In [0]:
```
import os
def install_req():
  !apt-get install -qq curl g++ make
  !curl -L http://download.osgeo.org/libspatialindex/spatialindex-src-1.8.5.tar.gz | tar xz
  os.chdir('spatialindex-src-1.8.5')
  !./configure
  !make
  !make install


  !pip install geopandas shapely descartes rtree  mapclassify
  os.chdir('..')
```

In [0]:
```
#!pip uninstall geopandas rtree
install_req()
!ldconfig
```

In [3]:
```
! unzip /content/AISData.csv.zip
```

```
Archive:  /content/AISData.csv.zip
  inflating: AISData.csv
   creating: __MACOSX/
  inflating: __MACOSX/._AISData.csv
```

In [0]:
```
! unzip /content/Nima_Ports.zip
```

In [0]:
```
import pandas as pd
import geopandas as gdp
from shapely.geometry import Point,polygon
import matplotlib.pyplot as plt
import mapclassify
```

In [6]:
```
df=pd.read_csv('AISData.csv')
df.head(3)
```

Out[6]:

	Unnamed: 0	event_time	location.coordinates.0	location.coordinates.1	position_accuracy	mmsi	sog	cog
0	0	2019-04-11T09:47:30.153Z	-63.556082	44.624835	0.0	316013808	3.0	319.500000
1	1	2019-04-11T09:47:27.273Z	-63.556053	44.624817	0.0	316013808	3.0	320.700012
2	2	2019-04-11T09:47:34.340Z	-63.556138	44.624868	0.0	316013808	2.9	319.500000

In [7]:
```
df2 = gdp.read_file('assignment3shapefile.shp')
df2.head()
```

Out[7]:

	field_1	port_name	size	geometry
0	0	pointpolygon	0.0000	POLYGON ((-63.59160304069519 44.66492922546077,...
1	1	port1	0.0018	POLYGON ((-63.569431 44.649993, -63.5694396674...
2	2	port2	0.0018	POLYGON ((-63.60949000000001 44.675853, -63.60...
3	3	ind	0.0000	POLYGON ((-63.54742169380188 44.64697911403847...
4	4	port5	0.0018	POLYGON ((-63.568048 44.663875, -63.5680566674...

In [0]:
```
geo_df = gdp.GeoDataFrame(df.drop(['location.coordinates.0', 'location.coordinates.0'], axis=1),
crs={'init': 'epsg:4326'},
geometry=[Point(xy) for xy in zip(df['location.coordinates.0'], df['location.coordinates.1'])])
```

In [9]:
```
print(geo_df.shape)
```

```
(766671, 8)
```

In [0]:
```
geo_frame=geo_df[['event_time','mmsi','sog','cog','geometry']]
```

In [11]:
```
print('size of dataframe is',geo_frame.shape)
```

```
size of dataframe is (766671, 5)
```

In [12]:
```
merged=gdp.sjoin(geo_frame,df2,how='inner',op='intersects')
```

```
/usr/local/lib/python3.6/dist-packages/geopandas/tools/sjoin.py:56: UserWarning: CRS of frames being joined does not matc
h!({'init': 'epsg:4326'} != {})
  '({} != {})' % (left_df.crs, right_df.crs))
```

In [13]:
```
merged.head()
```

Out[13]:

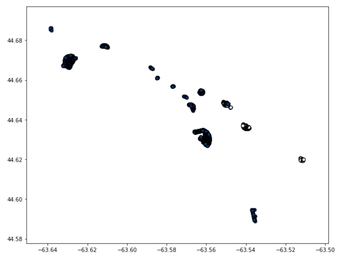
	event_time	mmsi	sog	cog	geometry	index_right	field_1	port_name	size
3124	2019-06-28T09:54:52.526Z	316013808	0.1	59.700001	POINT (-63.51242666666667 44.62054166666667)	8	8	auto_port	0.0015
3125	2019-06-28T09:54:52.526Z	316013808	0.1	59.700001	POINT (-63.51242666666667 44.62054166666667)	8	8	auto_port	0.0015
3126	2019-05-18T10:18:55.155Z	316013808	0.0	24.299999	POINT (-63.51236166666666 44.62050166666667)	8	8	auto_port	0.0015
3127	2019-06-28T09:52:13.732Z	316013808	0.3	70.000000	POINT (-63.5124 44.62049666666667)	8	8	auto_port	0.0015
3128	2019-06-28T09:52:13.732Z	316013808	0.3	70.000000	POINT (-63.5124 44.62049666666667)	8	8	auto_port	0.0015

