Θέματα Εφαρμογών Βάσεων Δεδομένων : Ιδιωτικότητα Δεδομένων

4. Power Law Graphs

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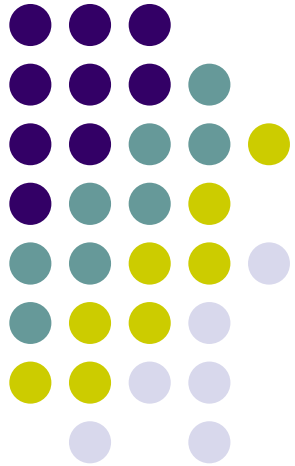
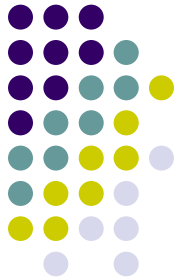


Barabási-Albert (BA) Scale Free Model



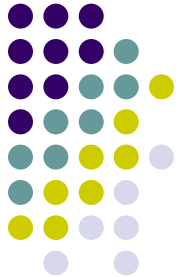
- Algorithm for generating random scale free networks (graphs) that they have **power law** (or scale free) degree distributions.

- Power law: $P(k)=ck(^{-}\gamma)$: constant c, $2<\gamma<3$

- Two important general concepts:
  - **Growth**
  - **Preferential attachment**

Both growth and preferential attachment exist in real networks.

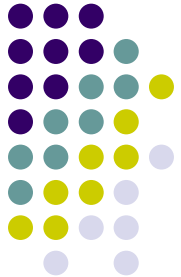
Basic concept of BA model



- *Growth*: the number of nodes in the network increases over time.

- *Preferential attachment:* the more connected node is the more likely to receive new links. Nodes with higher degree have stronger ability to grab links added to the network.
    - For example, how connected people in a social network or on the web pages links such as Google, Wikipedia etc

Parameters of algorithm



- Input
  - n: # of nodes
  - m: # of edges to attach from a new node to existing nodes
  - seed: (int) for random number generator (default=None)
- Output
  - G: Graph
- The initialization is a graph with no nodes and mo edges.

Basic steps of algorithm

1. Starting with an initial network (graph) with a few nodes. (→growth)

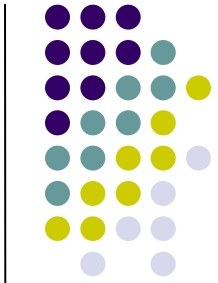
   no: nodes of initialization (no>=2)

   mo: edges of initialization

   Each of these nodes(n0) must have at least one connection (or fully connected). The final structure does not depend on the initial number of nodes.

2. At each time step, a new node is added. Older nodes with a higher degree have a higher probability of attracting edges from a new node. (→ preferential attachment)

Connection probability



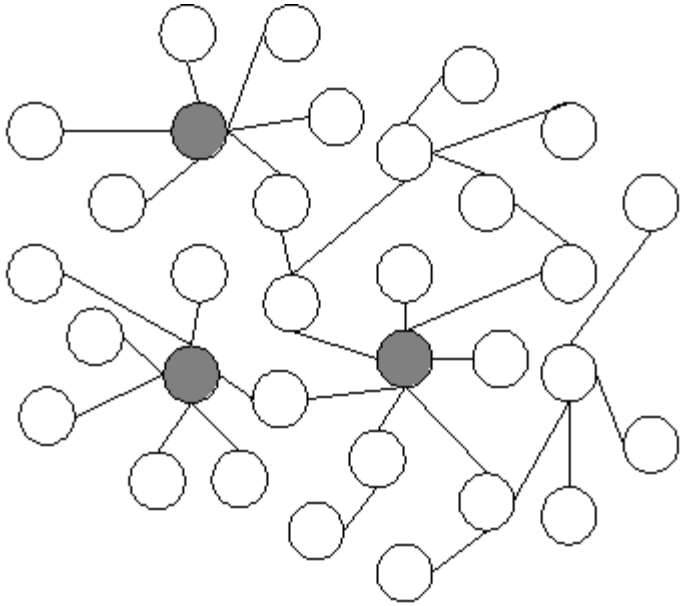
- Connection probability-Preferential attachment

