Chapter II - International Trade Networks and World Trade Web

Downloaded the datasets from Comtrade

Starting from the Comtrade web site it is possible to download the datasets related to the International Trade.

Starting from the Express Selection (instructions)

Interface that you can reach through the path:

1) comtrade.un.org/Legacy Annual

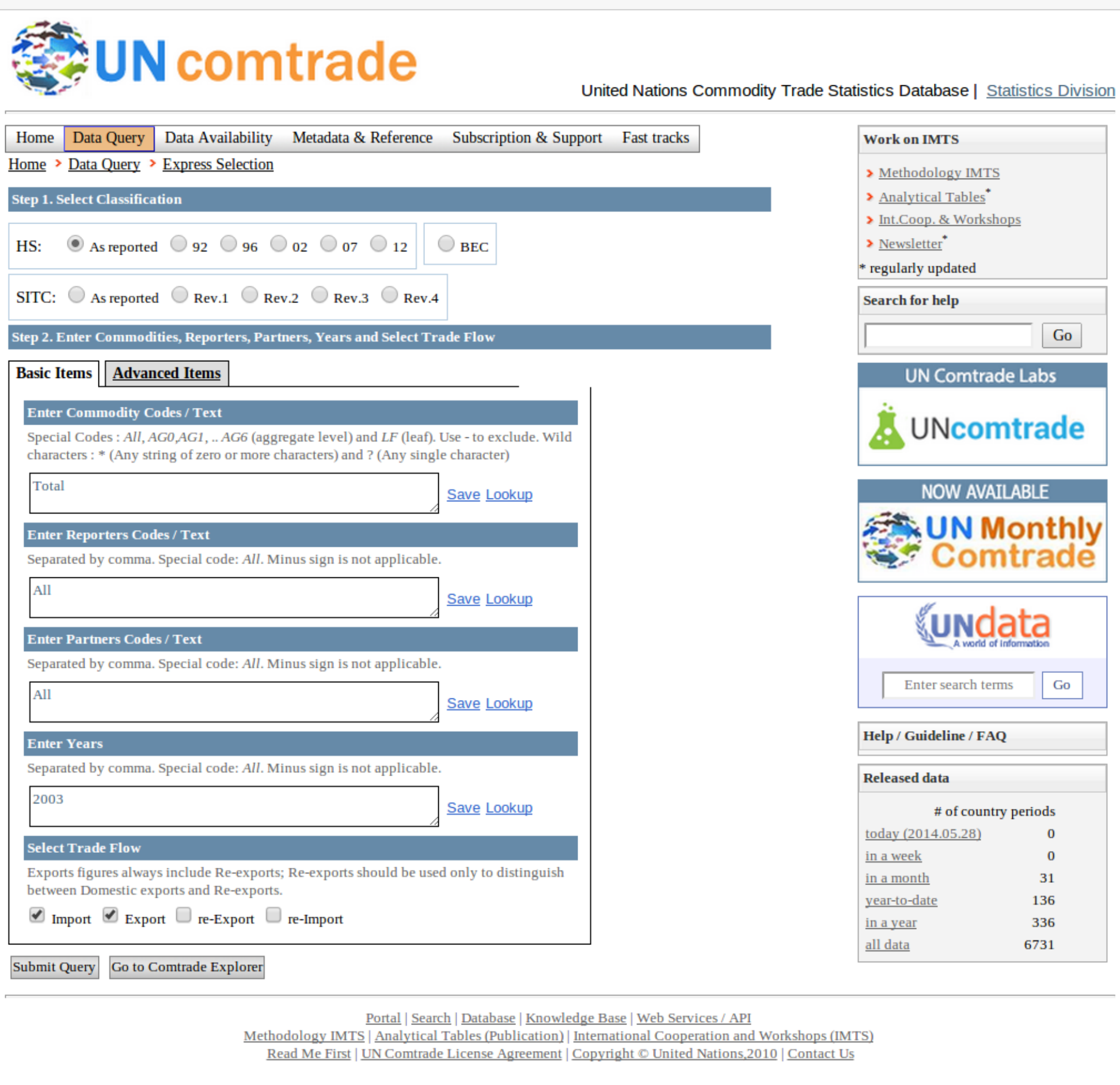
2) Data/Data Query/Express Selection

Table of Content:

In [2]:

```
from IPython.display import Image
Image(filename='C:/Users/shrey/OneDrive/Desktop/Data Engineering/Assignment 2 Data/figs/comtrade_query_interface.pn
g')
```

Out[2]:



UN comtrade

United Nations Commodity Trade Statistics Database | Statistics Division

Home | Data Query | Data Availability | Metadata & Reference | Subscription & Support | Fast tracks

Home > Data Query > Express Selection

Step 1. Select Classification

HS: ● As reported ○ 92 ○ 96 ○ 02 ○ 07 ○ 12 ○ BEC

SITC: ○ As reported ○ Rev.1 ○ Rev.2 ○ Rev.3 ○ Rev.4

Step 2. Enter Commodities, Reporters, Partners, Years and Select Trade Flow

Basic Items | Advanced Items

Enter Commodity Codes / Text

Special Codes : *All*, *AG0*,*AG1*, .. *AG6* (aggregate level) and *LF* (leaf). Use - to exclude. Wild characters : * (Any string of zero or more characters) and ? (Any single character)

Total

Save Lookup

Enter Reporters Codes / Text

Separated by comma. Special code: *All*. Minus sign is not applicable.

All

Save Lookup

Enter Partners Codes / Text

Separated by comma. Special code: *All*. Minus sign is not applicable.

All

Save Lookup

Enter Years

Separated by comma. Special code: *All*. Minus sign is not applicable.

2003

Save Lookup

Select Trade Flow

Exports figures always include Re-exports; Re-exports should be used only to distinguish between Domestic exports and Re-exports.

☑ Import ☑ Export ☐ re-Export ☐ re-Import

Submit Query | Go to Comtrade Explorer

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Released data

	# of country periods
today (2014.05.28)	0
in a week	0
in a month	31
year-to-date	136
in a year	336
all data	6731

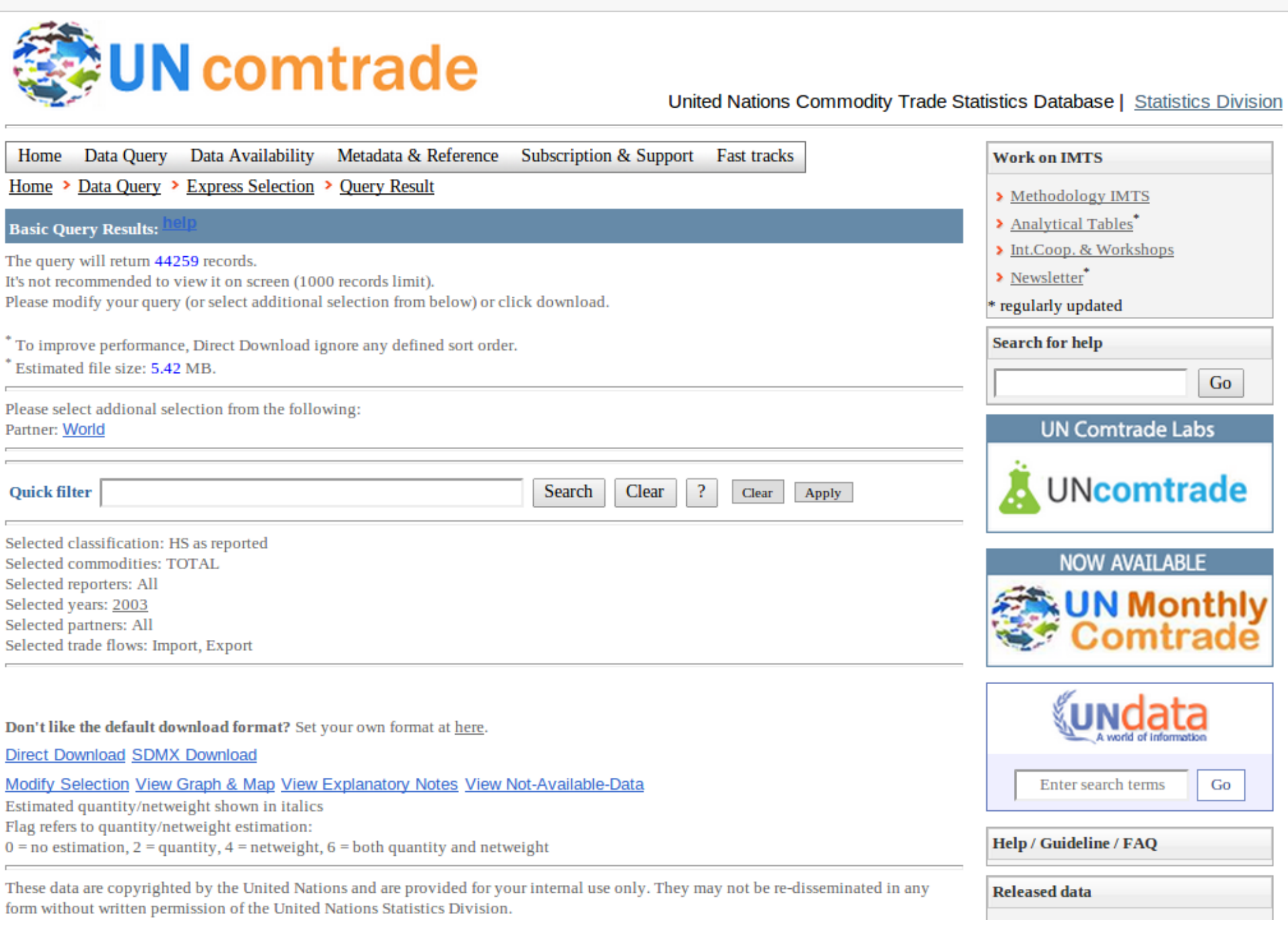
Portal | Search | Database | Knowledge Base | Web Services / API
Methodology IMTS | Analytical Tables (Publication) | International Cooperation and Workshops (IMTS)
Read Me First | UN Comtrade License Agreement | Copyright © United Nations,2010 | Contact Us

From the download page you can get the CSV file with all the data through the link 'Direct Download'

In [3]:

```
Image(filename='C:/Users/shrey/OneDrive/Desktop/Data Engineering/Assignment 2 Data/figs/comtrade_download_page.png')
```

Out[3]:



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Home > Data Query > Express Selection > Query Result

Basic Query Results: help

The query will return 44259 records.
It's not recommended to view it on screen (1000 records limit).
Please modify your query (or select additional selection from below) or click download.

* To improve performance, Direct Download ignore any defined sort order.
* Estimated file size: 5.42 MB.

Please select addional selection from the following:
Partner: World

Quick filter | Search | Clear | ? | Clear | Apply

Selected classification: HS as reported
Selected commodities: TOTAL
Selected reporters: All
Selected years: 2003
Selected partners: All
Selected trade flows: Import, Export

Don't like the default download format? Set your own format at here.

Direct Download SDMX Download

Modify Selection View Graph & Map View Explanatory Notes View Not-Available-Data

Estimated quantity/netweight shown in italics
Flag refers to quantity/netweight estimation:
0 = no estimation, 2 = quantity, 4 = netweight, 6 = both quantity and netweight

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Released data

Special 'Countiries' to be exluded when loading data:

- 472 Africa CAMEU region, nes
- 899 Areas, nes
- 471 CACM, nes
- 129 Caribbean, nes
- 221 Eastern Europe, nes
- 97 EU-27
- 697 Europe EFTA, nes
- 492 Europe EU, nes
- 838 Free Zones
- 473 LAIA, nes
- 536 Neutral Zone
- 637 North America and Central America, nes
- 290 Northern Africa, nes
- 527 Oceania, nes
- 577 Other Africa, nes
- 490 Other Asia, nes
- 568 Other Europe, nes
- 636 Rest of America, nes
- 839 Special Categories
- 879 Western Asia, nes
- 0 World

Network Symmetrisation:

In [2]:

```
# Function to return net symmetry for the dataset
def net_symmetrisation(wtn_file, exclude_countries):
    DG=nx.DiGraph()

    Reporter_pos=1
    Partner_pos=3
    Flow_code_pos=2
    Value_pos=9

    dic_trade_flows={}
    hfile=open(wtn_file,'r')

    header=hfile.readline()
    lines=hfile.readlines()
    for l in lines:
        l_split=l.split(',')
        #the following is to prevent parsing lines without data
        if len(l_split)<2: continue
        reporter=int(l_split[Reporter_pos])
        partner=int(l_split[Partner_pos])
        flow_code=int(l_split[Flow_code_pos])
        value=float(l_split[Value_pos])

        if ( (reporter in exclude_countries) or \
            (partner in exclude_countries) or (reporter==partner) ):
            continue

        if flow_code==1 and value>0.0:
            #1=Import, 2=Export
            if (partner,reporter,2) in dic_trade_flows:
                DG[partner][reporter]['weight']= \
                (DG[partner][reporter]['weight']+value)/2.0
            else:
                DG.add_edge(partner, reporter, weight=value)
                dic_trade_flows[(partner,reporter,1)]= \
                value #this is to mark the exixtence of the link

        elif flow_code==2 and value>0.0:
            #1=Import, 2=Export
            if (reporter,partner,1) in dic_trade_flows:
                DG[reporter][partner]['weight']= \
                (DG[reporter][partner]['weight']+value)/2.0
            else:
                DG.add_edge(reporter, partner, weight=value)
                #this is to mark the exixtence of the link
                dic_trade_flows[(reporter,partner,2)]=value
        else:
            print ("trade flow not present\n")

    hfile.close()

    return DG
```

Generate the aggregate network:

In [4]:

```
#importing the main modules

import networkx as nx

#countries to be excluded
exclude_countries=[472,899,471,129,221,97,697,492,838,473,536,\
637,290,527,577,490,568,636,839,879,0]

#this is the magic command to have the graphic embedded
#in the notebook
%pylab inline

DG=net_symmetrisation("C:/Users/shrey/data/comtrade_trade_data_total_2003.csv",exclude_countries)
print ("number of nodes :", DG.number_of_nodes())
print ("number of edges :", DG.number_of_edges())
```

```
Populating the interactive namespace from numpy and matplotlib
number of nodes : 232
number of edges : 27901
```

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Reciprocity :

We can define both the reciprocity in the unweighted case as:

$$r = \frac{L^{\leftrightarrow}}{L}$$

where

$$L^{\leftrightarrow}$$

is the number of reciprocated links that for a connected network ammounts to

$$2L - N(N-1)$$

In [5]:

```
#unweighted case
N=DG.number_of_nodes()
L=DG.number_of_edges()

r=float((2*L-N*(N-1)))/L

print (r)
```

```
0.07920863051503531
```

In the weighted case the formula changes in:

$$r = \frac{W^{\leftrightarrow}}{W}$$

where

$$W^{\leftrightarrow} = \sum_i \sum_{j \neq i} w_{ij}^{\leftrightarrow}$$

is the sum of the reciprocated weights with

$$w_{ij}^{\leftrightarrow} = min[w_{ij}, w_{ji}] = w_{ji}^{\leftrightarrow}$$

and

$$W = \sum_i \sum_{j \neq i} w_{ij}$$

In [ ]:

```
#weighted case
W=0
W_rep=0
for n in DG.nodes():
    for e in DG.out_edges(n,data=True):
        W+=e[2]['weight']
        if DG.has_edge(e[1],e[0]):
            W_rep+=min(DG[e[0]][e[1]]['weight'],DG[e[1]][e[0]] \
                       ['weight'])

print (W,W_rep,W_rep/W)
```

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Assortativity:

In [10]:

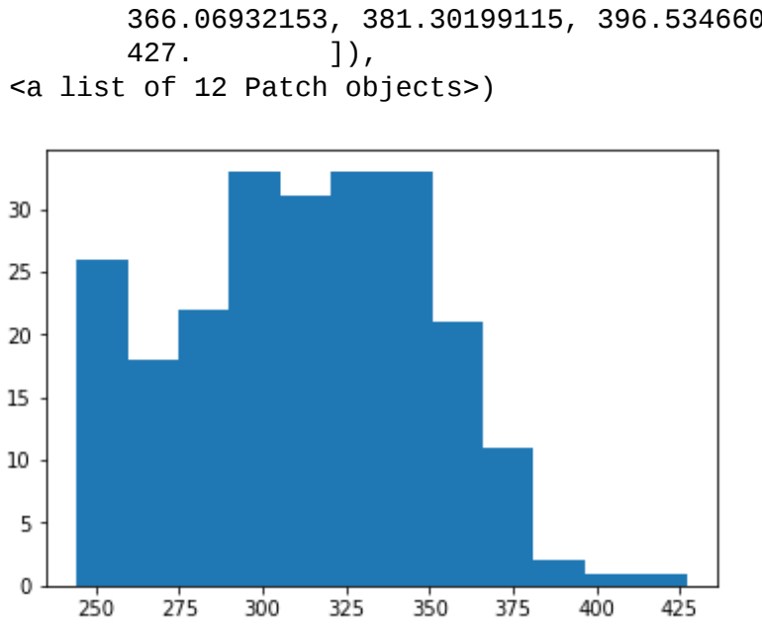
```
#K_nn distribution
list_Knn=[]

for n in DG.nodes():
    degree=0.0
    count = 0
    #print("n here ",n)
    for nn in DG.neighbors(n):
        #print("neigh",nn)
        degree += DG.degree(nn)
        count += 1
        #print("degree",degree,count)
    list_Knn.append(degree/count)

#plot the histogram
hist(list_Knn,bins=12)
```

Out[10]:

```
(array([26., 18., 22., 33., 31., 33., 33., 21., 11.,  2.,  1.,  1.]),
 array([244.2079646 , 259.44063422, 274.67330383, 289.90597345,
        305.13864307, 320.37131268, 335.6039823 , 350.83665192,
        366.06932153, 381.30199115, 396.53466077, 411.76733038,
        427.        ]),
 <a list of 12 Patch objects>)
```



In [11]:

```
#basic Pearson correlation coefficient for the
r=nx.degree_assortativity_coefficient(DG)
print (r)
```

```
-0.33500264363818966
```

to compute the weighted version of the assortativity Networkx has extra parameters and also the possibility to decide for 'out' or 'in' degree correlations both for the source and target nodes (the default is x='out',y='in')

In [12]:

```
#weighted version
r=nx.degree_pearson_correlation_coefficient(DG,weight='weight', \
                                            x='out',y='out')
print (r)
```

```
-0.06967819605206091
```

Density and Strength (in and out):

Loadging product Networks:

In [13]:

```
dic_product_netowrks={}
commodity_codes=['09','10','27','29','30','39','52','71','72','84', \
'85','87','90','93']
for c in commodity_codes:
    dic_product_netowrks[c]=net_symmetrisation("C:/Users/shrey/data/comtrade_trade_data_2003_product_"+c+".csv",excl
ude_countries)

DG_aggregate=net_symmetrisation("C:/Users/shrey/data/comtrade_trade_data_total_2003.csv",exclude_countries)
```

Rescale the weighted ajacency aggregate matrix

$$w_{ij}^{tot} = \frac{w_{ij}^{tot}}{\sum_{hk} w_{hk}^{tot}}$$

In [14]:

```
w_tot=0.0
for u,v,d  in DG_aggregate.edges(data=True):
    w_tot+=d['weight']
for u,v,d  in DG_aggregate.edges(data=True):
    d['weight']=d['weight']/w_tot
```

Rescale the weighted ajacency product matrices

$$w_{ij}^{c} = \frac{w_{ij}^{c}}{\sum_{hk} w_{hk}^{c}}$$

In [15]:

```
for c in commodity_codes:
    l_p=[]
    w_tot=0.0
    for u,v,d  in dic_product_netowrks[c].edges(data=True):
        w_tot+=d['weight']
    for u,v,d  in dic_product_netowrks[c].edges(data=True):
        d['weight']=d['weight']/w_tot
```

Generate the table with the quantities

$$Density\ w_{ij}\ NS_{in}/ND_{in}\ NS_{out}/ND_{out}$$

In [21]:

```
density_aggregate=DG_aggregate.number_of_edges() / \
(DG_aggregate.number_of_nodes()*(DG_aggregate.number_of_nodes()-1.0))

w_agg=[]
NS_in=[]
NS_out=[]
for u,v,d in DG_aggregate.edges(data=True):
    w_agg.append(d['weight'])
for n in DG_aggregate.nodes():
    if DG_aggregate.in_degree(n)>0:
        NS_in.append(DG_aggregate.in_degree(n,weight='weight')/ \
                     DG_aggregate.in_degree(n))
    if DG_aggregate.out_degree(n)>0:
        NS_out.append(DG_aggregate.out_degree(n,weight='weight')/ \
                    DG_aggregate.out_degree(n))

for c in commodity_codes:
    density_commodity=dic_product_netowrks[c].number_of_edges() / \
    (dic_product_netowrks[c].number_of_nodes()*(dic_product_netowrks[c].number_of_nodes()-1.0))
    w_c=[]
    NS_c_in=[]
    NS_c_out=[]
    for u,v,d  in dic_product_netowrks[c].edges(data=True):
        w_c.append(d['weight'])
    for n in dic_product_netowrks[c].nodes():
        if dic_product_netowrks[c].in_degree(n)>0:
            NS_c_in.append(dic_product_netowrks[c].in_degree (n, \
            weight='weight')/dic_product_netowrks[c].in_degree(n))
        if dic_product_netowrks[c].out_degree(n)>0:
            NS_c_out.append(dic_product_netowrks[c].out_degree(n, \
            weight='weight')/dic_product_netowrks[c].out_degree(n))

    print (c,str(round(density_commodity/density_aggregate,4))+ \
    " & "+str(round(mean(w_c)/mean(w_agg),4))+" & "+ \
    str(round(mean(NS_c_in)/mean(NS_in),4))+" & "+ \
    str(round(mean(NS_c_out)/mean(NS_out),4)))
```

```
09 0.309 & 3.3811 & 2.553 & 2.3906
10 0.1961 & 5.5195 & 5.9919 & 2.5718
27 0.3057 & 3.3575 & 2.6786 & 3.2979
29 0.3103 & 3.3664 & 2.3579 & 1.6286
30 0.3662 & 2.803 & 2.3308 & 1.267
39 0.4926 & 2.0478 & 1.753 & 1.1385
52 0.2864 & 3.5839 & 2.7572 & 2.1254
71 0.2843 & 3.6746 & 1.9479 & 2.6704
72 0.3081 & 3.3315 & 2.5847 & 1.8484
84 0.6195 & 1.6281 & 1.3359 & 1.0259
85 0.5963 & 1.6917 & 1.3518 & 1.0692
87 0.4465 & 2.259 & 1.7488 & 1.1105
90 0.4734 & 2.1492 & 1.5879 & 1.0993
93 0.1415 & 8.4677 & 6.0618 & 4.0279
```

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Revealed Comparative Advantage:

In [19]:

```
def RCA(c,p):
    X_cp=dic_product_netowrks[p].out_degree(c,weight='weight')
    X_c=DG_aggregate.out_degree(c,weight='weight')

    X_p=0.0
    for n in dic_product_netowrks[p].nodes():
        X_p+=dic_product_netowrks[p].out_degree(n,weight='weight')

    X_tot=0.0
    for n in DG_aggregate.nodes():
        X_tot+=DG_aggregate.out_degree(n,weight='weight')

    RCA_cp=(X_cp/X_c)/(X_p/X_tot)

    return RCA_cp

p='93'
c=381
print (RCA(c,p))
```

```
2.104705551640614
```

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Bipartite Network:

Defining the country-product matrix:

In [20]:

```
# Import libraries
import numpy as np

num_countries=DG_aggregate.number_of_nodes()
num_products=len(commodity_codes)

#generate array indices
country_index={}
i=0
for c in DG_aggregate.nodes():
    country_index[c]=i
    i+=1

M=np.zeros((num_countries,num_products))

for pos_p,p in enumerate(commodity_codes):
    for c in dic_product_netowrks[p].nodes():
        if RCA(c,p)>1.0:
            M[country_index[c]][pos_p]=1.0
    print ("\r")

C=np.dot(M,M.transpose())
P=np.dot(M.transpose(),M)

print (C)
print (P)
```

```
[[1. 0. 0. ... 1. 0. 0.]
 [0. 3. 1. ... 0. 0. 0.]
 [0. 1. 3. ... 0. 1. 0.]
 ...
 [1. 0. 0. ... 1. 0. 0.]
 [0. 0. 1. ... 0. 2. 0.]
 [0. 0. 0. ... 0. 0. 0.]]
[[83. 27. 28.  4.  6.  6. 29. 31. 20.  1.  3.  3.  5. 12.]
 [27. 59. 19.  4.  4.  8. 27. 18. 19.  5.  3.  7.  3. 12.]
 [28. 19. 71.  4.  2.  7. 20. 16. 14.  3.  4.  4.  1.  9.]
 [ 4.  4.  4. 20.  9.  9.  2.  6.  5.  5.  4.  3.  7.  7.]
 [ 6.  4.  2.  9. 27. 15.  7.  6. 10.  9.  3.  8.  9. 10.]
 [ 6.  8.  7.  9. 15. 37. 10.  7. 15. 10. 10.  8.  9. 11.]
 [29. 27. 20.  2.  7. 10. 69. 19. 18.  4.  5.  7.  5. 14.]
 [31. 18. 16.  6.  6.  7. 19. 57. 10.  4.  3.  4.  6.  9.]
 [20. 19. 14.  5. 10. 15. 18. 10. 56.  7.  7. 12.  2. 15.]
 [ 1.  5.  3.  5.  9. 10.  4.  4.  7. 26. 12.  9.  7.  6.]
 [ 3.  3.  4.  4.  3. 10.  5.  3.  7. 12. 26.  5.  8.  6.]
 [ 3.  7.  4.  3.  8.  8.  7.  4. 12.  9.  5. 27.  5. 11.]
 [ 5.  3.  1.  7.  9.  9.  5.  6.  2.  7.  8.  5. 20.  5.]
 [12. 12.  9.  7. 10. 11. 14.  9. 15.  6.  6. 11.  5. 38.]]
```

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In [ ]: