Handout for Session 8 (with Solutions)

1. Brief Overview of Data Analytics Using Pandas

Loading data

[1]:
```
import pandas as pd
base='https://raw.githubusercontent.com/chendaniely/pandas_for_everyone/master/data/'
filename='gapminder.tsv'
data=pd.read_csv(base+filename,sep='\t')
data.head()
```

	country	continent	year	lifeExp	pop	gdpPercap
0	Afghanistan	Asia	1952	28.801	8425333	779.445314
1	Afghanistan	Asia	1957	30.332	9240934	820.853030
2	Afghanistan	Asia	1962	31.997	10267083	853.100710
3	Afghanistan	Asia	1967	34.020	11537966	836.197138
4	Afghanistan	Asia	1972	36.088	13079460	739.981106

Obtaining Basic Information

[2]:
```
data.shape
```

```
(1704, 6)
```

[3]:
```
data.describe()
```

	year	lifeExp	pop	gdpPercap
count	1704.00000	1704.000000	1.704000e+03	1704.000000
mean	1979.50000	59.474439	2.960121e+07	7215.327081
std	17.26533	12.917107	1.061579e+08	9857.454543
min	1952.00000	23.599000	6.001100e+04	241.165877
25%	1965.75000	48.198000	2.793664e+06	1202.060309
50%	1979.50000	60.712500	7.023596e+06	3531.846989
75%	1993.25000	70.845500	1.958522e+07	9325.462346
max	2007.00000	82.603000	1.318683e+09	113523.132900

[4]:
```
data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1704 entries, 0 to 1703
Data columns (total 6 columns):
country      1704 non-null object
continent    1704 non-null object
year         1704 non-null int64
lifeExp      1704 non-null float64
pop          1704 non-null int64
gdpPercap    1704 non-null float64
dtypes: float64(2), int64(2), object(2)
memory usage: 80.0+ KB
```

Manipulating data

```
[5]: data['gdp']=data['pop']*data['gdpPercap']/1e9
     data['pop']/=1e6
     data['gdpPercap']/=1e3
     data=data.set_index('year')
     data.head(3)
```

```
          country continent  lifeExp        pop  gdpPercap       gdp
year
1952  Afghanistan      Asia   28.801   8.425333   0.779445  6.567086
1957  Afghanistan      Asia   30.332   9.240934   0.820853  7.585449
1962  Afghanistan      Asia   31.997  10.267083   0.853101  8.758856
```

Filtering data

```
[6]: usa=data.query('country=="United States"')
     usa.head(3)
```

```
            country continent  lifeExp      pop  gdpPercap          gdp
year
1952  United States  Americas    68.44  157.553  13.990482  2204.242423
1957  United States  Americas    69.49  171.984  14.847127  2553.468311
1962  United States  Americas    70.21  186.538  16.173146  3016.906282
```

```
[7]: usa=data[data['country']=='United States']
     usa.head(3)
```

```
            country continent  lifeExp      pop  gdpPercap          gdp
year
1952  United States  Americas    68.44  157.553  13.990482  2204.242423
1957  United States  Americas    69.49  171.984  14.847127  2553.468311
1962  United States  Americas    70.21  186.538  16.173146  3016.906282
```

```
[8]: gdp=usa['gdp']
     gdp.head()
```

```
year
1952    2204.242423
1957    2553.468311
1962    3016.906282
1967    3880.918003
1972    4576.999720
Name: gdp, dtype: float64
```

Plotting data

```
[9]: import matplotlib.pyplot as plt
     gdp.plot(title='GDP of USA')
     plt.xlabel('Year')
     plt.ylabel('GDP')
     plt.show()
```

```
<Figure size 640x480 with 1 Axes>
```

2. Pandas Series Basics

2.1 Creating a Series Object

From list

```
[10]: import pandas as pd
      s=pd.Series([5,6,4])
      s
```

```
0    5
1    6
2    4
dtype: int64
```

```
[11]: s=pd.Series([5,6,4],index=['apple','orange','grape'])
      s
```

```
apple     5
orange    6
grape     4
dtype: int64
```

From dictionary

```
[12]: s=pd.Series({'apple':5,'orange':6,'grape':4})
      s
```

```
apple     5
orange    6
grape     4
dtype: int64
```