- A new node will be connected to node i depends on the connectivity ki of that node.
  Probability of attachment is given by:

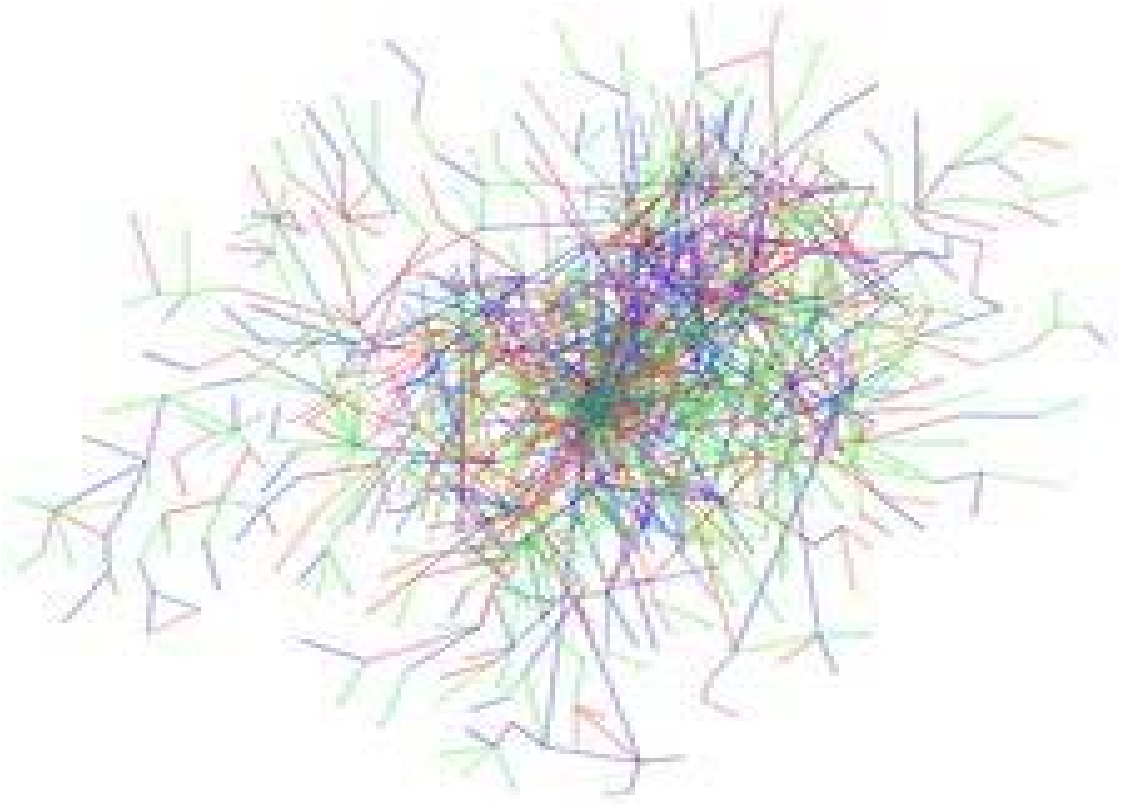
$$P(ki) = ki / \Sigma i\ ki$$

This can result in self-loops or multiple edges.

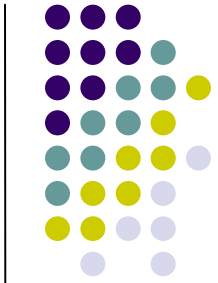
1st example of power law graph



2nd example of power law graph

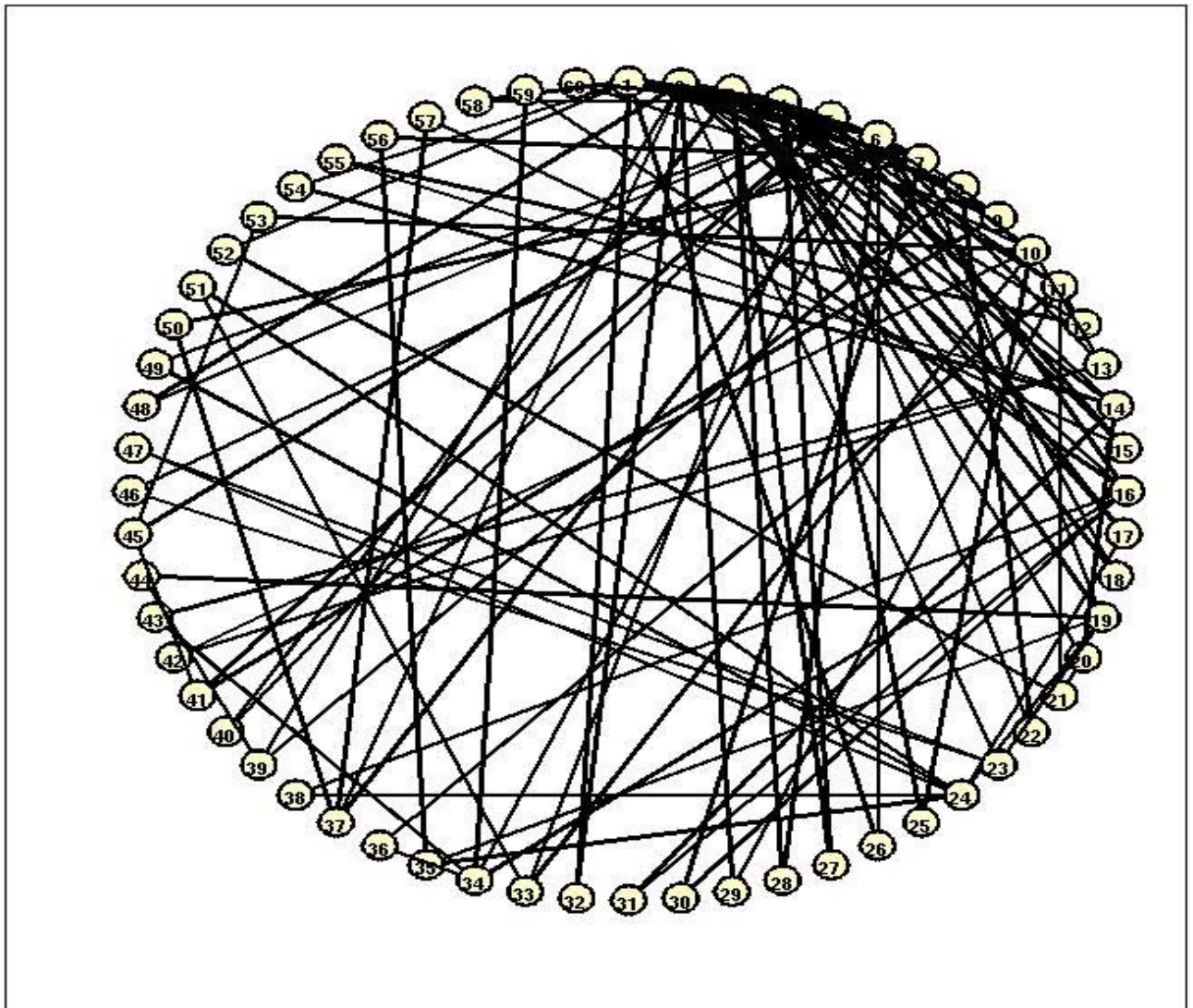


Applications



- Applied to generate any undirected network
- Such as,
  - the collaboration network among scientist
  - the movie actor network
  - or other social networks in which connections between edges are undirected…

Fully connected power law graph (n=60,no=6, m=2,mo=5)



Non fully connected power law graph (n=60,no=6,m=2)