Answer 1

In [14]:
```
plt.figure(figsize=(7,7))
merged['geometry'].plot(edgecolor="k",figsize=(10,10),cmap="Blues")
```

Out[14]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x7ff58bd7a2b0>
```

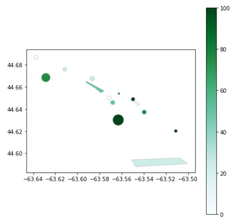
```
<Figure size 504x504 with 0 Axes>
```



Answer 2

In [0]:
```
count=merged.groupby(['port_name'],as_index=False)['mmsi'].agg('count')
count_port = df2[['port_name','geometry']].merge(count,on='port_name')
```

In [16]:
```
fig,ax=plt.subplots(1,figsize=(7,7))
count_port.plot(column='mmsi',scheme="QUANTILES", cmap='BuGn', linewidth=0.8,  edgecolor='0.8',ax=ax)
vmin,vmax=0,100
sm = plt.cm.ScalarMappable(cmap='BuGn', norm=plt.Normalize(vmin=vmin, vmax=vmax))# empty array for the data range
sm._A = []# add the colorbar to the figure
cbar = fig.colorbar(sm)
```



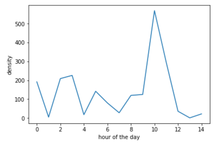
Answer 4

In [0]:
```
auto_port=merged[merged['port_name']=='auto_port'][['event_time','geometry']]
```

In [0]:
```
auto_port['hour']=auto_port['event_time'].apply(lambda x : pd.to_datetime(x).hour)
```

In [19]:
```
density=auto_port.groupby('hour',as_index=False).agg('count')
plt.plot(density.index,density['event_time'])
plt.xlabel('hour of the day')
plt.ylabel('density')
```

Out[19]:
```
Text(0, 0.5, 'density')
```



Answer 5

Data can change over time. This can result in poor and degrading predictive performance in predictive models that assume a static relationship between input and output variables. This problem of the changing underlying relationships in the data is called concept drift in the field of machine learning.

In the above visualization of auto_port message density,we can observe that the message density has always been chaning throughout each hours.This leads to concept drift.The message density is at it's peak at 10.00. and very low at 14.00

Answer 6

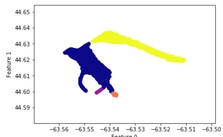
In [0]:
```
X=df[['location.coordinates.0','location.coordinates.1']][:10000]
```

I have considered only 10000 rows due to memory usage issues,you can change it as you need.

In [0]:
```
from sklearn.cluster import DBSCAN
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)# cluster the data into five clusters
dbscan = DBSCAN(eps=0.123, min_samples = 2)
clusters = dbscan.fit_predict(X_scaled)# plot the cluster assignments
```

In [22]:
```
plt.scatter(X['location.coordinates.0'], X['location.coordinates.1'], c=clusters, cmap="plasma")
plt.xlabel("Feature 0")
plt.ylabel("Feature 1")
```

Out[22]:
```
Text(0, 0.5, 'Feature 1')
```



Answer 3

In [0]:
```
df.sort_values(by='event_time',inplace=True)
S = pd.to_datetime(df.event_time)[:100] - #only considering 100 examples
for i, g in df.groupby(('18 - S[0]).astype('timedelta64[h]')):
        print (g.reset_index(drop=True))
        #plot not done
```

References

- http://geopandas.org/
- https://stackoverflow.com/
- https://towardsdatascience.com/geopandas-101-plot-any-data-with-a-latitude-and-longitude-on-a-map-98e01944b972

In [ ]:
```

```