Advanced Algorithms and Computational Models (module A)

Final project

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Final

The *Barabasi-Albert* (BA) model generates scale-free networks. We start with m_0 nodes, with a number of links arbitrarily chosen so that each node has at least one link.
It relies on two main steps:

- **Growth**

  At each time step a new node is added with m ($m \leq m_0$) links that connect the new node to m nodes already in the network

- **Preferential Attachment**

  The probability $\Pi(k)$ that a link of the new node connects to node i depends on the degree k_i as

$$\Pi(k_i) = \frac{k_i}{\sum_j k_j}$$

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In this project, only the growth mechanism is taken into account. According to the theory, the time evolution of the degree of a node is given by

$$k_i(t) = m\, ln\left(e\frac{m_0 + t - 1}{m_0 + t_i - 1}\right)$$

t_i being the arrival time of node i
And the degree distribution goes as:

$$p(k) = \frac{e}{m} exp\left(- \frac{k}{m}\right)$$

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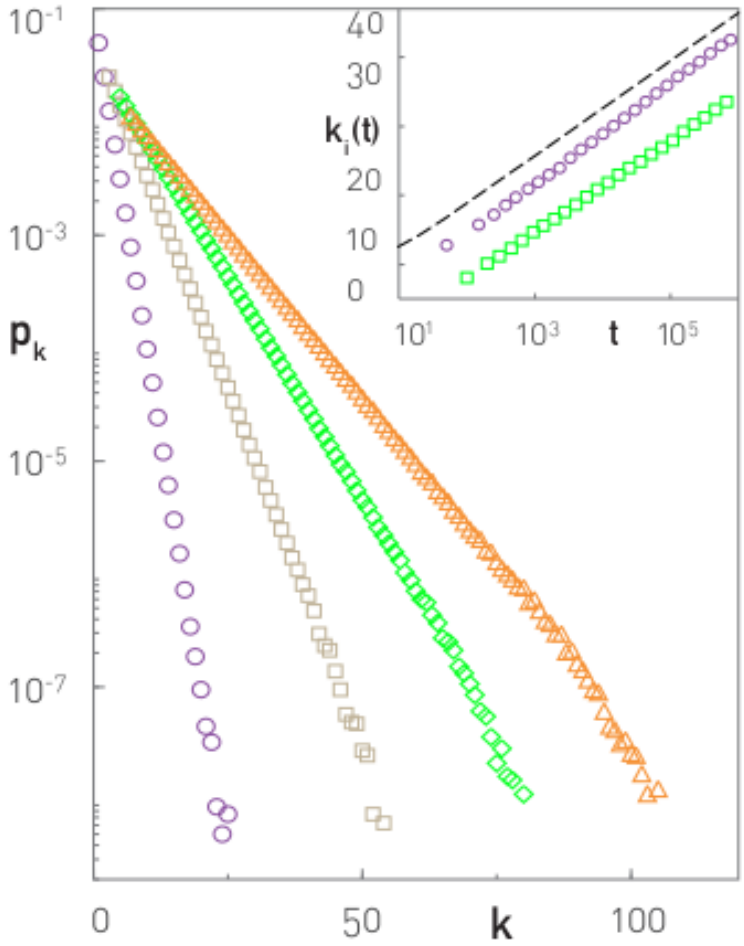

Figure 1

$m_0 = m = 1$ (circles), 3 (squares), 5 (diamonds), 7 (triangles)

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What to do:

1. Create an initial network composed of a limited number of nodes, m_0 being the initial number of links. Note that no isolated nodes are allowed in the initial network. Of course this implies that the number of initial nodes and m_0 must be careful decided. Also note that m_0 is an input parameter of the experiment.
2. Create an iterative process in which a new node is added at each iteration. Each new node has $m = m_0$ links that, at variance with the standard BA model, are connected on a purely random basis with $m = m_0$ already existing nodes.
3. The iterative process ends when N nodes have been added. Note that N is an input parameter of the experiment. Its value should be around $10^3 - -10^4$

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What to do:

4. Measure the degree distributions for (at least) three different values of $m = m_0$ and plot them
5. Measure the time evolution of the average degree for each of the three different values of $m = m_0$ and plot them

Caution

The code (and the plots in jpg or png format) must be sent via email to my email address at least two working days before the examination.
Students are strongly advised to submit the code for approval **before** offical dispatch. A meeting must be scheduled via email.