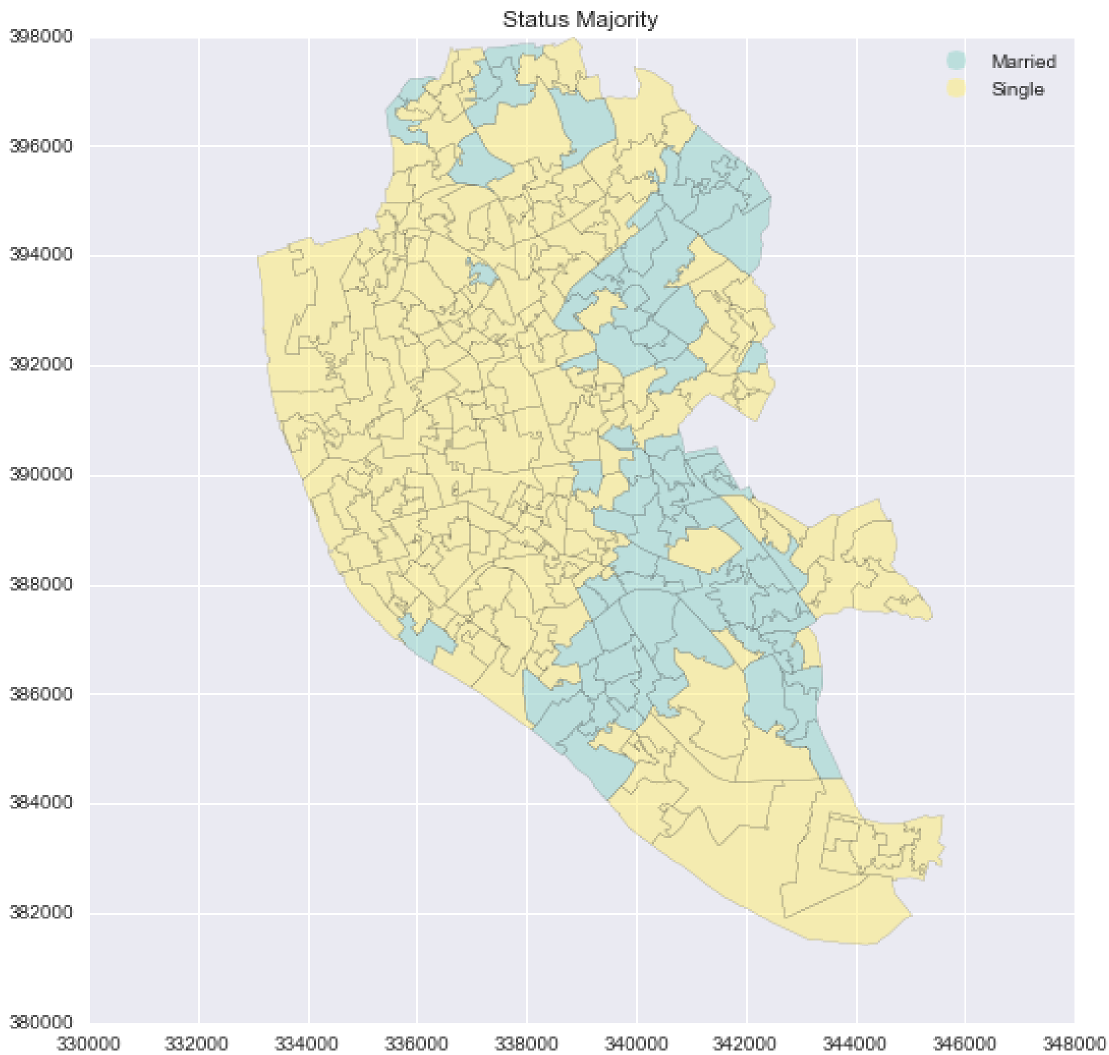
```
CPU times: user 5 s, sys: 1.34 s, total: 6.34 s
Wall time: 6.34 s
```