From scratch

```
[13]: s=pd.Series()
      s['apple']=5
      s['orange']=6
      s['grape']=4
      s
```

```
apple     5
orange    6
grape     4
dtype: int64
```

2.2 Indexing a Series

Obtaining a single element

```
[14]: s[1]
```

```
6
```

```
[15]: s.iloc[1]
```

```
6
```

```
[16]: s.loc['orange']
```

```
6
```

Slicing a contiguous chunk.

```
[17]: s[:2]
```

```
apple     5
orange    6
dtype: int64
```

```
[18]: s.iloc[:2]
```

```
apple     5
orange    6
dtype: int64
```

```
[19]: s.loc[:'orange']
```

```
apple     5
orange    6
dtype: int64
```

Fancy indexing: specifying a list of positions

```
[20]: s[[0,2]]
```

```
apple    5
grape    4
dtype: int64
```

```
[21]: s.iloc[[0,2]]
```

```
apple    5
grape    4
dtype: int64
```

```
[22]: s.loc[['apple','orange']]
```

```
apple     5
orange    6
dtype: int64
```

Boolean indexing: specifying whether to include each element

```
[23]: s[[True,False,True]]
```

```
apple    5
grape    4
dtype: int64
```

Q1-a: Create the following `Series` object using three ways.

```
Fritos     20
Cheetos    15
Lays       25
dtype: int64
```

```
[24]: t=pd.Series({'Fritos':20,'Cheetos':15,'Lays':25})
      t
```

```
Fritos     20
Cheetos    15
Lays       25
dtype: int64
```

```
[25]: t=pd.Series([20,15,25],index=['Fritos','Cheetos','Lays'])
      t
```

```
Fritos     20
Cheetos    15
Lays       25
dtype: int64
```

```
[26]: t=pd.Series()
      t['Fritos']=20
      t['Cheetos']=15
      t['Lays']=25
      t
```

```
Fritos     20
Cheetos    15
Lays       25
dtype: int64
```

Q1-b: Obtain the single element corresponding to `"Lays"` using five ways.

```
[27]: t[2]
```

```
25
```

```
[28]: t[-1]
```

```
25
```

```
[29]: t.iloc[2]
```

```
25
```

```
[30]: t.iloc[-1]
```

```
25
```

```
[31]: t.loc['Lays']
```

```
25
```

Q1-c: Obtain everything but the first element using at least four ways.

```
[32]: t[1:]
```

```
Cheetos    15
Lays       25
dtype: int64
```

```
[33]: t.iloc[1:]
```

```
Cheetos    15
Lays       25
dtype: int64
```

```
[34]: t.loc['Cheetos':]
```

```
Cheetos    15
Lays       25
dtype: int64
```

```
[35]: t[[False,True,True]]
```

```
Cheetos    15
Lays       25
dtype: int64
```

2.3 Manipulating a Series Object

Basic information

```
[36]: s.index
```

```
Index(['apple', 'orange', 'grape'], dtype='object')
```

```
[37]: s.values
```

```
array([5, 6, 4])
```

```
[38]: s.unique()
```

```
array([5, 6, 4])
```

```
[39]: s.describe()
```

```
count    3.0
mean     5.0
std      1.0
min      4.0
25%      4.5
50%      5.0
75%      5.5
max      6.0
dtype: float64
```

Arithmetics

```
[40]: s+1
```

```
apple     6
orange    7
grape     5
dtype: int64
```

```
[41]: s>5
```

```
apple     False
orange     True
grape     False
dtype: bool
```

```
[42]: s[s>5]
```

```
orange    6
dtype: int64
```

```
[43]: (s>=6) | (s<=4)
```

```
apple     False
orange     True
grape      True
dtype: bool
```

```
[44]: s[(s>=6) | (s<=4)]
```

```
orange    6
grape     4
dtype: int64
```

```
[45]: (s>=5) & (s<=6)
```

```
apple      True
orange     True
grape     False
dtype: bool
```

```
[46]: s[(s>=5) & (s<=6)]
```

```
apple     5
orange    6
dtype: int64
```

Vectorized functions

```
[47]: import numpy as np
      np.exp(s)
```

```
apple     148.413159
orange    403.428793
grape      54.598150
dtype: float64
```

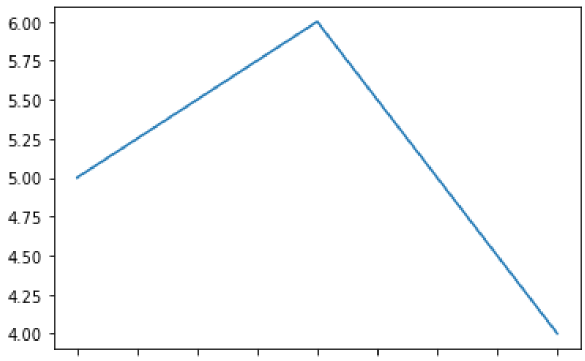
```
[48]: s.mean()
```

```
5.0
```

Plotting

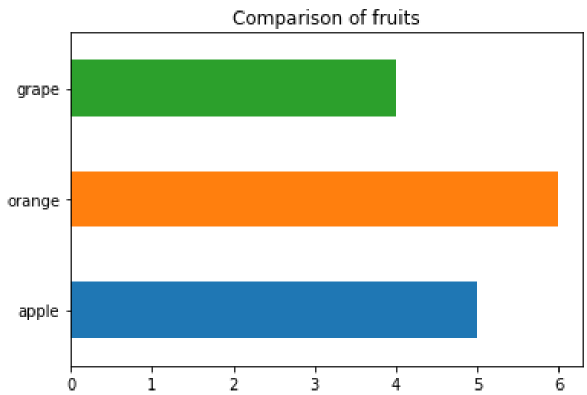
```
[49]: s.plot()
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f471e14f5f8>
```




```
[50]: s.plot(kind='barh',title='Comparison of fruits')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f471e09e390>
```



Q2-a: Run the function `describe` on the Series `gdp` (from part 1 of this handout).

```
[51]: gdp.describe()
```

```
count       12.000000
mean      6396.826912
std       3524.169583
min       2204.242423
25%       3664.915073
50%       5554.323909
75%       8606.556438
max      12934.458535
Name: gdp, dtype: float64
```

Q2-b: Write an expression divides the Series `gdp` by 1000 and round to 2 decimal places (using the `round` function).

```
[52]: round(gdp/1000,2)
```

```
year
1952     2.20
1957     2.55
1962     3.02
1967     3.88
1972     4.58
1977     5.30
1982     5.81
1987     7.26
1992     8.22
1997     9.76
2002    11.25
2007    12.93
Name: gdp, dtype: float64
```

Q2-c: Filter the Series gdp for values above 10000.

```
[53]: gdp[gdp>10000]
```

```
year
2002    11247.278678
2007    12934.458535
Name: gdp, dtype: float64
```

Q2-d: Obtain a Series corresponding to the life expectancy in USA when the GDP is above 10 trillion. (Hint: obtain the life expectancy column using `usa['lifeExp']` and use boolean indexing on gdp1 as in Q2-b.)

```
[54]: usa['lifeExp'][gdp>10000]
```

```
year
2002    77.310
2007    78.242
Name: lifeExp, dtype: float64
```

Q2-e: Compute the average life expectancy in the data set for USA when the GDP is above 10 trillion. (Hint: call the function `mean` of the above Series.)

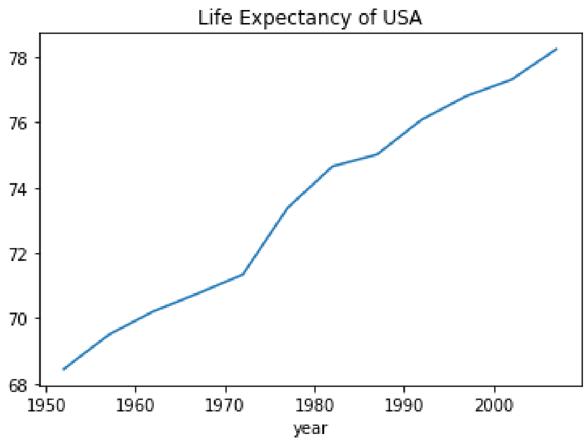
```
[55]: usa['lifeExp'][usa['gdp']>10000].mean()
```

```
77.77600000000001
```

