Advanced Panda Operations

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In [1]:
```
# load world energy data.
# Source: http://unstats.un.org/unsd/environment/excel_file_tables/2013/Energy%20Indicators.xls

def load_energy_data():

    import pandas as pd
    import re

    # I could use lambda as follows but too many things to check.  So creating separate function: data_cleanup.
    # energy = pd.read_excel('Energy Indicators.xls', header=1, skiprows=16, skip_footer=38, na_values='...',
    #                        converters = {'Unnamed: 2' : lambda x :
    #                                      "South Korea" if x=="Republic of Korea" else
    #                                      "United States" if x=="United States of America20" else
    #                                      "United Kingdom" if x== "United Kingdom of Great Britain and Northern Ireland
    #                                      "Hong Kong" if x=="China, Hong Kong Special Administrative Region" else
    #                                      x
    #                                     })

    def data_cleanup(x):
        # first strip additional numbers at the end.
        x = x.rstrip('1234567890')  # remove footnote numbers associated with some countries.
        x = re.sub('\(.+\)','',x)   # remove other info like 'Bolivia (Plurinational State of)' should be 'Bolivia',
        x = x.rstrip()              # remove blanks at the end of a string
        if x=="Republic of Korea":
            return "South Korea"
        elif x=="United States of America":
            return "United States"
        elif x== "United Kingdom of Great Britain and Northern Ireland":
            return "United Kingdom"
        elif x=="China, Hong Kong Special Administrative Region":
            return "Hong Kong"
        else:
            return x


    # read excel and skip first 15 rows, line 16 is a header, skip 38 rows in footer.

    # I tried converting energy supply Gigjoules in the same forumla using:
    # converters={'Petajoules' : lambda x : x*1000000}.  This ran into an issue."
    # The "..." should convert to NaN.  But that didn't work, as it converted "..." to "..." times 1000000!!!

    energy = pd.read_excel('http://unstats.un.org/unsd/environment/excel_file_tables/2013/Energy%20Indicators.xls',
                           sheetname='Energy',header=1, skiprows=16, skip_footer=38, na_values='...',
                            converters = {'Unnamed: 2' : lambda x : data_cleanup(x)})

    #rename columns,
    energy.columns= ['one','two','Country','Energy Supply', 'Energy Supply per Capita', '% Renewable']

    #get rid of first two columns.
    energy = energy[['Country','Energy Supply', 'Energy Supply per Capita', '% Renewable']]

    # Convert to Gigajoules.
    energy['Energy Supply'] = energy['Energy Supply'] * 1000000

    return energy

energy=load_energy_data()

energy
```

Out[1]:

	Country	Energy Supply	Energy Supply per Capita	% Renewable
0	Afghanistan	3.210000e+08	10.0	78.669280
1	Albania	1.020000e+08	35.0	100.000000
2	Algeria	1.959000e+09	51.0	0.551010
3	American Samoa	NaN	NaN	0.641026
4	Andorra	9.000000e+06	121.0	88.695650
5	Angola	6.420000e+08	27.0	70.909090
6	Anguilla	2.000000e+06	136.0	0.000000
7	Antigua and Barbuda	8.000000e+06	84.0	0.000000
8	Argentina	3.378000e+09	79.0	24.064520
9	Armenia	1.430000e+08	48.0	28.236060
10	Aruba	1.200000e+07	120.0	14.870690
11	Australia	5.386000e+09	231.0	11.810810
12	Austria	1.391000e+09	164.0	72.452820
13	Azerbaijan	5.670000e+08	60.0	6.384345
14	Bahamas	4.500000e+07	118.0	0.000000
15	Bahrain	5.740000e+08	425.0	0.000000
16	Bangladesh	1.625000e+09	10.0	1.966329
17	Barbados	1.900000e+07	69.0	0.000000