1.8 [Extension 3] Maps from lecture slides

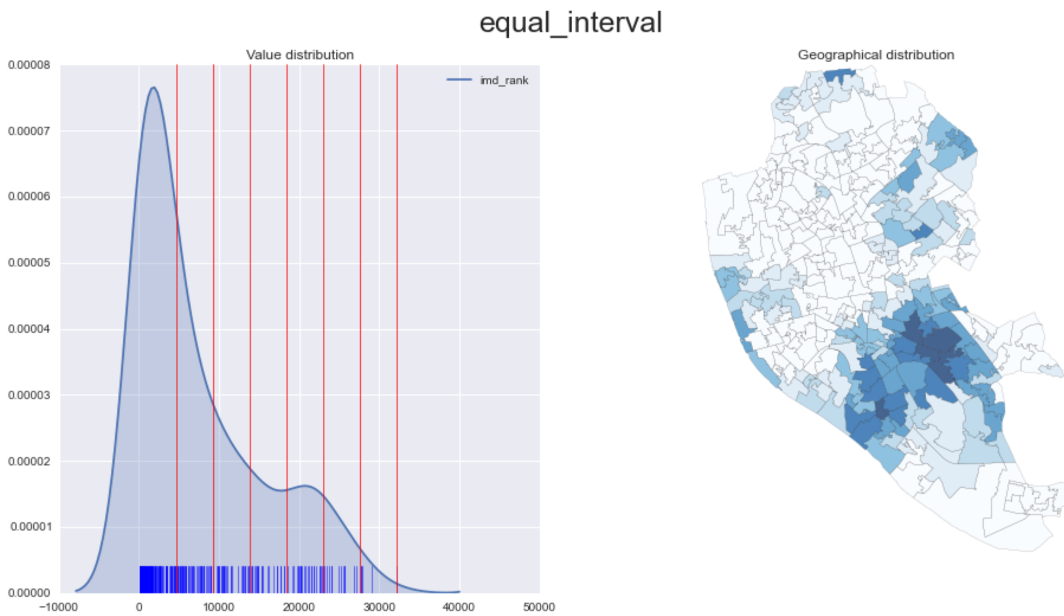
- Unique values

In [20]:
```
f, ax = plt.subplots(1, figsize=(9, 9))
both.plot(column='Status_Majority', categorical=True, legend=True, axes=ax, \
          linewidth=0.1, colormap='Set3')
ax.set_title('Status Majority')
plt.axis('equal')
plt.savefig('../lectures/figs/l04_unique_values.png')
plt.show()
```



- Choropleth classifiers

```
In [21]: def plot_scheme(scheme, var, db, figsize=(16, 8), saveto=None):
             '''
             Plot the distribution over value and geographical space of variable 'var' using scheme 'sc
             ...

             Arguments
             ---------
             scheme   : str
                        Name of the classification scheme to use
             var      : str
                        Variable name
             db       : GeoDataFrame
                        Table with input data
             figsize  : Tuple
                        [Optional. Default = (16, 8)] Size of the figure to be created.
             saveto   : None/str
                        [Optional. Default = None] Path for file to save the plot.
             '''
             from pysal.esda.mapclassify import Quantiles, Equal_Interval, Fisher_Jenks
             schemes = {'equal_interval': Equal_Interval, \
                        'quantiles': Quantiles, \
                        'fisher_jenks': Fisher_Jenks}
             classi = schemes[scheme](db[var], k=7)
             f, (ax1, ax2) = plt.subplots(1, 2, figsize=figsize)
             # KDE
             sns.kdeplot(db[var], shade=True, ax=ax1)
             sns.rugplot(db[var], alpha=0.5, ax=ax1)
             for cut in classi.bins:
                 ax1.axvline(cut, color='red', linewidth=0.75)
             ax1.set_title('Value distribution')
             # Map
             p = db.plot(column=var, scheme=scheme, alpha=0.75, k=7, \
                      colormap=plt.cm.Blues, axes=ax2, linewidth=0.1)
             ax2.axis('equal')
             ax2.set_axis_off()
             ax2.set_title('Geographical distribution')
             f.suptitle(scheme, size=25)
             if saveto:
                 plt.savefig(saveto)
             plt.show()

In [22]: plot_scheme('equal_interval', 'imd_rank', imd, saveto='../lectures/figs/l04_equal_interval.png
```



- Conditional map

```
In [23]: plot_scheme('quantiles', 'imd_rank', imd, saveto='../lectures/figs/l04_quantiles.png')
```