IMD0105 - Special Issues in Information Technology VI

Network Analysis

Natal-RN
May 2017

Agenda

- Introduction about network analysis
- What is a network
- API
- Creating a network
- Adding nodes and edges
- Visualizing network

Previously on last class (...)

What is a network?

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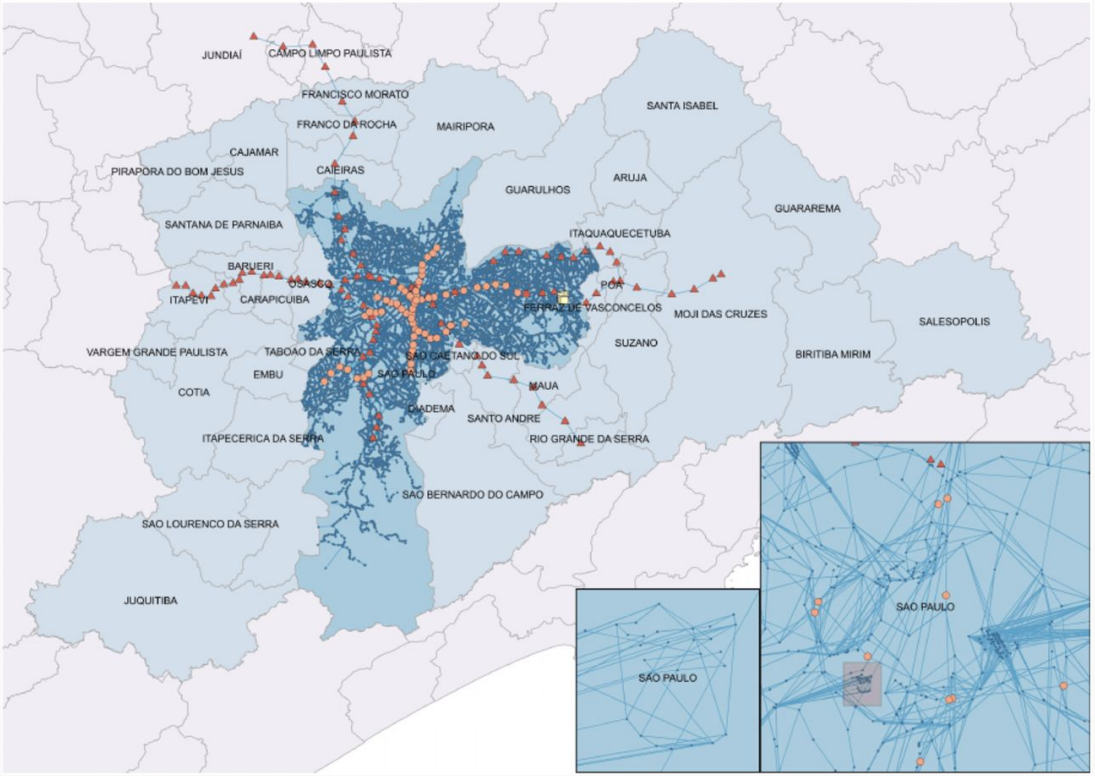
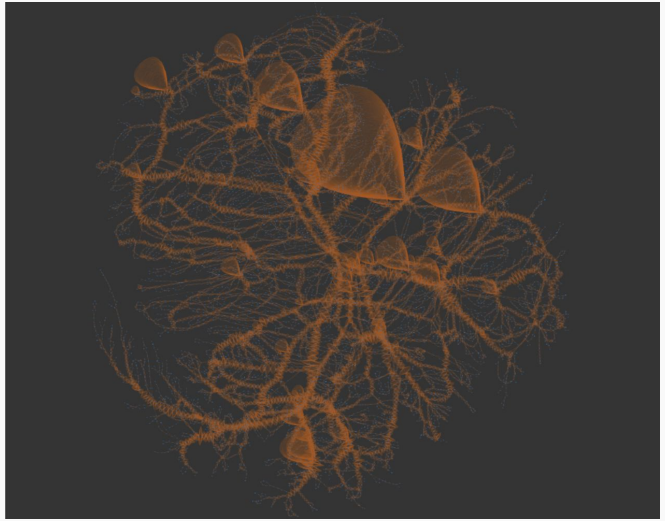
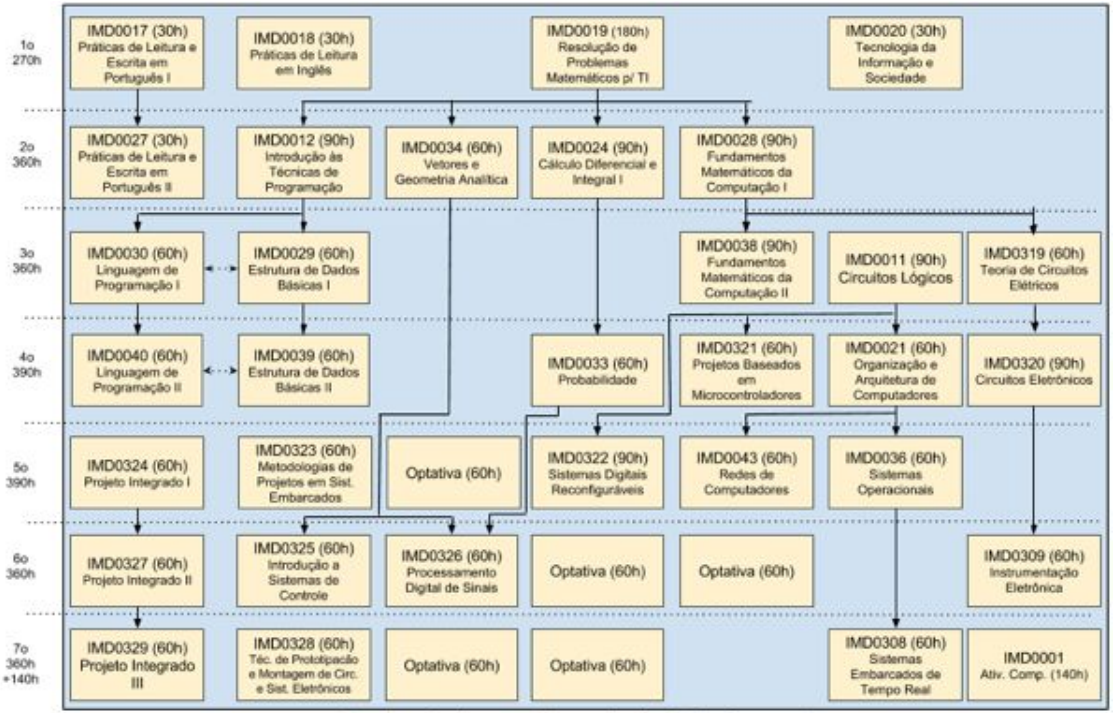


