COMPLEX NETWORKS Task: Barabasi-Albert, power-laws and binning

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I propose you a task about power-laws, distribution of degrees, and binning.

Please, individually, not by the teams you have been working together, follow these items and generate, as usual, a Python notebook:

1. Generate a BA random graph from NetworkX. You can take $N = 10^4 - 10^6$ with no problems.
2. Plot the degree distribution on a log-log scale
3. Try to fit the distribution to a power-law. What happens with the parameters of the distribution? Take into account that:
   - Can be approximated by a continuous function
   - The distribution should be properly normalized
   - The minimum value of the distribution is not 0
4. Now compute the cumulative distribution function just to check that this distribution looks much smoother. Plot the complementary $P(X \geq x) = 1 - CDF$ also in a log-log scale
5. Try to fit it this function to a power-law. What happens with the exponents? Take into account the relationship between this distribution and the original one. See the figures.
6. Now, in order to smooth the original curve, you can make a "logarithmic binning", by taking intervals of increasing exponential length. For instance, $2, 3 : 4, 5 : 8, 9 : 16, 17 : 32, 33 : 64, \ldots$. In general, you can adjust the base $r^1, r^1 + 1 : r^2, r^2 + 1 : r^3$ (rounded to the nearest integer, of course).

7. This "binned" distribution can also be fitted. What happens with the exponent?

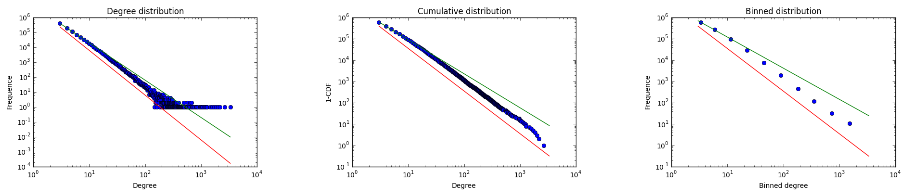

Figure 1: HINTS: The three relevant distributions with their respective fittings. Green line corresponds to a "not very good" fit. Red line corresponds to the "expected slope" of the distribution.