Homework 04

NAME: Grant Pemberton

STUDENT ID: 3034347047

In [1]:
```
# Load required modules
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

Pandas Introduction

Reading File

1.1) Read the CSV file called 'data3.csv' into a dataframe called df.

Data description

- Data source: http://www.fao.org/nr/water/aquastat/data/query/index.html?* (http://www.fao.org/nr/water/aquastat/data/query/index.html?*) lang=en
- Data, units:
- GDP, current USD (CPI adjusted)
- NRI, mm/yr
- Population density, inhab/km^2
- Total area of the country, 1000 ha = 10km^2
- Total Population, unit 1000 inhabitants

In [2]:
```
# your code here

df = pd.read_csv('data3.csv')
#using pandas ".read_csv()" method
```

2.1) Display the first 10 rows of the dataframe

In [3]:
```
# your code here

df.head(10)
#row indicies 0-9
```

Out[3]:

	Area	Area Id	Variable Name	Variable Id	Year	Value	Symbol	Other
0	Argentina	9.0	Total area of the country	4100.0	1962.0	278040.0	E	NaN
1	Argentina	9.0	Total area of the country	4100.0	1967.0	278040.0	E	NaN
2	Argentina	9.0	Total area of the country	4100.0	1972.0	278040.0	E	NaN
3	Argentina	9.0	Total area of the country	4100.0	1977.0	278040.0	E	NaN
4	Argentina	9.0	Total area of the country	4100.0	1982.0	278040.0	E	NaN
5	Argentina	9.0	Total area of the country	4100.0	1987.0	278040.0	E	NaN
6	Argentina	9.0	Total area of the country	4100.0	1992.0	278040.0	E	NaN
7	Argentina	9.0	Total area of the country	4100.0	1997.0	278040.0	E	NaN
8	Argentina	9.0	Total area of the country	4100.0	2002.0	278040.0	E	NaN
9	Argentina	9.0	Total area of the country	4100.0	2007.0	278040.0	E	NaN

2.2) Display the column names.

In [4]:
```
# your code here


df.head(0)
#I think this looks better than the below, but the .columns member works
 too (and probably gives more info)


#also
#df.columns
```

Out[4]:

	Area	Area Id	Variable Name	Variable Id	Year	Value	Symbol	Other

2.3) Use iloc to display the first 3 rows and first 4 columns.

In [5]:
```
# your code here

df.iloc[0:3,0:4] # 0th to 3rd row, 0th to 4th column
```

Out[5]:

	Area	Area Id	Variable Name	Variable Id
0	Argentina	9.0	Total area of the country	4100.0
1	Argentina	9.0	Total area of the country	4100.0
2	Argentina	9.0	Total area of the country	4100.0

Data Preprocessing

3.1) Find all the rows that have 'NaN' in the 'Symbol' column. Display first 5 rows.

Hint : You might have to use a mask

In [6]:
```
# your code here


df[(df['Symbol']!= 'E')].head(5)
```

Out[6]:

	Area	Area Id	Variable Name	Variable Id	Year	Value	Symbol	Other
390	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
391	E - External data	NaN	NaN	NaN	NaN	NaN	NaN	NaN
392	I - AQUASTAT estimate	NaN	NaN	NaN	NaN	NaN	NaN	NaN
393	K - Aggregate data	NaN	NaN	NaN	NaN	NaN	NaN	NaN
394	L - Modelled data	NaN	NaN	NaN	NaN	NaN	NaN	NaN

3.2) Now, we will try to get rid of the NaN valued rows and columns. First, drop the column 'Other' which only has 'NaN' values. Then drop all other rows that have any column with a value 'NaN'. Then display the last 5 rows of the dataframe.

In [7]:
```
# your code here

df = pd.read_csv('data3.csv')
#reload the data in this function

df = df.drop('Other', axis=1)
#drop the column that only has NaN's in it

# ^ works

df = df.dropna(subset=['Symbol'])
#drop remaining rows that contain Nan's

df.tail(5)
```

Out[7]:

	Area	Area Id	Variable Name	Variable Id	Year	Value	Symbol
385	United States of America	231.0	National Rainfall Index (NRI)	4472.0	1981.0	949.2	E
386	United States of America	231.0	National Rainfall Index (NRI)	4472.0	1984.0	974.6	E
387	United States of America	231.0	National Rainfall Index (NRI)	4472.0	1992.0	1020.0	E
388	United States of America	231.0	National Rainfall Index (NRI)	4472.0	1996.0	1005.0	E
389	United States of America	231.0	National Rainfall Index (NRI)	4472.0	2002.0	938.7	E

4.1) For our analysis we do not want all the columns in our dataframe. Lets drop all the redundant columns/ features.

Drop columns: Area Id, Variable Id, Symbol. Save the new dataframe as df1. Display the first 5 rows of the new dataframe.

In [8]:

```
# your code here

df = df.drop('Area Id', axis=1)
#drop the 'Area Id' column

df = df.drop('Variable Id', axis=1)
#drop the 'Variable Id' column

df = df.drop('Symbol', axis=1)
#drop the 'Symbol' column




df1 = df
#create new dataframe

df1.tail(5)
#display the end of the new dataframe
```

Out[8]:

	Area	Variable Name	Year	Value
385	United States of America	National Rainfall Index (NRI)	1981.0	949.2
386	United States of America	National Rainfall Index (NRI)	1984.0	974.6
387	United States of America	National Rainfall Index (NRI)	1992.0	1020.0
388	United States of America	National Rainfall Index (NRI)	1996.0	1005.0
389	United States of America	National Rainfall Index (NRI)	2002.0	938.7

4.2) Display all the unique values in your new dataframe for columns: Area, Variable Name, Year.

In [9]:

```
# your code here

print (pd.unique(df1['Area']))

print (pd.unique(df1['Variable Name']))

print (pd.unique(df1['Year']))
```

```
['Argentina' 'Australia' 'Germany' 'Iceland' 'Ireland' 'Sweden'
 'United States of America']
['Total area of the country' 'Total population' 'Population density'
 'Gross Domestic Product (GDP)' 'National Rainfall Index (NRI)']
[1962. 1967. 1972. 1977. 1982. 1987. 1992. 1997. 2002. 2007. 2012. 201
4.
 2015. 1963. 1970. 1974. 1978. 1984. 1990. 1964. 1981. 1985. 1996. 200
1.
 1969. 1973. 1979. 1993. 1971. 1975. 1986. 1991. 1998. 2000. 1965. 198
3.
 1988. 1995.]
```

4.3) Convert the Year column to pandas datetime. Convert the 'Year' column float values to pandas datetime objects, where each year is represented as the first day of that year. Also display the first 5 values of column after conversion.

For eg: 1962.0 will be represented as 1962-01-01

In [10]:
```
# your code here


df1['Year'] = df1['Year'].astype(int)



df1['Year'] = pd.to_datetime(df1['Year'], format = '%Y')

df1.head(5)