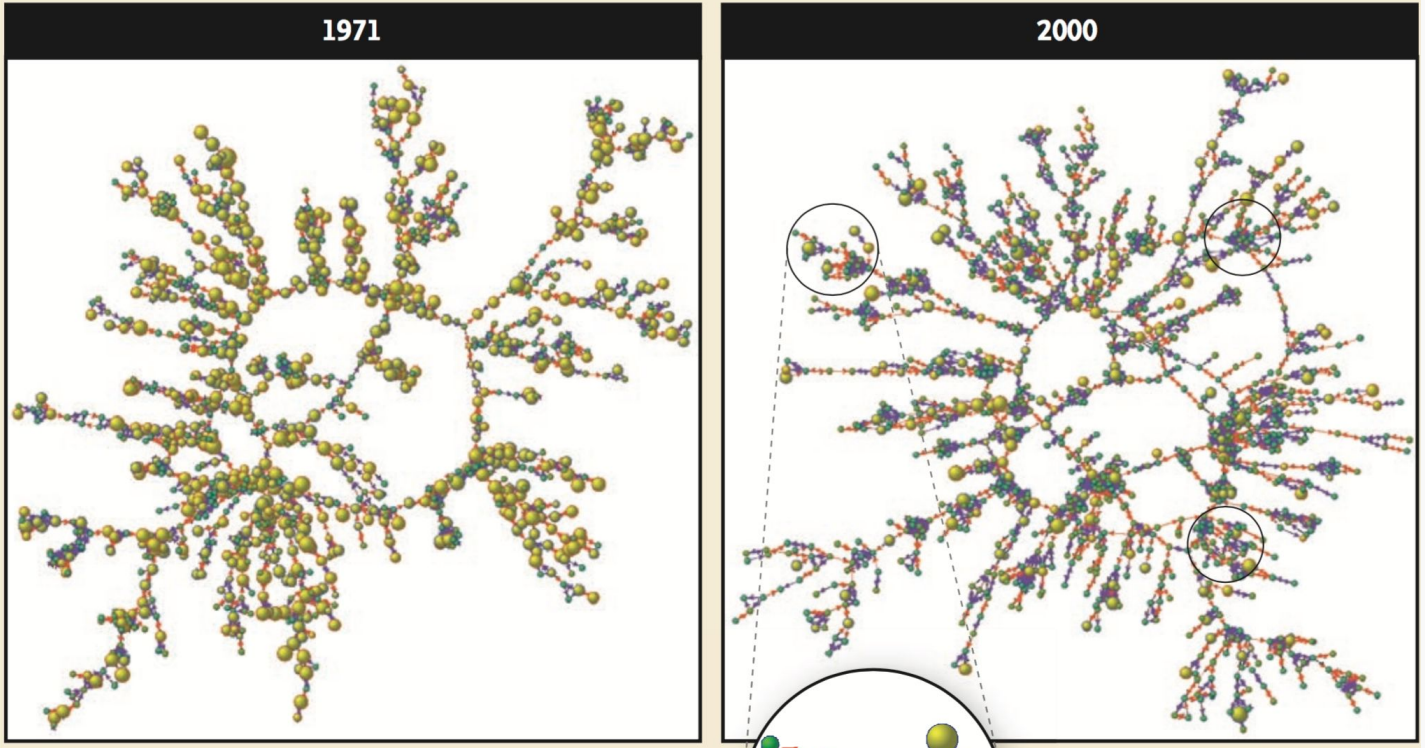


https://goo.gl/l8SS2X

What is a network?

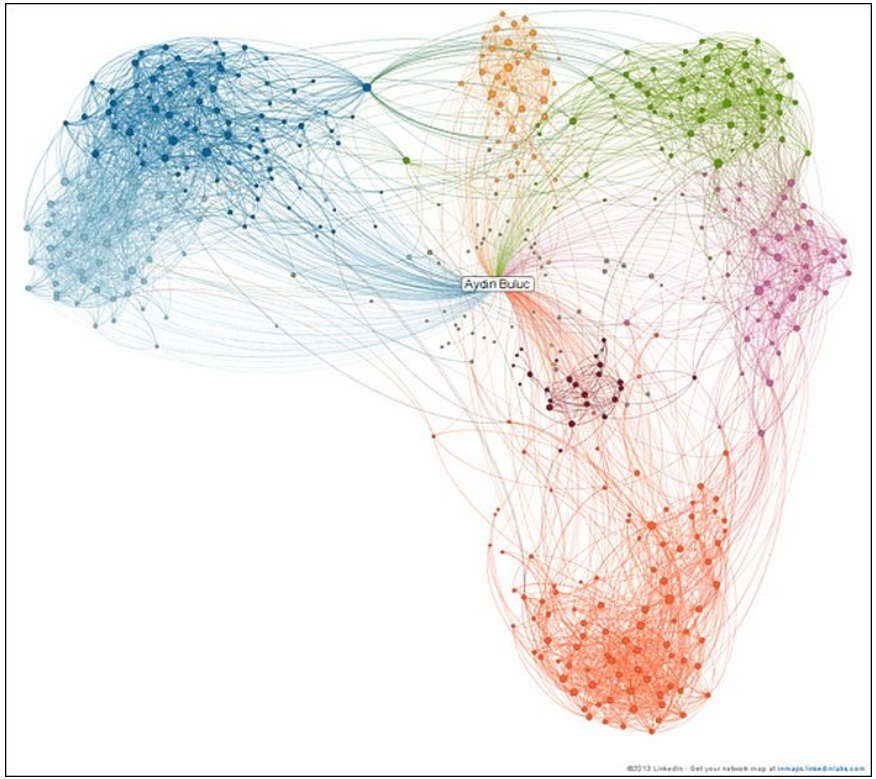


Bacharelado em Tecnologia da Informação
Ênfase em Sistemas Embarcados (MT)



The Collective Dynamics of Smoking in a Large Social Network.
Nicholas A. Christakis, M.D., Ph.D., M.P.H., and James H. Fowler, Ph.D.
N Engl J Med 2008; 358:2249-2258May 22, 2008

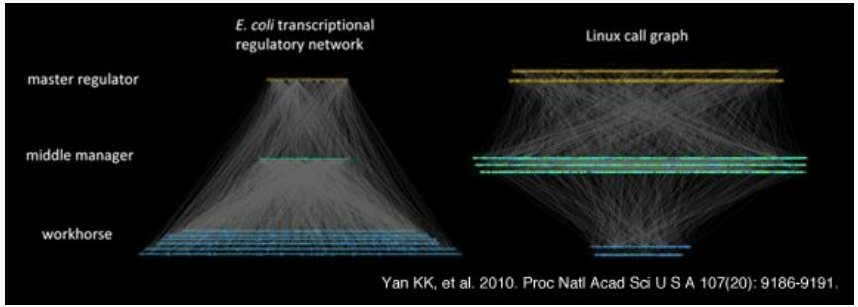
What is a network?



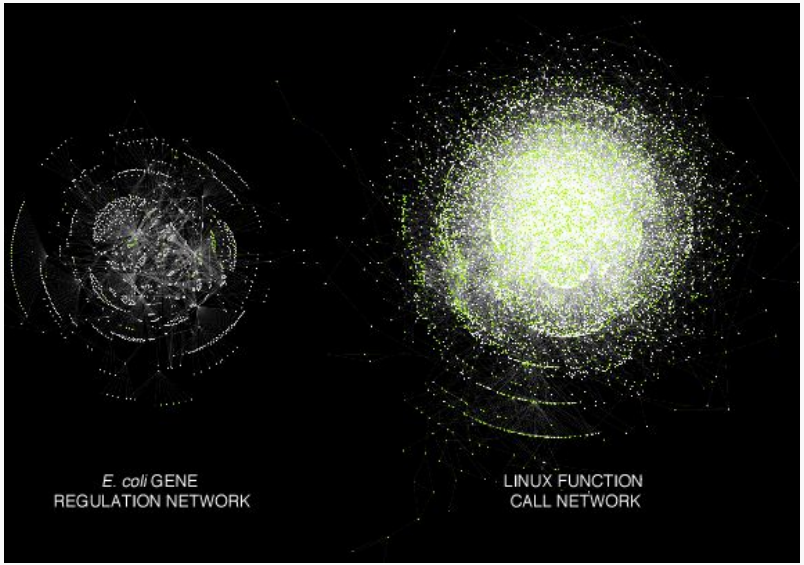
A Berkeley Lab researcher applies graph theory to find genes useful for biofuels.

http://ascr-discovery.science.doe.gov/2013/09/sifting-genomes/

What is a network?

