Problem Set 2

Building Blocks of Networks

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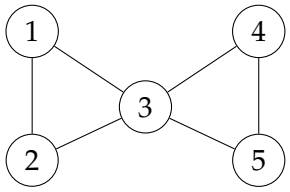
1. Calculate the maximum number of links for a network of
   (a) $n = 5$
   (b) $n = 10$
   (c) $n = 15$
   (d) $n = 20$
2. Network G has a set $V(G)$ with 15 elements and a set $E(G)$ with 35 elements. Cal-culate the density of network G.
3. Using the network below:



   (a) Write the node set
   (b) Write the link set
4. Using the following sets:

$$V(G) = \{1,2,3,4,5,6,7,8\}$$
$$E(G) = \{(1,2),(6,1),(2,3),(3,4),(4,5),(6,5)\}$$

   Draw the network G

3, Follow the steps below to create a network and extract some quantities of it.

&_' Start by creating 20 nodes.

&`' Among the nodes created, connect some of them to produce 30 links. HINT: *We don't really care which nodes to connect, the only thing that should match is m.*

&a' Calculate the density of your created network using any `Python` function at your disposal (or write your own).

4, A aj_qq has 25 students that start the semester not knowing each other. By the end of the semester, 30 friendships were formed. What is the density of this social net-work? How many more friendships would be needed for the social network to be a complete network?

Problem Set 2.

(1a) $n=5$, max number assumes network is a complete network. density, amount of actual / max. Completeness of network?

$m_{complete}$ / m = links, n = nodes / 5 nodes, what's maximum amount of links in the network. links exist between two nodes.

$m_{complete}(5) = \binom{5}{2}$ Binomial looks for combinations, $n(n-1)/2$

$(5)(4)/2 = 20/2$ [10 maximum number of links]

(1b) $n=10$ $V(6)=\{0,0,0,0,0,0,0,0,0,0\}$
Nodes can be anything. $E(6)_{max} = ?$ or $m_{complete}(10)$ or $\binom{10}{2}$ or $10(10-1)/2$

$(10)(9)/2 = 90/2$ [45 links possible]

(1c.) 15 nodes in network, how many combos of 2, links exist between 2 nodes, use binomial for combination checks

$\binom{15}{2}$; $(15)(14)/2$, $210/2$, [105 possible]

(1d) 20 nodes? $(20)(19)/2$ [190 max number]

Every 5 node increase increases gap by +25.

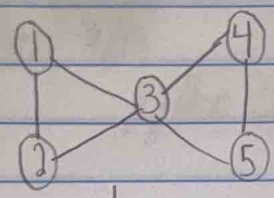
+35
25
+60
25
+85

(2) $V(6)$ = Vertices, or nodes, or n. Set containing all nodes in network
$V(6)$ has 15 nodes / elements.
$E(6)$, edges, links, has 35 elements. / density, P, 0 to 1.

$\binom{15}{2} = (15)(14)/2 = 105$ max number of links, actual = 35 $\frac{1}{10}$

[$p(6) = 35/105 = 1/3$]

Problem Set 2, continued...

(3) 

Node set, V(G), vertices, nodes

$V(G) = \{1,2,3,4,5\}$

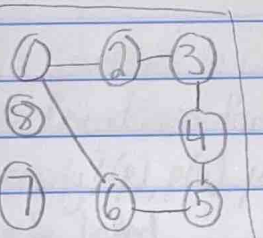
$E(G) = \{(1,2),(1,3),(2,3),(3,4),(3,5),(4,5)\}$

↓ Undirected

$(1,2) = (2,1)$

(4) $V(G) = \{1,2,3,4,5,6,7,8\}$, nodes in network, elements

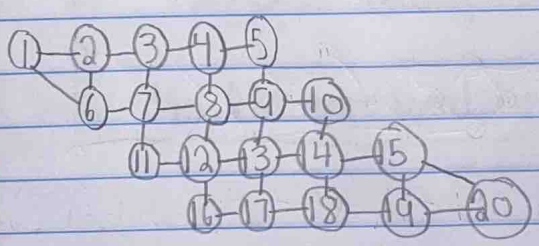
$E(G) = \{(1,2),(6,1),(2,3),(3,4),(4,5),(6,5)\}$, links in network



*Note that not all nodes are connected, not needed to be a network

20 elements in node set, 20 nodes.

(5a)/(5b) $V(G) = \{0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0\}$



(5c) Wants to know density, probability that any two nodes (random) will be connected, or linked

probability = how many links exist / theoretical maximum in network.

m / m_{max}

30 links in our network, need to know what the max number of links we can have in a system of 20 nodes, use binomial.

20 elements or nodes, $(20)(19)/2 = 380/2 = 190$ max links, probability equals $30/190 = 3/19$

Problem Set 2, Continued...

(5c) (p) = 3/19

Python Code:

```
import networkx as nx
#Create network, using nx.graph(),
automatically add nodes by adding links
to network using .add_edges() function

nx.density(G) #Retrieve density
```

(6) 25 students in class
30 friendships formed at end of semester
Density? (p), p(G) probability that any 2 students will have a friendship, or be linked.
p(G) need max number of links in the network, binomial.

n = 25 (25)(24)/2 = 300 maximum friendships/links, 30 real
m = 30 ~~30/300~~ 1/10 Density = 1/10

p(G) = 1/10, 270 more friendships needed for complete network