Q2-f: Plot the life expectancy of USA in the data set using a line plot.

```
[56]: usa['lifeExp'].plot(title='Life Expectancy of USA')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f471e00ac50>
```



3. Pandas DataFrame Basics II

3.1 Creating a DataFrame Object

From list of lists

```
[57]: import pandas as pd
      df=pd.DataFrame([[5,3,'M'],[6,2,'M'],[4,1,'S']])
      df
```

	0	1	2
0	5	3	M
1	6	2	M
2	4	1	S

```
[58]: df=pd.DataFrame([[5,3,'M'],[6,2,'M'],[4,1,'S']],\
                      index=['apple','orange','grape'],\
                      columns=['Number','Rank','Size'])
      df
```

	Number	Rank	Size
apple	5	3	M
orange	6	2	M
grape	4	1	S

From dictionary of columns

```
[59]: df=pd.DataFrame({'Number':[5,6,4],'Rank':[2,1,3], 'Size':['M','M','S']},\
                      index=['apple','orange','grape'])
      df
```

	Number	Rank	Size
apple	5	2	M
orange	6	1	M
grape	4	3	S

3.2 Indexing a DataFrame

Obtaining a single element

```
[60]: df['Number'][0]
```

```
5
```

```
[61]: df.iloc[0,0]
```

```
5
```

```
[62]: df.loc['apple','Number']
```

```
5
```

Obtaining a column

```
[63]: df['Number']
```

```
apple     5
orange    6
grape     4
Name: Number, dtype: int64
```

```
[64]: df.iloc[:,0]
```

```
apple     5
orange    6
grape     4
Name: Number, dtype: int64
```

```
[65]: df.loc[:,'Number']
```

```
apple     5
orange    6
grape     4
Name: Number, dtype: int64
```

Obtaining a row

```
[66]: df.iloc[1,:]
```

```
Number    6
Rank      1
Size      M
Name: orange, dtype: object
```

```
[67]: df.loc['orange',:]
```

```
Number    6
Rank      1
Size      M
Name: orange, dtype: object
```

Obtaining particular rows

```
[68]: df.iloc[[0,2],:]
```

```
       Number  Rank Size
apple       5     2    M
grape       4     3    S
```

```
[69]: df.loc[['apple','grape'],:]
```

```
       Number  Rank Size
apple       5     2    M
grape       4     3    S
```

```
[70]: # Boolean indexing for Dataframes selects rows
      df[[True,False,True]]
```

```
       Number  Rank Size
apple       5     2    M
grape       4     3    S
```

Q3-a: Obtain the second column of the DataFrame `df` in at least three ways.

```
[71]: df['Rank']
```

```
apple     2
orange    1
grape     3
Name: Rank, dtype: int64
```

```
[72]: df.iloc[:,-1]
```

```
apple     M
orange    M
grape     S
Name: Size, dtype: object
```

```
[73]: df.loc[:,'Rank']
```

```
apple     2
orange    1
grape     3
Name: Rank, dtype: int64
```

Q3-b: Obtain the second and third row of the DataFrame `df` in at least five ways.

```
[74]: df.iloc[1:3,:]
```

```
        Number  Rank Size
orange       6     1    M
grape        4     3    S
```

```
[75]: df.iloc[[1,2],:]
```

```
        Number  Rank Size
orange       6     1    M
grape        4     3    S
```

```
[76]: df.loc['orange':'grape',:]
```

```
        Number  Rank Size
orange       6     1    M
grape        4     3    S
```

```
[77]: df.loc[['orange','grape'],:]
```

```
        Number  Rank Size
orange       6     1    M
grape        4     3    S
```

```
[78]: df[[False,True,True]]
```

```
        Number  Rank Size
orange       6     1    M
grape        4     3    S
```

Q3-c: Obtain the rank of orange in at least four ways.

```
[79]: df['Rank']['orange']
```

```
1
```

```
[80]: df['Rank'][2]
```

```
3
```

```
[81]: df.iloc[2,1]
```

```
3
```

```
[82]: df.loc['orange','Rank']
```

```
1
```

Q4-a: Obtain the set of unique continents in the DataFrame `data`. (Hint: use the function `unique` associated with the Series `data['continent']`.)

```
[83]: data['continent'].unique()
```

```
array(['Asia', 'Europe', 'Africa', 'Americas', 'Oceania'], dtype=object)
```

Q4-b: Filter for the rows of the DataFrame `data` for which the continent is "Americas", year is 2007, and GDP is at least 1000. (You can either use the `query` function associated with the DataFrame or boolean indexing.)

```
[84]: data.query('continent=="Americas" and year==2007 and gdp >=1000').head()
```

```
          country continent  lifeExp         pop  gdpPercap           gdp
year
2007       Brazil  Americas   72.390  190.010647   9.065801   1722.598680
2007       Canada  Americas   80.653   33.390141  36.319235   1212.704378
2007       Mexico  Americas   76.195  108.700891  11.977575   1301.973070
2007  United States  Americas   78.242  301.139947  42.951653  12934.458535
```

```
[85]: data[(data['continent']=='Americas') & (data.index==2007) & (data['gdp']>=1000)]
```

```
          country continent  lifeExp         pop  gdpPercap           gdp
year
2007       Brazil  Americas   72.390  190.010647   9.065801   1722.598680
2007       Canada  Americas   80.653   33.390141  36.319235   1212.704378
2007       Mexico  Americas   76.195  108.700891  11.977575   1301.973070
2007  United States  Americas   78.242  301.139947  42.951653  12934.458535
```

Q4-c: Compute the average `gdpPercap` of the countries in the Americas in 1952, and also in 2007. (No need to do population weighted average.)

```
[86]: data.query('continent=="Americas" and year==1952')['gdpPercap'].mean()
```

```
4.0790625522
```

```
[87]: data['gdpPercap'][(data['continent']=='Americas') & (data.index==1952)].mean()
```

```
4.0790625522
```

```
[88]: data.query('continent=="Americas" and year==2007')['gdpPercap'].mean()
```

```
11.00303162536
```

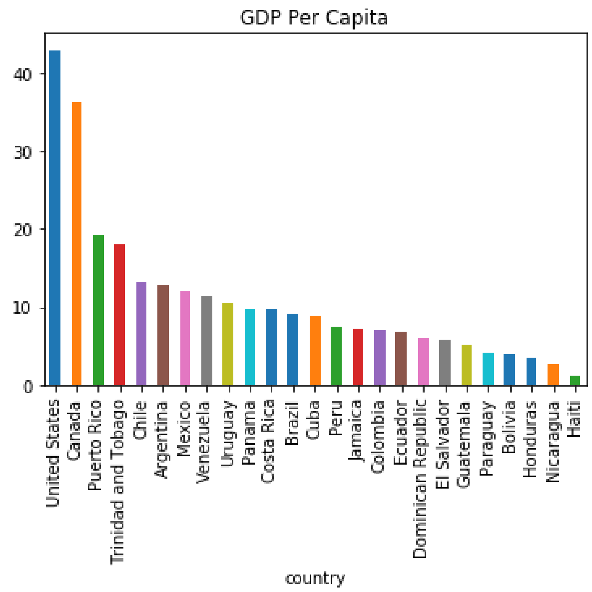
```
[89]: data['gdpPercap'][(data['continent']=='Americas') & (data.index==2007)].mean()
```

```
11.00303162536
```

Q4-d: Create a bar graphs of the `gdpPercap` of countries in the Americas for the year 2007. (Optional: sort the bars in descending order.)

```
[90]: data.query('continent=="Americas" and year==2007').\
          sort_values(by='gdpPercap',ascending=False).\
          plot(x='country',y='gdpPercap',kind='bar',legend=False,title='GDP Per Capita')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7f471e14f550>
```


GDP Per Capita
0
10
20
30
40
United States
Canada
Puerto Rico
Trinidad and Tobago
Chile
Argentina
Mexico
Venezuela
Uruguay
Panama
Costa Rica
Brazil
Cuba
Peru
Jamaica
Colombia
Ecuador
Dominican Republic
El Salvador
Guatemala
Paraguay
Bolivia
Honduras
Nicaragua
Haiti
country