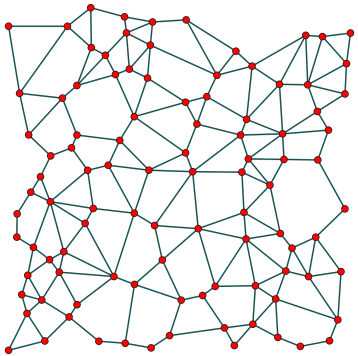


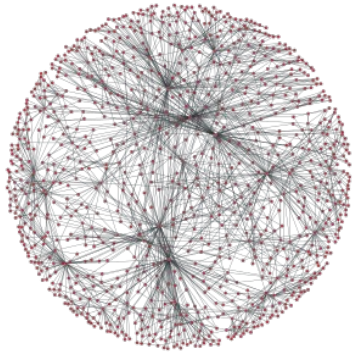
http://www.pnas.org/content/107/20/9186.abstract



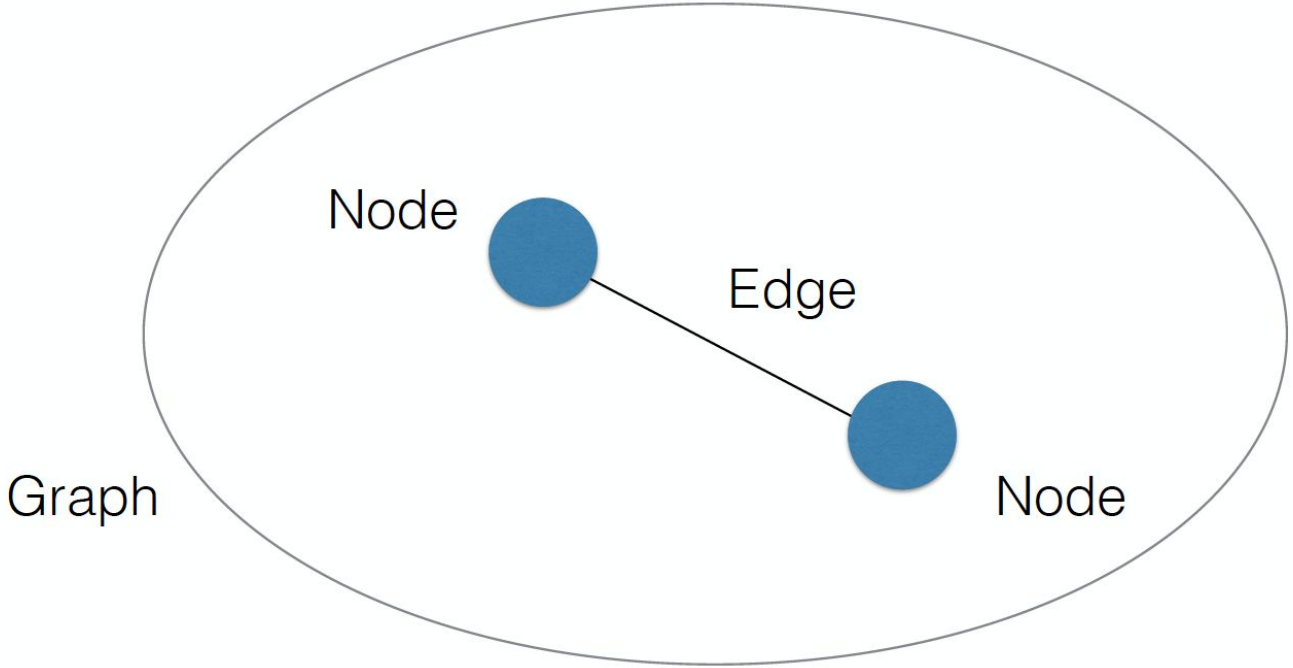
What is a network?

- A collection of points joined by lines
- Mathematically: graph
  - A gentle introduction to graph theory: https://dev.to/vaidehijoshi/a-gentle-introduction-to-graph-theory
- Representation of relationship between discrete objects
- A way of exploring data

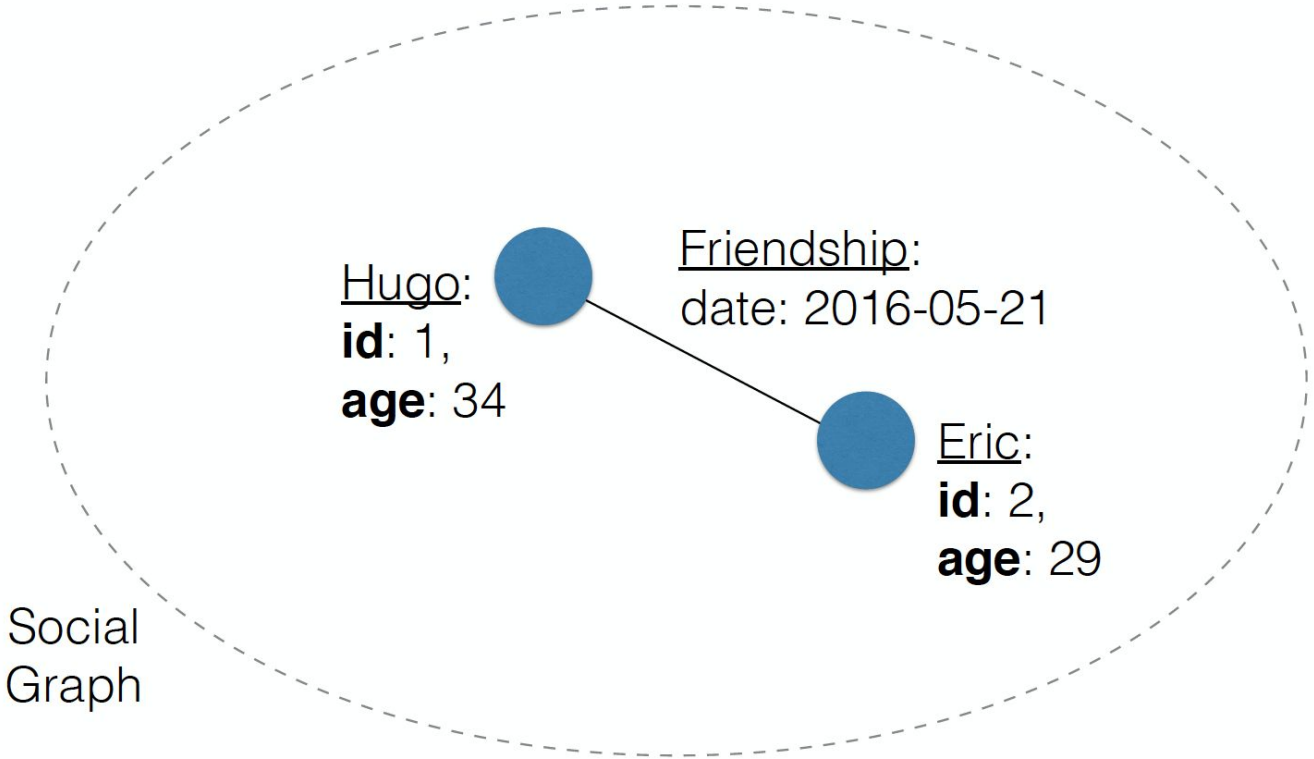




Network Structure

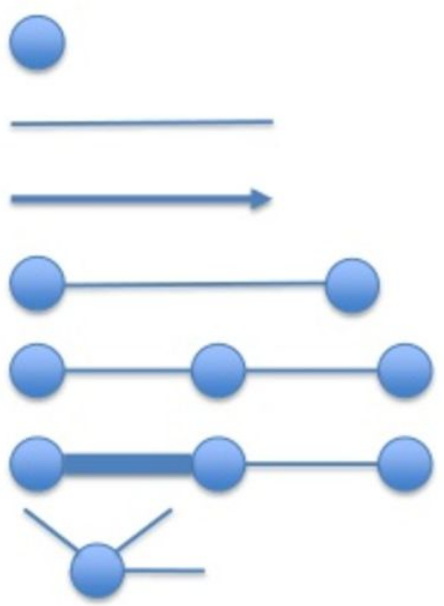


Network Structure



Network Structure

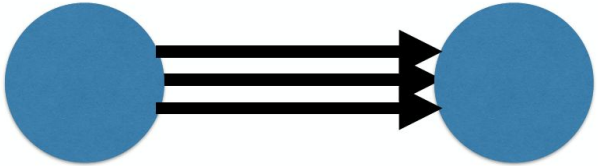
- Vertex/node
- Edge
- Directed
- Connectivity
- Path
- Weight
- Degree



Types of Graphs

Undirected: Facebook social graph

Directed: Twitter social graph



MultiDiGraph: trip records between bike sharing stations

Handle with networks: a tool perspective

- https://networkx.github.io/
- https://gephi.org/
- http://www.cytoscape.org/
- http://www.graphviz.org/

NetworkX API Basics

```
import networkx as nx
import matplotlib.pyplot as plt

# Instantiate an empty, undirected graph object.
g = nx.Graph()

# add a single node
g.add_node(1)

# use .add_nodes_from() to add in bulk of nodes
g.add_nodes_from([2,3,'four',5])

# view de graph
g.nodes()
```

Adding nodes

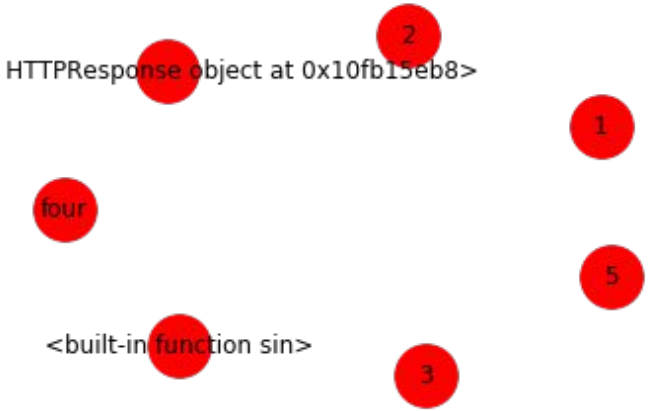
A node can be any of the so-called hashable objects - strings, numbers, files, functions, etc.

```
# Add a sine function as node, which is imported from the math module.
from math import sin
g.add_node(sin)
```

```
import urllib
url = 'http://dados.ufrn.br/api/action/datastore_search?resource_id=6b0f
fileobj = urllib.request.urlopen(url)

# Add a http response object to graph
g.add_node(fileobj)
```

