1-4

November 1, 2021

Problem 1-4

[ ]:
```
# Install a pip package in the current Jupyter kernel
! pip install numpy pandas python-igraph matplotlib pycairo cairocffi
```

```
Requirement already satisfied: numpy in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (1.21.3)
Requirement already satisfied: pandas in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (1.3.4)
Requirement already satisfied: python-igraph in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (0.9.7)
Requirement already satisfied: matplotlib in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (3.4.3)
Requirement already satisfied: pycairo in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (1.20.1)
Requirement already satisfied: cairocffi in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (1.3.0)
Requirement already satisfied: python-dateutil>=2.7.3 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
pandas) (2.8.2)
Requirement already satisfied: pytz>=2017.3 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
pandas) (2021.3)
Requirement already satisfied: texttable>=1.6.2 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
python-igraph) (1.6.4)
Requirement already satisfied: pyparsing>=2.2.1 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
matplotlib) (3.0.3)
Requirement already satisfied: kiwisolver>=1.0.1 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
matplotlib) (1.3.2)
Requirement already satisfied: pillow>=6.2.0 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
matplotlib) (8.3.2)
Requirement already satisfied: cycler>=0.10 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
matplotlib) (0.10.0)
```

```
Requirement already satisfied: cffi>=1.1.0 in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
cairocffi) (1.14.6)
Requirement already satisfied: pycparser in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
cffi>=1.1.0->cairocffi) (2.20)
Requirement already satisfied: six in
/workplace/anaconda3/envs/complex_network/lib/python3.9/site-packages (from
cycler>=0.10->matplotlib) (1.16.0)
```

[ ]:
```python
import pandas as pd
import igraph as ig
from igraph import *
import numpy as np

path = '/workplace/CNA/Complex-Network-Analysis-Exercises/A1/
 ↪FAOSTAT_data_10-26-2021.csv'
data = pd.read_csv(path)
others_values=data[data['Partner Countries']== 'Others (adjustment)']
FAO_values = data[data['Partner Countries']== 'Total FAO']
Unspecified = data[data['Partner Countries']== 'Unspecified Area']
data = data.drop(others_values.index, axis=0)
data = data.drop(FAO_values.index, axis=0)
data = data.drop(Unspecified.index, axis=0)
df = data.fillna('NULL')
NULL_values = df[df['Flag']!= 'NULL']
df = df.drop(NULL_values.index, axis=0)
df=df.reset_index()

print(df.columns)
print(df.head())

#compare these features with the ones of the exersice session
print(df.shape)
print(df[df['Reporter Countries']=='United States of America'].Value.sum())
print(df[df['Partner Countries']=='United States of America'].Value.sum())
df_1 = df[['Reporter Countries', 'Partner Countries', 'Value']]
```

```
Index(['index', 'Domain Code', 'Domain', 'Reporter Country Code (FAO)',
       'Reporter Countries', 'Partner Country Code (FAO)', 'Partner Countries',
       'Element Code', 'Element', 'Item Code', 'Item', 'Year Code', 'Year',
       'Unit', 'Value', 'Flag', 'Flag Description'],
      dtype='object')
   index Domain Code               Domain  Reporter Country Code (FAO)  \
0      0          FT  Forestry Trade Flows                            2
1      3          FT  Forestry Trade Flows                            2
2      4          FT  Forestry Trade Flows                            3
3      5          FT  Forestry Trade Flows                            3
```

```
4      6          FT  Forestry Trade Flows                            3

  Reporter Countries  Partner Country Code (FAO) Partner Countries  \
0        Afghanistan                          68            France
1        Afghanistan                         165          Pakistan
2            Albania                          11           Austria
3            Albania                          33            Canada
4            Albania                          68            France

   Element Code       Element  Item Code                          Item  \
0          5922  Export Value       1633  Sawnwood, non-coniferous all
1          5922  Export Value       1671                    Newsprint
2          5922  Export Value       1633  Sawnwood, non-coniferous all
3          5922  Export Value       1619     Wood chips and particles
4          5922  Export Value       1632         Sawnwood, coniferous

   Year Code  Year      Unit  Value  Flag Flag Description
0       2017  2017  1000 US$     37  NULL    Official data
1       2017  2017  1000 US$      2  NULL    Official data
2       2017  2017  1000 US$     29  NULL    Official data
3       2017  2017  1000 US$      0  NULL    Official data
4       2017  2017  1000 US$     13  NULL    Official data
(15402, 17)
5047564
4949057
```

[ ]:
```python
def task1(df):
    g = ig.Graph.TupleList(df[["Reporter Countries", "Partner Countries"]].
↪itertuples(index=False), directed=True)
    g.es['weight'] = list(abs(df['Value']))
    print(g.summary())


    #test by comparing with pd dataframe
    for index in range(len(df)):
        v1, v2 = g.get_edgelist()[index]

        assert (g.vs['name'][v1]==df["Reporter Countries"][index]), "Oh no!␣
↪'Reporter failed!"
        assert (g.vs['name'][v2]==df["Partner Countries"][index]), "Oh no!␣
↪Partner failed!"
        assert (g.es['weight'][index]==df["Value"][index]), "Oh no! Value␣
↪failed!"
    return g

def plot_task(g, save_name, margin):
    visual_style = {"vertex_size":15,
```

```
                "vertex_label":g.vs()["name"],
                "edge_width": [(np.log(value+1)+1) for value in g.
↪es()['weight']],
                "edge_label":g.es()['weight'],
                "margin": margin}
    g.simplify(multiple=True, loops=True, combine_edges=dict(weight="sum"))

    layout = g.layout("kk")
    plot(g, save_name, **visual_style, layout=layout)


g = task1(df_1.iloc[:100,:])
plot_task(g, 'task1_first100.pdf', 20)
```

```
IGRAPH DNW- 46 100 --
+ attr: name (v), weight (e)
```

[ ]:
```
def task2(g, search_name, df):
    vertex = g.vs.find(name=search_name)
    print("Vertex index: ", vertex.index)

    #print(g.es.select(_source=vertex.index)['weight'])
    weights = g.es.select()()['weight']

    dtype = [('partner', float), ('weight', float)]
    v2_array=np.zeros((1, len(g.es.select()['weight'])), dtype=dtype)

    #find the partners according to the vertex.index
    i=0
    for (v1,v2), weight in zip(g.get_edgelist(), np.asarray(weights)):
        if v1==vertex.index:
            v2_array[0,i]=(v2, weight)
            i+=1

    #order the partners according to the weights and choose the 3 best ones
    ordered_v2=np.sort(v2_array, axis=1, order='weight')
    #print(ordered_v2)
    #print(ordered_v2[0,-3:]['weight'])

    #find the corresponding partner names
    seq = g.vs.select(ordered_v2[0,-3:]['partner'])
    partners=[v['name'] for v in seq]

    print(partners)
    g_new = Graph()
    g_new.add_vertices(4)
    g_new.add_edges([(0,1), (0,2), (0,3)])
```

```
    g_new.es['weight'] = list(ordered_v2[0,-3:]['weight'])
    g_new.vs['name'] = [search_name, *partners]


    #control
    sorted_df = df[df["Reporter Countries"] == search_name]
    sorted_df=sorted_df.sort_values(by=['Value'])
    values=list(sorted_df[-3:]["Value"])
    values=[float(i) for i in values]

    #control
    if (g_new.vs['name'][1:]==list(sorted_df[-3:]["Partner Countries"])):
        print('Partners are right')
    if (g_new.es['weight']==values):
        print('Values are right')
    return g_new
```

[ ]:
```
g = task1(df_1.iloc[:,:])
g_new=task2(g, 'Uruguay', df_1)
plot_task(g_new, 'task2.pdf', 100)
```

```
IGRAPH DNW- 168 15402 --
+ attr: name (v), weight (e)
Vertex index:  36
['United States of America', 'Mexico', 'China']
Partners are right
Values are right
```

[ ]:
```
def task3(g, search_name, df):
    vertex = g.vs.find(name=search_name)
    print("Vertex index: ", vertex.index)

    export_value=np.sum(g.es.select(_source=vertex.index)['weight'])
    import_value=np.sum(g.es.select(_target=vertex.index)['weight'])
    print('Yearly net export' , export_value)
    print('Yearly net import', import_value)

    if export_value <= import_value:
        print('This country is an net importer.')
    else:
        print('This country is an net exporter.')


    #control
    df_exporter = df[df["Reporter Countries"] == search_name]
    df_importer = df[df["Partner Countries"] == search_name]
```

```
    export_value_control=np.sum(df_exporter["Value"])
    import_value_control=np.sum(df_importer["Value"])
    #print(import_value_control)
    #print(export_value_control)


    #control
    if (import_value_control==import_value):
        print('Import value is right')
    if (export_value_control==export_value):
        print('Export value is right')
    return g_new
```

[ ]:
```
g = task1(df_1.iloc[:,:])
g_new=task3(g, 'Germany', df_1)
```

```
IGRAPH DNW- 168 15402 --
+ attr: name (v), weight (e)
Vertex index:  39
Yearly net export 3593196
Yearly net import 3785835
This country is an net importer.
Import value is right
Export value is right
```