18	Belarus	1.142000e+09	120.0	0.463389
19	Belgium	2.338000e+09	210.0	9.959739
20	Belize	1.300000e+07	39.0	64.690030
21	Benin	1.700000e+08	16.0	0.000000
22	Bermuda	6.000000e+06	88.0	0.000000
23	Bhutan	6.300000e+07	83.0	100.000000
24	Bolivia	3.360000e+08	32.0	31.477120
25	Bonaire, Sint Eustatius and Saba	5.000000e+06	213.0	0.000000
26	Bosnia and Herzegovina	2.660000e+08	70.0	41.464670
27	Botswana	8.600000e+07	39.0	0.131406
28	Brazil	1.214900e+10	59.0	69.648030
29	British Virgin Islands	2.000000e+06	85.0	0.000000
...	...	...	...	...
197	Switzerland	1.113000e+09	136.0	57.745480
198	Syrian Arab Republic	5.420000e+08	28.0	11.568270
199	Tajikistan	1.060000e+08	13.0	99.742920
200	Thailand	5.336000e+09	79.0	4.305189
201	The former Yugoslav Republic of Macedonia	1.170000e+08	56.0	26.140470
202	Timor-Leste	7.000000e+06	6.0	0.000000
203	Togo	1.340000e+08	19.0	80.180180
204	Tonga	3.000000e+06	28.0	0.000000
205	Trinidad and Tobago	8.240000e+08	611.0	0.000000
206	Tunisia	4.300000e+08	39.0	3.492547
207	Turkey	4.897000e+09	64.0	28.536690
208	Turkmenistan	1.102000e+09	210.0	0.000000
209	Turks and Caicos Islands	3.000000e+06	85.0	0.000000
210	Tuvalu	NaN	NaN	0.000000
211	Uganda	4.520000e+08	12.0	68.018180
212	Ukraine	4.844000e+09	107.0	8.067312
213	United Arab Emirates	2.710000e+09	300.0	0.000000
214	United Kingdom	7.920000e+09	124.0	10.600470
215	United Republic of Tanzania	9.940000e+08	20.0	31.072840
216	United States	9.083800e+10	286.0	11.570980
217	United States Virgin Islands	NaN	NaN	0.000000
218	Uruguay	1.960000e+08	58.0	71.605040
219	Uzbekistan	1.798000e+09	62.0	21.328410
220	Vanuatu	3.000000e+06	10.0	14.705880
221	Venezuela	2.871000e+09	95.0	67.834520
222	Viet Nam	2.554000e+09	28.0	45.321520
223	Wallis and Futuna Islands	0.000000e+00	26.0	0.000000
224	Yemen	3.440000e+08	13.0	0.000000
225	Zambia	4.000000e+08	26.0	99.714670
226	Zimbabwe	4.800000e+08	32.0	52.536120

227 rows × 4 columns

In [3]:
```
def load_gdp_data():
    # load world's gdp data.
    # Source: http://data.worldbank.org/indicator/NY.GDP.MKTP.CD

    import pandas as pd

    gdp = pd.read_excel('http://api.worldbank.org/v2/en/indicator/NY.GDP.MKTP.CD?downloadformat=excel',
                        sheetname='Data',header=1, skiprows=2,
                        converters = {'Country Name' : lambda x :
                                      "South Korea" if x=="Korea, Rep." else
                                      "Iran" if x=="Iran, Islamic Rep." else
                                      "Hong Kong" if x=="Hong Kong SAR, China" else
                                      x
                                     })

    # Use only the last 10 years (2006-2015) of GDP data.
    gdp_current_years=gdp[list(gdp.columns[0:1]) + list(gdp.columns[50:])]

    # drop year 2016 as it has no values.
    # We can use drop command.  Remember, axis=0 for rows and axis=1 for columns.
    gdp_current_years=gdp_current_years.drop('2016', axis=1)
    gdp_current_years=gdp_current_years.rename(columns={'Country Name':'Country'})
    #gdp_current_years
    return gdp_current_years

gdp_current_years=load_gdp_data()

gdp_current_years
```

Out[3]:

	Country	2006	2007	2008	2009	2010	2011	2012	2013	2014
0	Aruba	2.421475e+09	2.623726e+09	2.791961e+09	2.498933e+09	2.467704e+09	2.584464e+09	NaN	NaN	NaN
1	Andorra	3.536633e+09	4.010991e+09	4.001201e+09	3.650083e+09	3.346517e+09	3.427023e+09	3.146152e+09	3.248925e+09	NaN
2	Afghanistan	7.057598e+09	9.843842e+09	1.019053e+10	1.248694e+10	1.593680e+10	1.793024e+10	2.053654e+10	2.004633e+10	2.005019e+10