Visualize the graph structure

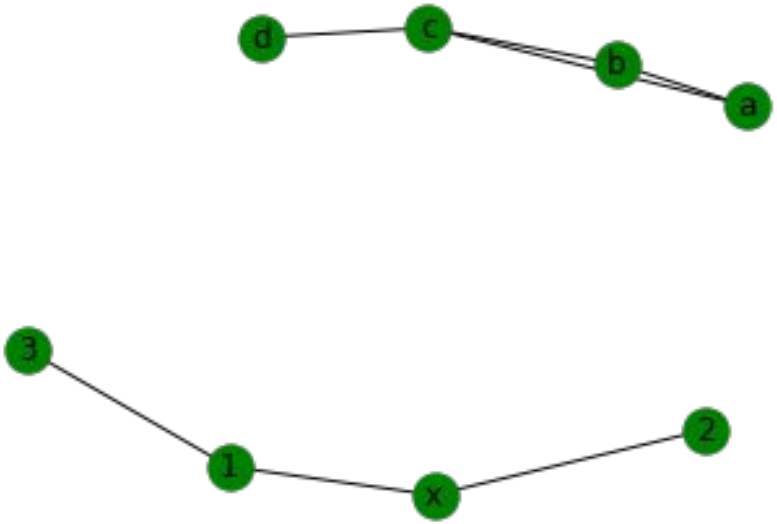
```
# Configure the plot's axis
plt.axis('off')

# Draw the network
nx.draw_networkx(g,pos=nx.spring_layout(g),
                 with_labels=True, node_size=1000)

# Plot the graph
plt.show()
```



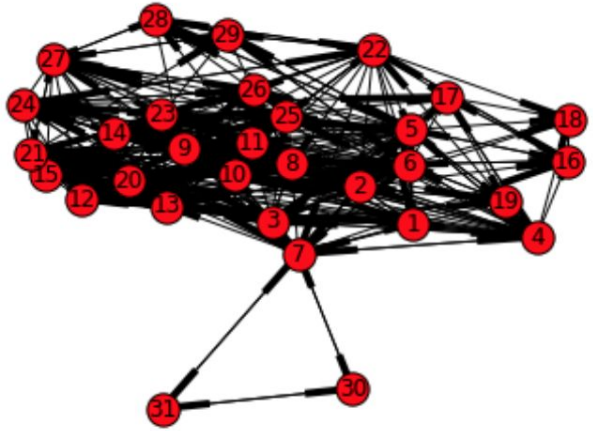
Adding edges

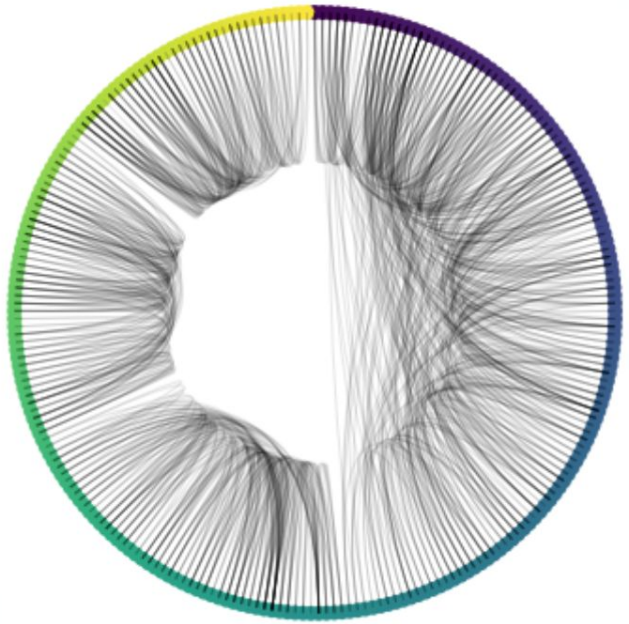
```
# Instantiate an empty, undirected graph object.
G = nx.Graph()

# Demonstrate a second method of creating a graph.
G.add_edge(1,3)

# Add another edge with a weight.
G.add_edge(2,'x',weight=0.9) # other way G.add_edge('2', 'x', { 'distance': 0.4})
G.add_edge(1,'x',weight=3.142)

# Add edges from a list of tuples.
edgelist=[('a','b',5.0),('b','c',3.0),('a','c',1.0),('c','d',7.3)]
G.add_weighted_edges_from(edgelist)

# Visualize the graph structure.
nx.draw_networkx(G, with_labels=True, node_color='green')

# Plot the graph structure.
plt.axis('off')
plt.show()
```

Visualizing the previous example



Irrational vs Rational Visualization

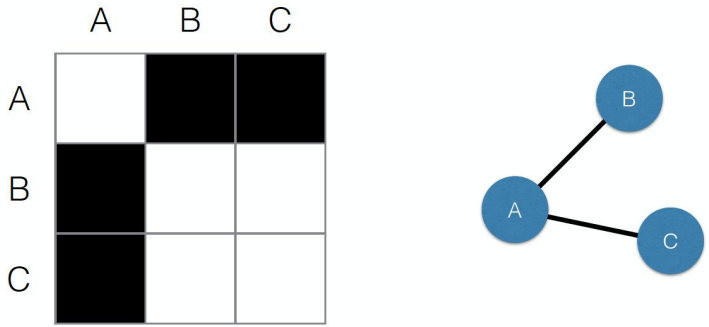




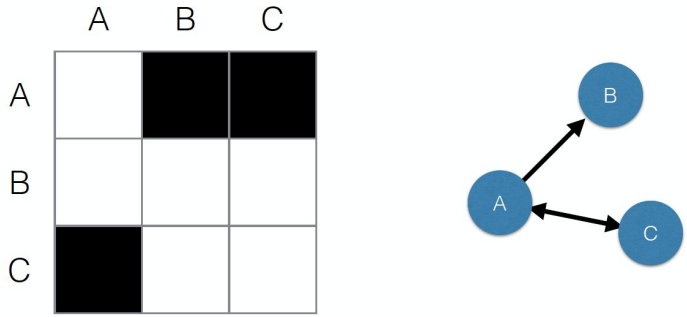
Visualizing networks

- Matrix plots
- Arc plots
- Circos plots

Matrix plots

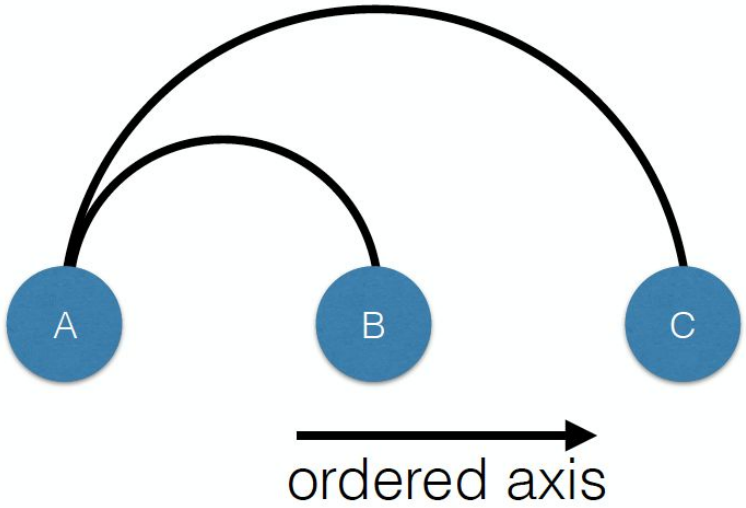


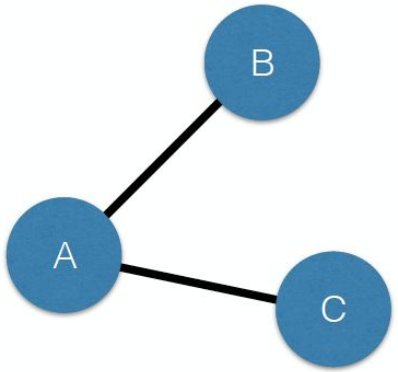
Undirected Graph



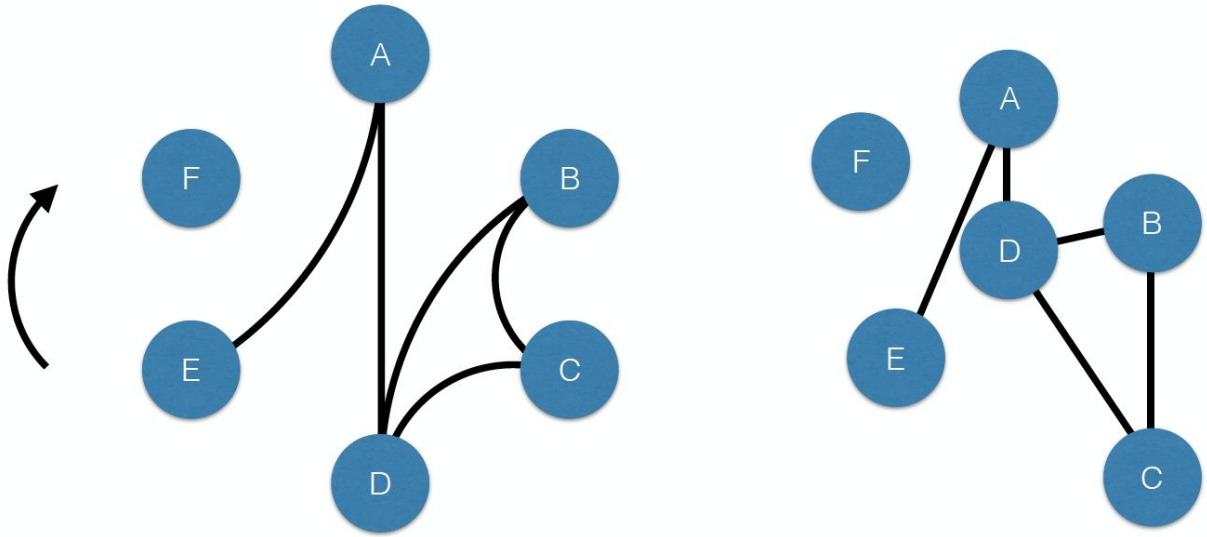
Directed Graph

Arc Plot



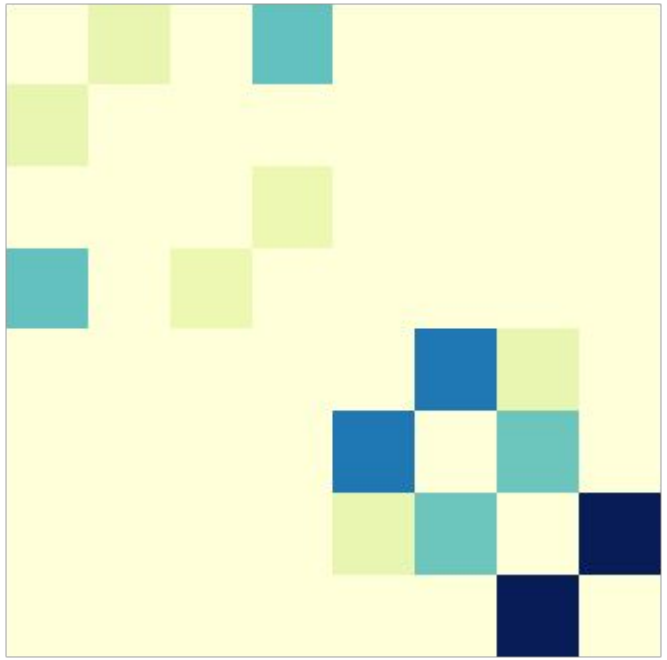


Circos Plot



Visualizing using Matrix plot

```
# Import nxviz
import nxviz as nv

# Create the MatrixPlot object: m
m = nv.MatrixPlot(G)

# Draw m to the screen
m.draw()

# Display the plot
plt.show()
```



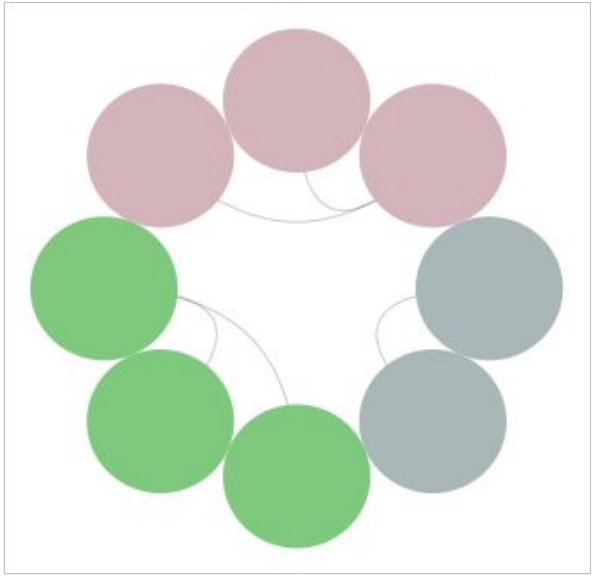
Visualizing using Circos plot: step #1

```
# Instantiate an empty, undirected graph object.
G = nx.Graph()

nodes = [(1, {'category': 'A', 'occupation': 'scientist'}),
         (2, {'category': 'F', 'occupation': 'scientist'}),
         (3, {'category': 'C', 'occupation': 'politician'}),
         (4, {'category': 'R', 'occupation': 'celebrity'}),
         (5, {'category': 'C', 'occupation': 'politician'}),
         (6, {'category': 'P', 'occupation': 'celebrity'}),
         (7, {'category': 'P', 'occupation': 'celebrity'}),
         (8, {'category': 'D', 'occupation': 'scientist'})
        ]
G.add_nodes_from(nodes)