#df_google['date'] = pd.to_datetime(df_google['date'],infer_datetime_for
mat=True) --> something like this...
```

Out[10]:

	Area	Variable Name	Year	Value
0	Argentina	Total area of the country	1962-01-01	278040.0
1	Argentina	Total area of the country	1967-01-01	278040.0
2	Argentina	Total area of the country	1972-01-01	278040.0
3	Argentina	Total area of the country	1977-01-01	278040.0
4	Argentina	Total area of the country	1982-01-01	278040.0

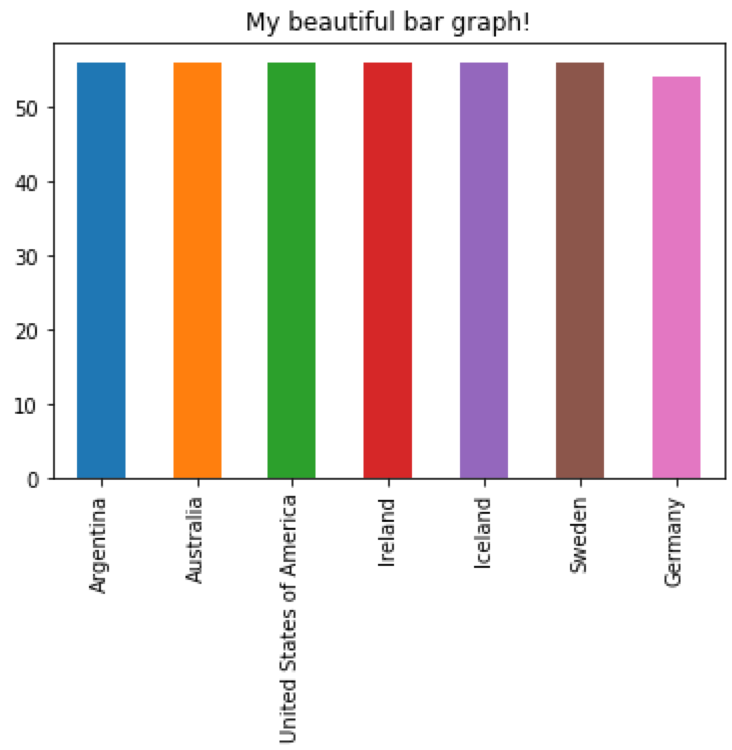
Plot

5.1) Use pandas to plot a bar graph showing the count for each unique value in the column 'Area'. Give it a title.

```
In [14]: # your code here

         pd.value_counts(df1['Area']).plot.bar(title = "My beautiful bar graph!")
         #value_counts works really well for this -- faster than hist()
```

```
Out[14]: <matplotlib.axes._subplots.AxesSubplot at 0x11f70ca20>
```



Extract specific statistics from the preprocessed data:

6.1) Create a dataframe 'dftemp' to store rows where Area is 'Iceland'. Display the dataframe.

In [18]:
```
# your code here


dftemp = df1[df1.Area == 'Iceland']
#this .Area member works well


dftemp

# ^^ it works!
```

Out[18]:

	Area	Variable Name	Year	Value
166	Iceland	Total area of the country	1962-01-01	1.030000e+04
167	Iceland	Total area of the country	1967-01-01	1.030000e+04
168	Iceland	Total area of the country	1972-01-01	1.030000e+04
169	Iceland	Total area of the country	1977-01-01	1.030000e+04
170	Iceland	Total area of the country	1982-01-01	1.030000e+04
171	Iceland	Total area of the country	1987-01-01	1.030000e+04
172	Iceland	Total area of the country	1992-01-01	1.030000e+04
173	Iceland	Total area of the country	1997-01-01	1.030000e+04
174	Iceland	Total area of the country	2002-01-01	1.030000e+04
175	Iceland	Total area of the country	2007-01-01	1.030000e+04
176	Iceland	Total area of the country	2012-01-01	1.030000e+04
177	Iceland	Total area of the country	2014-01-01	1.030000e+04
178	Iceland	Total population	1962-01-01	1.826000e+02
179	Iceland	Total population	1967-01-01	1.974000e+02
180	Iceland	Total population	1972-01-01	2.099000e+02
181	Iceland	Total population	1977-01-01	2.221000e+02
182	Iceland	Total population	1982-01-01	2.331000e+02
183	Iceland	Total population	1987-01-01	2.469000e+02
184	Iceland	Total population	1992-01-01	2.599000e+02
185	Iceland	Total population	1997-01-01	2.728000e+02
186	Iceland	Total population	2002-01-01	2.869000e+02
187	Iceland	Total population	2007-01-01	3.054000e+02
188	Iceland	Total population	2012-01-01	3.234000e+02
189	Iceland	Total population	2015-01-01	3.294000e+02
190	Iceland	Population density	1962-01-01	1.773000e+00
191	Iceland	Population density	1967-01-01	1.917000e+00
192	Iceland	Population density	1972-01-01	2.038000e+00
193	Iceland	Population density	1977-01-01	2.156000e+00
194	Iceland	Population density	1982-01-01	2.263000e+00
195	Iceland	Population density	1987-01-01	2.397000e+00
196	Iceland	Population density	1992-01-01	2.523000e+00
197	Iceland	Population density	1997-01-01	2.649000e+00

	Area	Variable Name	Year	Value
198	Iceland	Population density	2002-01-01	2.785000e+00
199	Iceland	Population density	2007-01-01	2.965000e+00
200	Iceland	Population density	2012-01-01	3.140000e+00
201	Iceland	Population density	2015-01-01	3.198000e+00
202	Iceland	Gross Domestic Product (GDP)	1962-01-01	2.849165e+08
203	Iceland	Gross Domestic Product (GDP)	1967-01-01	6.212260e+08
204	Iceland	Gross Domestic Product (GDP)	1972-01-01	8.465069e+08
205	Iceland	Gross Domestic Product (GDP)	1977-01-01	2.226539e+09
206	Iceland	Gross Domestic Product (GDP)	1982-01-01	3.232804e+09
207	Iceland	Gross Domestic Product (GDP)	1987-01-01	5.565384e+09
208	Iceland	Gross Domestic Product (GDP)	1992-01-01	7.138788e+09
209	Iceland	Gross Domestic Product (GDP)	1997-01-01	7.596126e+09
210	Iceland	Gross Domestic Product (GDP)	2002-01-01	9.161798e+09
211	Iceland	Gross Domestic Product (GDP)	2007-01-01	2.129384e+10
212	Iceland	Gross Domestic Product (GDP)	2012-01-01	1.419452e+10
213	Iceland	Gross Domestic Product (GDP)	2015-01-01	1.659849e+10
214	Iceland	National Rainfall Index (NRI)	1967-01-01	8.160000e+02
215	Iceland	National Rainfall Index (NRI)	1971-01-01	9.632000e+02
216	Iceland	National Rainfall Index (NRI)	1975-01-01	1.010000e+03
217	Iceland	National Rainfall Index (NRI)	1981-01-01	9.326000e+02
218	Iceland	National Rainfall Index (NRI)	1986-01-01	9.685000e+02
219	Iceland	National Rainfall Index (NRI)	1991-01-01	1.095000e+03
220	Iceland	National Rainfall Index (NRI)	1997-01-01	9.932000e+02
221	Iceland	National Rainfall Index (NRI)	1998-01-01	9.234000e+02

7.1) Print the years when the National Rainfall Index (NRI) was greater than 900 and less than 950 in Iceland. Use the dataframe you created in the previous question 'dftemp'.

```
In [ ]: # your code here
```

In [19]:
```
mask = (dftemp[dftemp["Variable Name"] == 'National Rainfall Index (NR
I)']['Value'] < 950) &\
(dftemp[dftemp["Variable Name"] == 'National Rainfall Index (NRI)']['Val
ue'] > 900)
#create mask

#mask
#^checks mask for debugging

dftemp[dftemp["Variable Name"] == 'National Rainfall Index (NRI)'].Year[
mask]
#get into the national rainfall data index, then display the year with
 '.Year' and apply the mask with '[mask]'
```

Out[19]:
```
217   1981-01-01
221   1998-01-01
Name: Year, dtype: datetime64[ns]
```

US statistics:

8.1) Create a new DataFrame called `df_usa` that only contains values where 'Area' is equal to 'United States of America'. Set the indices to be the 'Year' column (Use .set_index( )). Display the dataframe head.

In [20]:
```
# your code here


df_usa = df1[df1.Area == 'United States of America']
#create the df_usa dataFrame


df_usa = df_usa.set_index('Year')
#you need to assign the df_usa.set_index() to df_usa


df_usa.head()
#display the beginning
```

Out[20]:

	Area	Variable Name	Value
Year			
1962-01-01	United States of America	Total area of the country	962909.0
1967-01-01	United States of America	Total area of the country	962909.0
1972-01-01	United States of America	Total area of the country	962909.0
1977-01-01	United States of America	Total area of the country	962909.0
1982-01-01	United States of America	Total area of the country	962909.0

8.2) Pivot the DataFrame so that the unique values in the column 'Variable Name' becomes the columns. The DataFrame values should be the ones in the the 'Value' column. Save it in df_usa. Display the dataframe head.

In [21]:
```
# your code here


df_usa = df_usa.pivot(columns = "Variable Name", values = "Value" )

df_usa
```

```
Out[21]:
```

Variable Name	Gross Domestic Product (GDP)	National Rainfall Index (NRI)	Population density	Total area of the country	Total population
Year					
1962-01-01	6.050000e+11	NaN	19.93	962909.0	191861.0
1965-01-01	NaN	928.5	NaN	NaN	NaN
1967-01-01	8.620000e+11	NaN	21.16	962909.0	203713.0
1969-01-01	NaN	952.2	NaN	NaN	NaN
1972-01-01	1.280000e+12	NaN	22.14	962909.0	213220.0
1974-01-01	NaN	1008.0	NaN	NaN	NaN
1977-01-01	2.090000e+12	NaN	23.17	962909.0	223091.0
1981-01-01	NaN	949.2	NaN	NaN	NaN
1982-01-01	3.340000e+12	NaN	24.30	962909.0	233954.0
1984-01-01	NaN	974.6	NaN	NaN	NaN
1987-01-01	4.870000e+12	NaN	25.49	962909.0	245425.0
1992-01-01	6.540000e+12	1020.0	26.78	962909.0	257908.0
1996-01-01	NaN	1005.0	NaN	NaN	NaN
1997-01-01	8.610000e+12	NaN	28.34	962909.0	272883.0
2002-01-01	1.100000e+13	938.7	29.95	963203.0	288471.0
2007-01-01	1.450000e+13	NaN	31.32	963203.0	301656.0
2012-01-01	1.620000e+13	NaN	32.02	983151.0	314799.0
2014-01-01	NaN	NaN	NaN	983151.0	NaN

Variable Name	Gross Domestic Product (GDP)	National Rainfall Index (NRI)	Population density	Total area of the country	Total population
Year					
2015-01-01	1.790000e+13	NaN	32.73	NaN	321774.0

8.3) Rename new columns to ['GDP','NRI','PD','Area','Population'] and display the head.

In [22]:
```
# your code here
df_usa = df_usa.rename(columns = {'Gross Domestic Product (GDP)':'GDP'})
df_usa = df_usa.rename(columns = {'National Rainfall Index (NRI)': 'NRI'
})
df_usa = df_usa.rename(columns = {'Population density' : 'PD'})
df_usa = df_usa.rename(columns = {'Total area of the country' : 'Area'})
df_usa = df_usa.rename(columns = {'Total population':'Population'})

df_usa
```

Out[22]:

Variable Name	**GDP**	**NRI**	**PD**	**Area**	**Population**
Year					
1962-01-01	6.050000e+11	NaN	19.93	962909.0	191861.0
1965-01-01	NaN	928.5	NaN	NaN	NaN
1967-01-01	8.620000e+11	NaN	21.16	962909.0	203713.0
1969-01-01	NaN	952.2	NaN	NaN	NaN
1972-01-01	1.280000e+12	NaN	22.14	962909.0	213220.0
1974-01-01	NaN	1008.0	NaN	NaN	NaN
1977-01-01	2.090000e+12	NaN	23.17	962909.0	223091.0
1981-01-01	NaN	949.2	NaN	NaN	NaN
1982-01-01	3.340000e+12	NaN	24.30	962909.0	233954.0
1984-01-01	NaN	974.6	NaN	NaN	NaN
1987-01-01	4.870000e+12	NaN	25.49	962909.0	245425.0
1992-01-01	6.540000e+12	1020.0	26.78	962909.0	257908.0
1996-01-01	NaN	1005.0	NaN	NaN	NaN
1997-01-01	8.610000e+12	NaN	28.34	962909.0	272883.0
2002-01-01	1.100000e+13	938.7	29.95	963203.0	288471.0
2007-01-01	1.450000e+13	NaN	31.32	963203.0	301656.0
2012-01-01	1.620000e+13	NaN	32.02	983151.0	314799.0
2014-01-01	NaN	NaN	NaN	983151.0	NaN
2015-01-01	1.790000e+13	NaN	32.73	NaN	321774.0

8.4) Replace all 'Nan' values in df_usa with 0. Display the head of the dataframe.