3	Angola	4.178948e+10	6.044892e+10	8.417803e+10	7.549238e+10	8.247091e+10	1.041159e+11	1.153984e+11	1.249121e+11	1.267769e+11
4	Albania	8.992642e+09	1.070101e+10	1.288135e+10	1.204421e+10	1.192695e+10	1.289087e+10	1.231978e+10	1.278103e+10	1.321986e+10
5	Arab World	1.404103e+12	1.637573e+12	2.077761e+12	1.795462e+12	2.103839e+12	2.497297e+12	2.733908e+12	2.830820e+12	2.889755e+12
6	United Arab Emirates	2.221059e+11	2.579161e+11	3.154746e+11	2.535474e+11	2.860493e+11	3.485261e+11	3.734320e+11	3.885985e+11	4.019581e+11
7	Argentina	2.335817e+11	2.888333e+11	3.631375e+11	3.344904e+11	4.259161e+11	5.332003e+11	5.489346e+11	5.541552e+11	5.297262e+11
8	Armenia	6.384452e+09	9.206302e+09	1.166204e+10	8.647937e+09	9.260285e+09	1.014211e+10	1.061932e+10	1.112147e+10	1.160951e+10
	American									

In [4]:
```
def load_scimago_data():
    import pandas as pd
    # now load Scimago Journal & Country Rank data.
    # http://www.scimagojr.com/countryrank.php?category=2102

    scima_country_rank = pd.read_excel('http://www.scimagojr.com/countryrank.php?category=2102&out=xls',
                                       sheetname='Sheet1')

    return scima_country_rank

scima_country_rank=load_scimago_data()

scima_country_rank
```

Out[4]:

	Rank	Country	Documents	Citable documents	Citations	Self-citations	Citations per document	H index
0	1	China	127050	126767	597237	411683	4.70	138
1	2	United States	96661	94747	792274	265436	8.20	230
2	3	Japan	30504	30287	223024	61554	7.31	134
3	4	United Kingdom	20944	20357	206091	37874	9.84	139
4	5	Russian Federation	18534	18301	34266	12422	1.85	57
5	6	Canada	17899	17620	215003	40930	12.01	149
6	7	Germany	17027	16831	140566	27426	8.26	126
7	8	India	15005	14841	128763	37209	8.58	115
8	9	France	13153	12973	130632	28601	9.93	114
9	10	South Korea	11983	11923	114675	22595	9.57	104
10	11	Italy	10964	10794	111850	26661	10.20	106
11	12	Spain	9428	9330	123336	23964	13.08	115
12	13	Iran	8896	8819	57470	19125	6.46	72
13	14	Australia	8831	8725	90765	15606	10.28	107
14	15	Brazil	8668	8596	60702	14396	7.00	86
15	16	Taiwan	6468	6441	86099	14768	13.31	102
16	17	Turkey	5879	5827	91857	23165	15.62	104
17	18	Norway	5675	5634	32693	6024	5.76	74
18	19	Netherlands	5170	5105	48351	6067	9.35	85
19	20	Sweden	4565	4494	57889	9632	12.68	95
20	21	Malaysia	3914	3881	25545	6597	6.53	62
21	22	Switzerland	3636	3599	38962	6186	10.72	81
22	23	Denmark	3531	3494	37254	6191	10.55	85
23	24	Mexico	3249	3214	21524	4145	6.62	57
24	25	Poland	3123	3102	24852	5395	7.96	55
25	26	Saudi Arabia	2979	2930	21208	2469	7.12	61
26	27	Greece	2866	2835	41662	6226	14.54	82
27	28	Egypt	2789	2752	19123	2778	6.86	55
28	29	Belgium	2697	2642	23720	3300	8.79	63
29	30	Singapore	2488	2443	36098	3700	14.51	81
...	...	...	...	...	...	...	...	...
161	162	Greenland	3	3	49	0	16.33	2
162	163	Afghanistan	3	3	0	0	0.00	0
163	164	Cape Verde	3	3	5	0	1.67	1
164	165	French Guiana	3	3	1	1	0.33	1
165	166	Samoa	3	3	13	1	4.33	1
166	167	Cayman Islands	2	2	2	0	1.00	1
167	168	Andorra	2	2	13	0	6.50	1
168	169	Antigua and Barbuda	2	2	0	0	0.00	0
169	170	Haïti	2	2	4	1	2.00	1
170	171	Nauru	2	2	0	0	0.00	0
171	172	Seychelles	2	2	7	2	3.50	1
172	173	Mali	2	2	0	0	0.00	0
173	174	Bermuda	2	2	12	0	6.00	1
174	175	Chad	2	2	0	0	0.00	0
175	176	Burundi	2	2	23	0	11.50	1
176	177	Liberia	1	1	1	0	1.00	1
177	178	Togo	1	1	0	0	0.00	0
		British Indian Ocean Territory	1	1	37	0	37.00	1

