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An extended formalism for growing heterogeneous complex networks with preferential attachment

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We present a general formalism for models to study the evolution dynamics of complex networks. It is an extension of the preferential attachment model to heterogeneous networks, which we define as those where nodes have intrinsic properties that bias their attachment probabilities to other nodes. We would like to emphasize that the proposed class of models is quite general and contains most of the previous heterogeneous network models available in the literature, including the fitness model, as particular cases. Also it should be mentioned that athough there are some previous models that incorporate an internal property to nodes (e.g. hidden variables), none of them focuses on growing networks with such heterogeneity.

In this communication an analytical expression of the degree distribution has been derived for the general class of heterogeneous models presented. It has been shown analytically that all the models in this class present power laws in the degree distribution with different exponents.

We have also carried out a numerical simulation of the degree distribution and clustering in the threshold model. This is a particular case in the class of models proposed, where the attachment affinity is inversely related to the distance between node states as given by a space metric. This particular model is introduced in order to provide a benchmark for numerical simulation of heterogeneous networks, while loosing as little generality as possible in the choice. We think that the hypothesis of an inverse relationship between affinity and intrinsic distance (as given by a relevant metric) may be a reasonable proxy for many real networks where preferential attachment can be

considered as the most relevant linking mechanism. For instance, protein interactions tend to happen preferentially between molecules within low distance in a configuration space, while web pages tend to preferentially link to other pages within low distance in a semantic space.

References

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