```
In [23]: # your code here

         df_usa = df_usa.fillna(value = 0)
         #replaces NaNs with whatever the value is

         df_usa
```

Out[23]:

Variable Name	GDP	NRI	PD	Area	Population
Year					
1962-01-01	6.050000e+11	0.0	19.93	962909.0	191861.0
1965-01-01	0.000000e+00	928.5	0.00	0.0	0.0
1967-01-01	8.620000e+11	0.0	21.16	962909.0	203713.0
1969-01-01	0.000000e+00	952.2	0.00	0.0	0.0
1972-01-01	1.280000e+12	0.0	22.14	962909.0	213220.0
1974-01-01	0.000000e+00	1008.0	0.00	0.0	0.0
1977-01-01	2.090000e+12	0.0	23.17	962909.0	223091.0
1981-01-01	0.000000e+00	949.2	0.00	0.0	0.0
1982-01-01	3.340000e+12	0.0	24.30	962909.0	233954.0
1984-01-01	0.000000e+00	974.6	0.00	0.0	0.0
1987-01-01	4.870000e+12	0.0	25.49	962909.0	245425.0
1992-01-01	6.540000e+12	1020.0	26.78	962909.0	257908.0
1996-01-01	0.000000e+00	1005.0	0.00	0.0	0.0
1997-01-01	8.610000e+12	0.0	28.34	962909.0	272883.0
2002-01-01	1.100000e+13	938.7	29.95	963203.0	288471.0
2007-01-01	1.450000e+13	0.0	31.32	963203.0	301656.0
2012-01-01	1.620000e+13	0.0	32.02	983151.0	314799.0
2014-01-01	0.000000e+00	0.0	0.00	983151.0	0.0
2015-01-01	1.790000e+13	0.0	32.73	0.0	321774.0

Use df_usa:

9.1 Multiply the 'Area' column for all countries by 10 (so instead of 1000 ha, the unit becomes 100 ha = 1km^2). Display the dataframe head.

In [24]:
```
# your code here

df_usa.Area = df_usa.Area*10

df_usa.head()
```

Out[24]:

Variable Name	GDP	NRI	PD	Area	Population
Year					
1962-01-01	6.050000e+11	0.0	19.93	9629090.0	191861.0
1965-01-01	0.000000e+00	928.5	0.00	0.0	0.0
1967-01-01	8.620000e+11	0.0	21.16	9629090.0	203713.0
1969-01-01	0.000000e+00	952.2	0.00	0.0	0.0
1972-01-01	1.280000e+12	0.0	22.14	9629090.0	213220.0

9.2: Create a new column in df_usa called 'GDP/capita' and populate it with the calculated GDP per capita. Round the results to two decimal points. Display the dataframe head.

GDP per capita = (GDP / Population) * 1000

In [25]:
```
# your code here


df_usa['GDP/capita']= round((df_usa['GDP'])/(df_usa['Population'])*1000,
 2)
#using the above mentioned function


df_usa = df_usa.fillna(value = 0)
#resetting the Nans to the value = 0

df_usa.head()
```

Out[25]:

Variable Name	GDP	NRI	PD	Area	Population	GDP/capita
Year						
1962-01-01	6.050000e+11	0.0	19.93	9629090.0	191861.0	3.153325e+09
1965-01-01	0.000000e+00	928.5	0.00	0.0	0.0	0.000000e+00
1967-01-01	8.620000e+11	0.0	21.16	9629090.0	203713.0	4.231443e+09
1969-01-01	0.000000e+00	952.2	0.00	0.0	0.0	0.000000e+00
1972-01-01	1.280000e+12	0.0	22.14	9629090.0	213220.0	6.003189e+09

9.3: Find the maximum value of the 'NRI' column in the US (using pandas methods). What year does the max value occur? Display the values.

In [26]:
```
# your code here

print ("The max NRI is: ", df_usa.loc[df_usa['NRI'].idxmax()].NRI)
#note: this was very tricky to do

print ("From year: ", df_usa['NRI'].idxmax())
#use the indicies from before
```

```
The max NRI is:  1020.0
From year:  1992-01-01 00:00:00
```