178	179	British Indian Ocean Territory	1	1	37	0	37.00	1
179	180	American Samoa	1	1	0	0	0.00	0
180	181	Saint Helena	1	1	1	0	1.00	1
181	182	Gibraltar	1	1	0	0	0.00	0
182	183	Maldives	1	1	1	0	1.00	1
183	184	Gambia	1	1	0	0	0.00	0
184	185	Belize	1	1	6	0	6.00	1
185	186	Palau	1	1	0	0	0.00	0
186	187	Guyana	1	1	0	0	0.00	0
187	188	Christmas Island	1	1	0	0	0.00	0
188	189	Reunion	1	1	2	1	2.00	1
189	190	Saint Lucia	1	1	0	0	0.00	0
190	191	Mauritania	1	1	1	0	1.00	1

191 rows × 8 columns

In [6]:
```
def answer_one():
    import pandas as pd

    # Join the three datasets: GDP, Energy, and ScimEn into a new dataset (using the intersection of country names).
    # Use only the last 10 years (2006-2015) of GDP data and only the top 15 countries by Scimagojr
    #'Rank' (Rank 1 through 15).

    rank_energy = pd.merge(scima_country_rank,energy, how='inner', left_on='Country', right_on='Country')
    #The index of this DataFrame should be the name of the country.
    rank_energy_gdp = pd.merge(rank_energy, gdp_current_years, how='inner',
                               left_on='Country', right_on='Country').set_index(['Country'])

    return rank_energy_gdp[0:15]

rank_energy_gdp=answer_one()

rank_energy_gdp
```

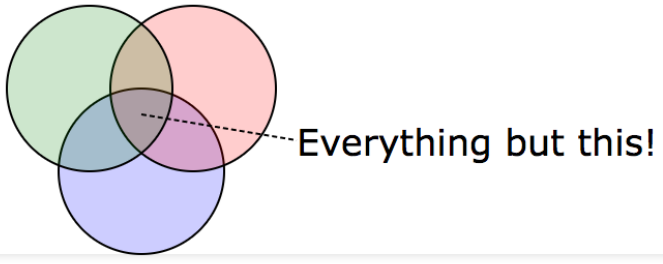
Out[6]:

	Rank	Documents	Citable documents	Citations	Self-citations	Citations per document	H index	Energy Supply	Energy Supply per Capita	% Renewable	2006	2007
Country												
China	1	127050	126767	597237	411683	4.70	138	1.271910e+11	93.0	19.754910	2.752132e+12	3.552183e+12
United States	2	96661	94747	792274	265436	8.20	230	9.083800e+10	286.0	11.570980	1.385589e+13	1.447764e+13
Japan	3	30504	30287	223024	61554	7.31	134	1.898400e+10	149.0	10.232820	4.356750e+12	4.356348e+12
United Kingdom	4	20944	20357	206091	37874	9.84	139	7.920000e+09	124.0	10.600470	2.678278e+12	3.063005e+12
Russian Federation	5	18534	18301	34266	12422	1.85	57	3.070900e+10	214.0	17.288680	9.899305e+11	1.299705e+12
Canada	6	17899	17620	215003	40930	12.01	149	1.043100e+10	296.0	61.945430	1.315415e+12	1.464977e+12
Germany	7	17027	16831	140566	27426	8.26	126	1.326100e+10	165.0	17.901530	3.002446e+12	3.439953e+12
India	8	15005	14841	128763	37209	8.58	115	3.319500e+10	26.0	14.969080	9.491168e+11	1.201072e+12
France	9	13153	12973	130632	28601	9.93	114	1.059700e+10	166.0	17.020280	2.325012e+12	2.663113e+12
South Korea	10	11983	11923	114675	22595	9.57	104	1.100700e+10	221.0	2.279353	1.011797e+12	1.122679e+12
Italy	11	10964	10794	111850	26661	10.20	106	6.530000e+09	109.0	33.667230	1.942634e+12	2.203053e+12
Spain	12	9428	9330	123336	23964	13.08	115	4.923000e+09	106.0	37.968590	1.264551e+12	1.479342e+12
Iran	13	8896	8819	57470	19125	6.46	72	9.172000e+09	119.0	5.707721	2.586457e+11	3.374745e+11
Australia	14	8831	8725	90765	15606	10.28	107	5.386000e+09	231.0	11.810810	7.468808e+11	8.530533e+11
Brazil	15	8668	8596	60702	14396	7.00	86	1.214900e+10	59.0	69.648030	1.107640e+12	1.397084e+12

The previous question joined three datasets then reduced this to just the top 15 entries. When you joined the datasets, but before you reduced this to the top 15 items, how many entries did you lose?

This function should return a single number.

In [7]:
```
%%HTML
<svg width="800" height="300">
  <circle cx="150" cy="180" r="80" fill-opacity="0.2" stroke="black" stroke-width="2" fill="blue" />
  <circle cx="200" cy="100" r="80" fill-opacity="0.2" stroke="black" stroke-width="2" fill="red" />
  <circle cx="100" cy="100" r="80" fill-opacity="0.2" stroke="black" stroke-width="2" fill="green" />
  <line x1="150" y1="125" x2="300" y2="150" stroke="black" stroke-width="2" fill="black" stroke-dasharray="5,3"/>
  <text  x="300" y="165" font-family="Verdana" font-size="35">Everything but this!</text>
</svg>
```



In [8]:
```
def answer_two():
    import pandas as pd
    # let's find out the union of all 3.
    # Subtract the intersect of all 3 from union. That will give us how many entries we removed.

    # Union
    rank_energy_unioun = pd.merge(scima_country_rank,energy, how='outer', left_on='Country', right_on='Country')
    rank_energy_gdp_unioun = pd.merge(rank_energy_unioun, gdp_current_years, how='outer', left_on='Country', right_on='

    # Calculate interset again, as its part of answer_one() function, not global.
    rank_energy_intetsect = pd.merge(scima_country_rank,energy, how='inner', left_on='Country', right_on='Country')
    rank_energy_gdp_intetsect = pd.merge(rank_energy_intetsect, gdp_current_years, how='inner',
                            left_on='Country', right_on='Country').set_index(['Country'])

    # Nunber of entries we removed are:
    ent_removed=rank_energy_gdp_unioun.shape[0]-rank_energy_gdp_intetsect.shape[0]
    return ent_removed

answer_two()
```

Out[8]:
```
156
```

What is the average GDP over the last 10 years for each country? (exclude missing values from this calculation.)

This function should return a Series named `avgGDP` with 15 countries and their average GDP sorted in descending order.

In [9]:
```
def answer_three():
    import pandas as pd
    import numpy as np
    def avgval(data):
        sel_columns=data[['2006',
                          '2007',
                          '2008',
                          '2009',
                          '2010',
                          '2011',
                          '2012',
                          '2013',
                          '2014',
                          '2015']]
        return pd.Series({'avgGDP0615': np.mean(sel_columns)})

    avgGDP=rank_energy_gdp.apply(avgval, axis=1)
    avgGDPSorted = avgGDP.sort_values(['avgGDP0615'], ascending=False)
    return avgGDPSorted['avgGDP0615']

avgGDP=answer_three()
#type(avgGDP)
avgGDP
```

Out[9]:
```
Country
United States         1.562297e+13
China                 6.934351e+12
Japan                 4.959066e+12
Germany               3.532675e+12
United Kingdom        2.724482e+12
France                2.686284e+12
Italy                 2.129754e+12
Brazil                1.980922e+12
Russian Federation    1.650196e+12
Canada                1.609883e+12
India                 1.597058e+12
Spain                 1.408716e+12
Australia             1.200847e+12
South Korea           1.165321e+12
Iran                  4.418080e+11
Name: avgGDP0615, dtype: float64
```

By how much had the GDP changed over the 10 year span for the country with the 6th largest average GDP?