```

```
# Adding edges
G.add_edge(1,2,weight=1)
G.add_edge(1,8,weight=1)
G.add_edge(3,5,weight=1)
G.add_edge(4,6,weight=1)
G.add_edge(4,7,weight=1)
```

Visualizing using Circos plot: step #2

```
# Import necessary modules to use Circos plot
import matplotlib.pyplot as plt
from nxviz import CircosPlot

# Create the CircosPlot object: c
c = CircosPlot(G,node_color='occupation',
               node_grouping='occupation')

# Draw c to the screen
c.draw()

# Display the plot
plt.show()
```



Visualizing Arc plots

```
# Import necessary modules
import matplotlib.pyplot as plt
from nxviz import ArcPlot

# Create the customized ArcPlot object: a
a = ArcPlot(G,node_order='occupation',node_color='occupation')

# Draw a to the screen
a.draw()

# Display the plot
plt.show()
```

Requesting network structure

- Getting neighbor information
- Removing nodes and edges
- Graph generators

Notebook - https://goo.gl/DeQJVv

Reference

- https://media.readthedocs.org/pdf/networkx/stable/networkx.pdf
- https://github.com/sandrofsousa/awesome-network-analysis
- https://www.researchgate.net/publication/304946197_Estudo_das_propriedades_e_robustez_da_rede_de_transporte_publico_de_Sao_Paulo
- http://www.hiveplot.com/
- https://github.com/ericmjl
- https://dev.to/vaidehijoshi/a-gentle-introduction-to-graph-theory