This function should return a single number.

In [11]:
```
def answer_four():
    import pandas as pd
    gdpchgcountry = pd.DataFrame(avgGDP)
    gdpchgcountry['Country']=gdpchgcountry.index
    x=gdpchgcountry.iloc[5]['Country']
    no5gdp=rank_energy_gdp[rank_energy_gdp.index==x]

    chg=no5gdp['2015']-no5gdp['2006']
    return chg[0]
gdpchg6=answer_four()

gdpchg6
```

Out[11]:
```
93823614678.845703
```

What is the mean `Energy Supply per Capita`?

This function should return a single number.

In [12]:
```
def answer_five():
    import numpy as np
    return np.mean(rank_energy_gdp['Energy Supply per Capita'])

meanengpercap = answer_five()

meanengpercap
```

Out[12]:
```
157.59999999999999
```

What country has the maximum % Renewable and what is the percentage?

This function should return a tuple with the name of the country and the percentage.

In [13]:
```
def answer_six():
    rank_energy_sorted=rank_energy_gdp.sort_values(['% Renewable'], ascending=False)
    country=rank_energy_sorted.index[0]
    topren=rank_energy_sorted['% Renewable'][0]
    return (country, topren)

topren= answer_six()

topren
```

Out[13]: ('Brazil', 69.648030000000006)

Create a new column that is the ratio of Self-Citations to Total Citations. What is the maximum value for this new column, and what country has the highest ratio?

This function should return a tuple with the name of the country and the ratio.

In [14]:
```
def answer_seven():
    rank_energy_gdp['SelfCitationRatio']=rank_energy_gdp['Self-citations']/rank_energy_gdp['Citations']
    rank_energy_gdp.sort_values(['SelfCitationRatio'], ascending=False)
    country=rank_energy_gdp.index[0]
    topren=rank_energy_gdp['SelfCitationRatio'][0]
    return (country, topren)

topren=answer_seven()
topren
```

Out[14]: ('China', 0.68931261793894216)

Create a column that estimates the population using Energy Supply and Energy Supply per capita. What is the third most populous country according to this estimate?

This function should return a single string value.

In [15]:
```
def answer_eight():
    rank_energy_gdp['Estpop']=rank_energy_gdp['Energy Supply']/rank_energy_gdp['Energy Supply per Capita']
    rank_energy_sorted=rank_energy_gdp.sort_values(['Estpop'], ascending=False)
    country=rank_energy_sorted.index[2]
    return country

topren=answer_eight()
topren
```

Out[15]: 'United States'

Create a column that estimates the number of citable documents per person. What is the correlation between the number of citable documents per capita and the energy supply per capita? Use the `.corr()` method, (Pearson's correlation).

This function should return a single number.

(Optional: Use the built-in function `plot9()` to visualize the relationship between Energy Supply per Capita vs. Citable docs per Capita)

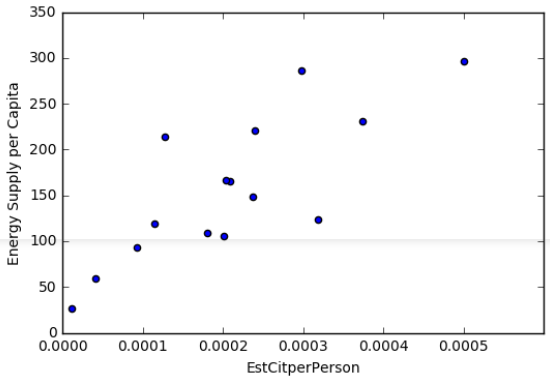
In [16]:
```
def answer_nine():
    rank_energy_gdp['EstCitperPerson']=rank_energy_gdp['Citable documents']/rank_energy_gdp['Estpop']
    return rank_energy_gdp['EstCitperPerson'].corr(rank_energy_gdp['Energy Supply per Capita'])

corrval=answer_nine()
corrval
```

Out[16]: 0.79400104354429457

In [17]:
```
def plot9():
    import matplotlib as plt
    %matplotlib inline
    rank_energy_gdp.plot(x='EstCitperPerson', y='Energy Supply per Capita', kind='scatter', xlim=[0, 0.0006])

plot9()
```



Create a new column with a 1 if the country's % Renewable value is at or above the median for all countries in the top 15, and a 0 if the country's % Renewable value is below the median.

This function should return a series named `HighRenew` whose index is the country name sorted in ascending order of rank.

In [18]:
```
def answer_ten():
    import numpy as np
    import pandas as pd
    renMedian=np.median(rank_energy_gdp['% Renewable'])
    rank_energy_gdp['RenEnergyState']=rank_energy_gdp.apply(lambda row: 1 if row['% Renewable'] >= renMedian else 0, ax
    rank_energy_sorted = rank_energy_gdp.sort_values(['Rank'])
    #HighRenew = pd.Series(rank_energy_sorted.index)
    return rank_energy_sorted['Rank']

country_list=answer_ten()
```

```
#type(country_list)
country_list
```

Out[18]:
```
Country
China                  1
United States          2
Japan                  3
United Kingdom         4
Russian Federation     5
Canada                 6
Germany                7
India                  8
France                 9
South Korea           10
Italy                 11
Spain                 12
Iran                  13
Australia             14
Brazil                15
Name: Rank, dtype: int64
```

Use the following dictionary to group the Countries by Continent, then create a dateframe that displays the sample size (the number of countries in each continent bin), and the sum, mean, and std deviation for the estimated population of each country.

```
ContinentDict  = {'China':'Asia',
                  'United States':'North America',
                  'Japan':'Asia',
                  'United Kingdom':'Europe',
                  'Russian Federation':'Europe',
                  'Canada':'North America',
                  'Germany':'Europe',
                  'India':'Asia',
                  'France':'Europe',
                  'South Korea':'Asia',
                  'Italy':'Europe',
                  'Spain':'Europe',
                  'Iran':'Asia',
                  'Australia':'Australia',
                  'Brazil':'South America'}
```

This function should return a DataFrame with index named Continent `['Asia', 'Australia', 'Europe', 'North America', 'South America']` and columns `['size', 'sum', 'mean', 'std']`

In [19]:
```
def answer_eleven():
    import pandas as pd
    import numpy as np
    ContinentDict  = {'China':'Asia',
                      'United States':'North America',
                      'Japan':'Asia',
                      'United Kingdom':'Europe',
                      'Russian Federation':'Europe',
                      'Canada':'North America',
                      'Germany':'Europe',
                      'India':'Asia',
                      'France':'Europe',
                      'South Korea':'Asia',
                      'Italy':'Europe',
                      'Spain':'Europe',
                      'Iran':'Asia',
                      'Australia':'Australia',
                      'Brazil':'South America'}

    rank_energy_gdp['Country']=rank_energy_gdp.index
    rank_energy_gdp['Continent']=rank_energy_gdp.apply(lambda row: ContinentDict[row['Country']], axis=1)

    return (rank_energy_gdp.set_index('Continent')
                    .groupby(level=0)['Estpop']
                     .agg({'size' : np.count_nonzero,
                           'sum' : np.sum,
                           'mean' : np.average,
                           'std' : np.std
                          }))

ans_ele=answer_eleven()

ans_ele
```

Out[19]:

	mean	std	size	sum
Continent				
Asia	5.797333e+08	6.790979e+08	5.0	2.898666e+09
Australia	2.331602e+07	NaN	1.0	2.331602e+07
Europe	7.632161e+07	3.464767e+07	6.0	4.579297e+08
North America	1.764276e+08	1.996696e+08	2.0	3.528552e+08
South America	2.059153e+08	NaN	1.0	2.059153e+08

Cut % Renewable into 5 bins. Group Top15 by the Continent, as well as these new % Renewable bins. How many countries are in each of these groups?

This function should return a ***Series*** *with a MultiIndex of `Continent`, then the bins for `% Renewable`. Do not include groups with no countries.*

In [20]:
```
def answer_twelve():
    import pandas as pd
    import numpy as np

    rank_energy_gdp['renewablecategory']=pd.cut(rank_energy_gdp['% Renewable'],5)
    rank_sorted=rank_energy_gdp.sort_values(['Continent','renewablecategory'], ascending=[True,True])
    return rank_sorted.groupby(['Continent', 'renewablecategory'])['Country'].count()

ans_12=answer_twelve()
#type(ans_12)
ans_12
```

Out[20]:
```
Continent      renewablecategory
Asia           (2.212, 15.753]      4
               (15.753, 29.227]     1
Australia      (2.212, 15.753]      1
Europe         (2.212, 15.753]      1
               (15.753, 29.227]     3
               (29.227, 42.701]     2
North America  (2.212, 15.753]      1
               (56.174, 69.648]     1
South America  (56.174, 69.648]     1
Name: Country, dtype: int64
```

Convert the Population Estimate series to a string with thousands separator (using commas). Do not round the results.

e.g. 317615384.61538464 -> 317,615,384.61538464

This function should return a Series `PopEst` whose index is the country name and whose values are the population estimate string.

In [21]:
```
def answer_thirteen():
    return rank_energy_gdp['Estpop'].apply(lambda row: '{:,}'.format(row))

ans_13=answer_thirteen()
ans_13
```

Out[21]:
```
Country
China                1,367,645,161.2903225
United States          317,615,384.61538464
Japan                  127,409,395.97315437
United Kingdom         63,870,967.741935484
Russian Federation           143,500,000.0
Canada                  35,239,864.86486486
Germany                 80,369,696.96969697
India                1,276,730,769.2307692
France                  63,837,349.39759036
South Korea            49,805,429.864253394
Italy                  59,908,256.880733944
Spain                    46,443,396.2264151
Iran                    77,075,630.25210084
Australia              23,316,017.316017315
Brazil                 205,915,254.23728815
Name: Estpop, dtype: object
```

Use the built in function `plot_optional()` to see an example visualization.

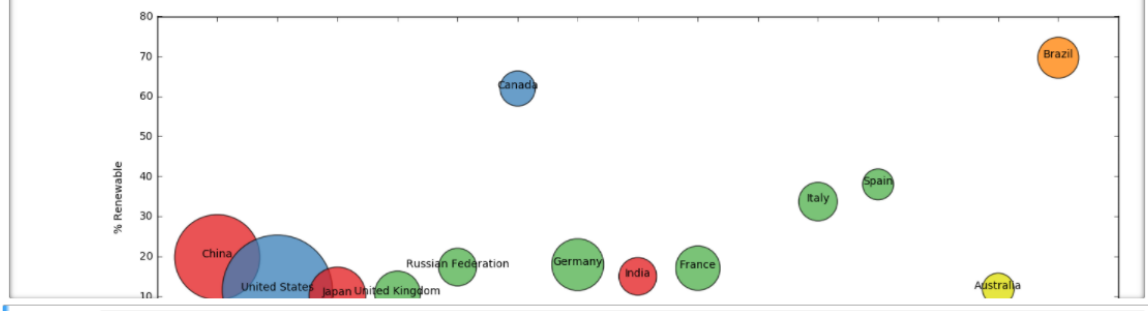
In [23]:
```
def plot_optional():
    import matplotlib as plt
    %matplotlib inline
    #Top15 = answer_one()
    ax = rank_energy_gdp.plot(x='Rank', y='% Renewable', kind='scatter',
                    c=['#e41a1c','#377eb8','#e41a1c','#4daf4a','#4daf4a','#377eb8','#4daf4a','#e41a1c',
                       '#4daf4a','#e41a1c','#4daf4a','#4daf4a','#e41a1c','#dede00','#ff7f00'],
                    xticks=range(1,16), s=6*rank_energy_gdp['2014']/10**10, alpha=.75, figsize=[16,6]);

    for i, txt in enumerate(rank_energy_gdp.index):
        ax.annotate(txt, [rank_energy_gdp['Rank'][i], rank_energy_gdp['% Renewable'][i]], ha='center')

    print("Visualization: % Renewable vs. Rank. The size of the bubble corresponds to the countries' \
2014 GDP, and the color corresponds to the continent.")

plot_optional()
```

```
Visualization: % Renewable vs. Rank. The size of the bubble corresponds to the countries' 2014 GDP, and the color cor
responds to the continent.
```



In [ ]: