Second Laboratory

Models of complex networks

Complex Networks

Universitat Rovira i Virgili

Master in Artificial Inteligence

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1 Models of complex networks

The four models have been generated for this exercise.

1.1 Plots of the networks

Plots taken from Pajeck of some of the generated networks, with size 50 for WS and ER; size 100 for BA and CM.
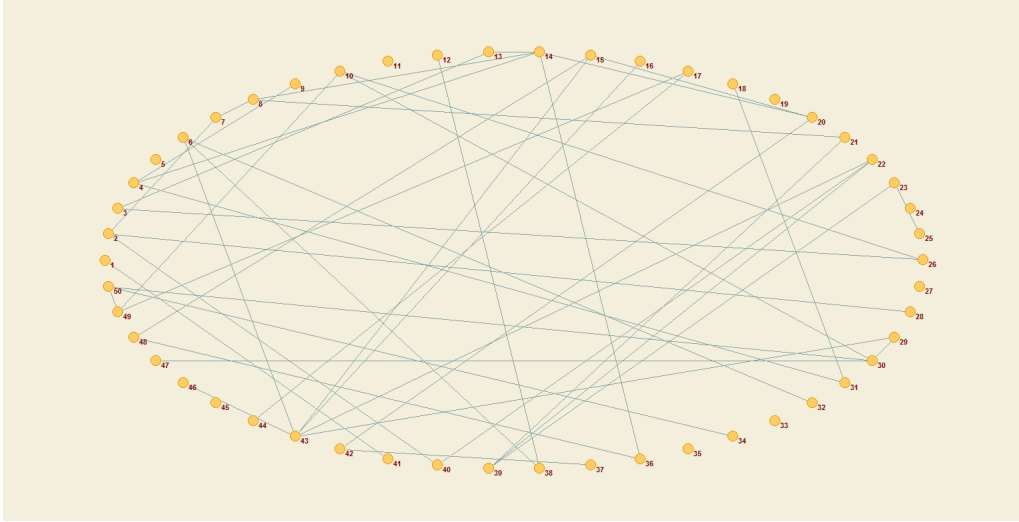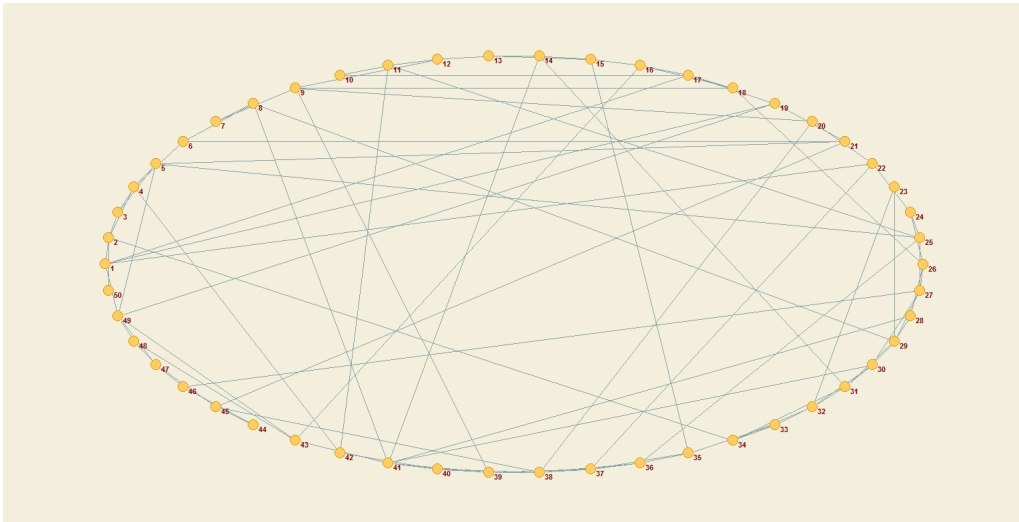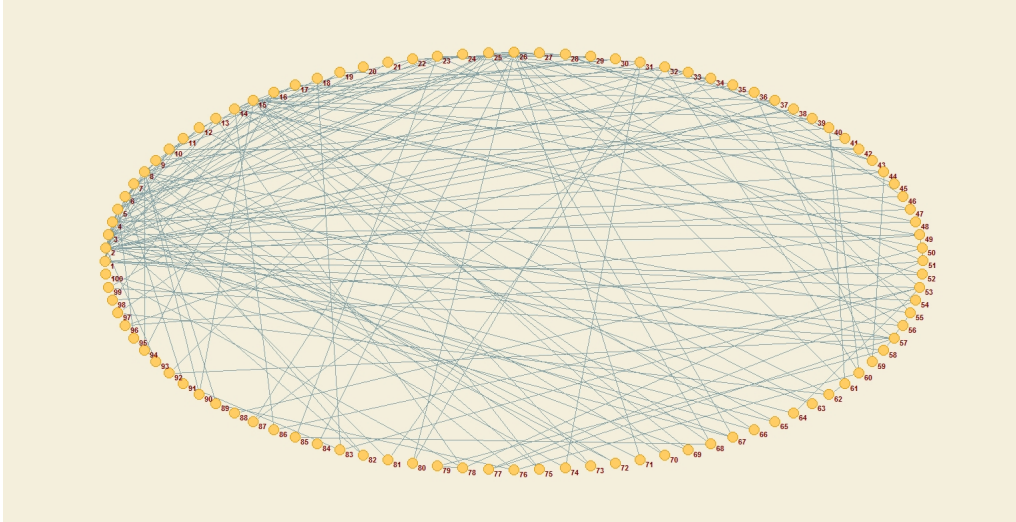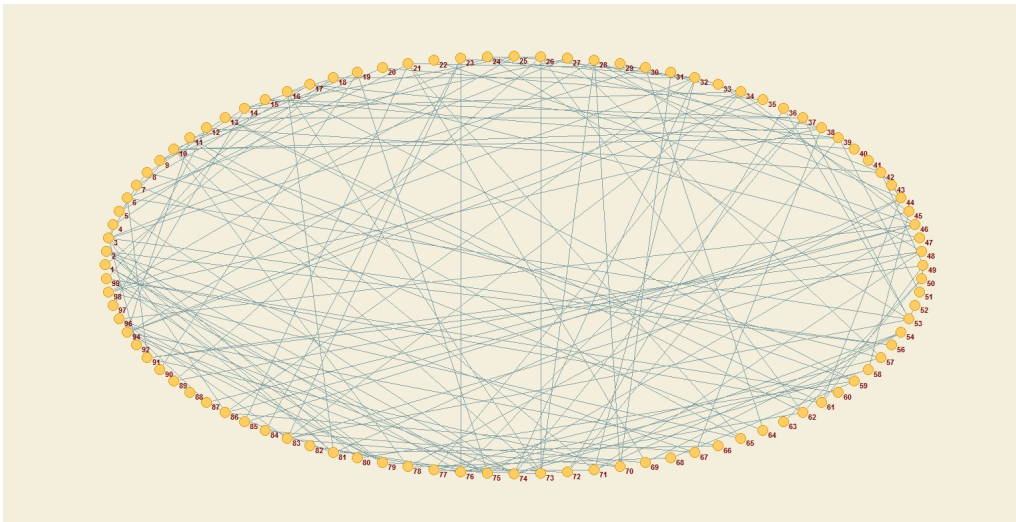

Figure 1: Erdös-Rényi with $n = 50$ and $p = 0.05$.

Figure 2: Watts-Strogatz model with $n = 50$ and $p = 0.5$.

1.2 Plot of the degree distribution for each model

Plot of the degree distribution of the previously shown networks in blue and theoretical distribution in green.

Figure 3: Barabási & Albert model for $n = 100$ and $k = 2$.

Figure 4: Configuration Model for the Poisson distribution with $n = 100$ and $\lambda = 4$.

For the Watts-Strogatz degree distribution Image7 the real theoretical degree distribution is missing. For the Barabási & Albert Image8 the real degree distribution starts at 0 whereas the empirical one starts at 2, this is due to the fact that there is a minimum degree that is not present in the real distribution by the probability density function. Nevertheless as with the other networks, the empirical and the real distributions are quite similar.

1.3   Rest of the exercise

The rest of the exercise is the implementation which can be found in the folder "CNGen", which contains the generator functions in "generators.py", some functions at "functions.py" and the main execution at "main.py", for the execution the python modules "matplotlib", "numpy" and "NetworkX" are needed.

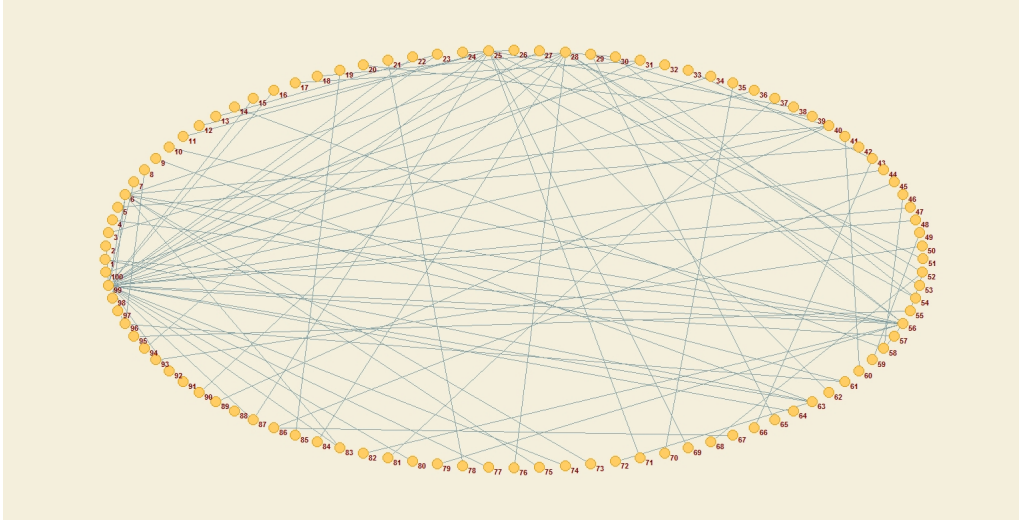The generated networks are saved in the "CNGen" folder, in the subfolder "networks".

Figure 5: Configuration Model for the Power Law distribution with $n = 100$ and $\gamma = 2.5$.

For the estimation of the exponent for the empirical degree distributions of BA and CM (SF), the results are not quite satisfactory, obtaining always a value between 1.9 and 2.1 when the real exponents vary between 2.5 and 4, it is not clear if there is an error in the code or if the networks need to be bigger for the results to converge, the biggest network for which the exponent was calculated was 1000.
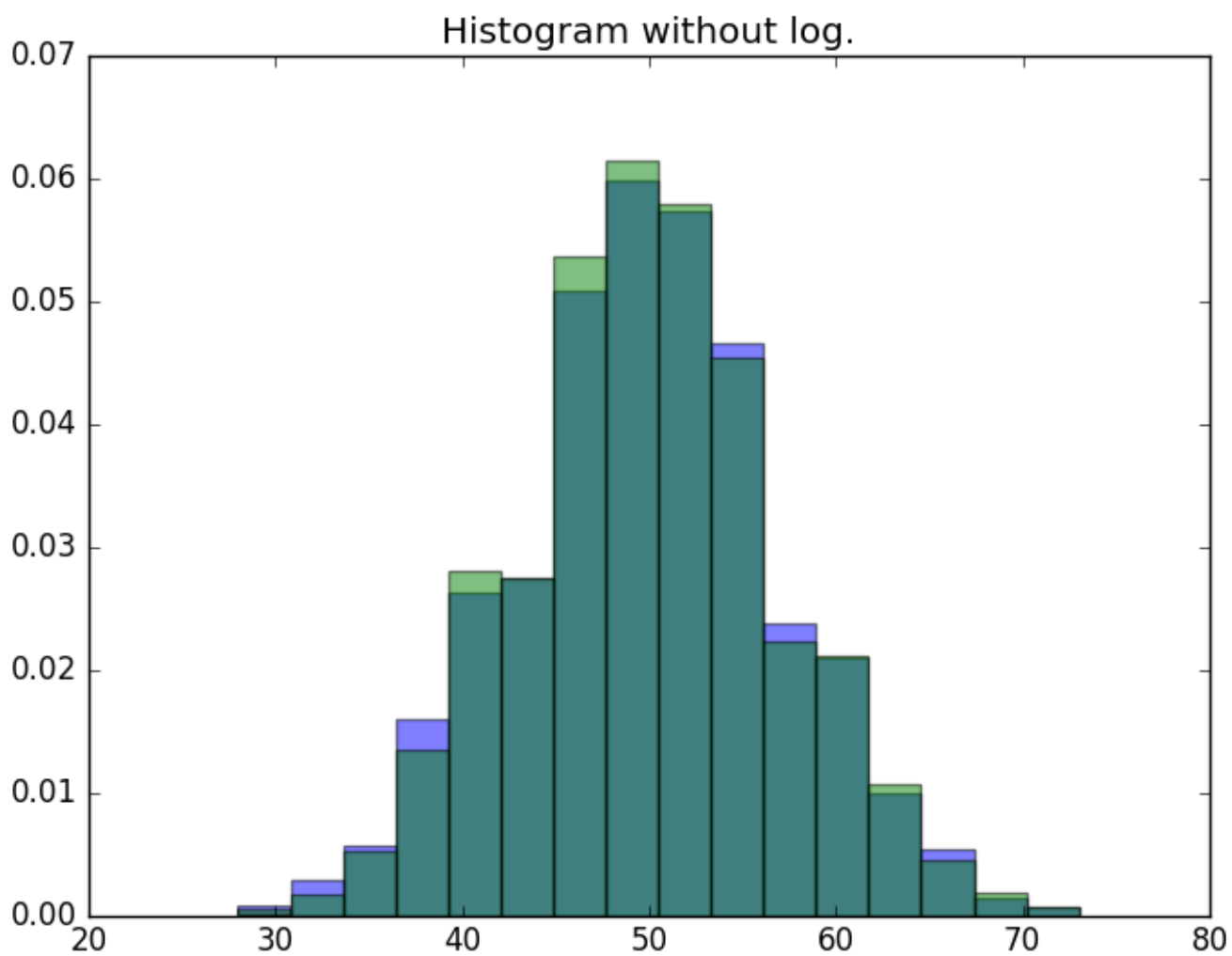
Figure 6: Erdös-Rényi model probability distribution with $n = 50$ and $p = 0.05$.

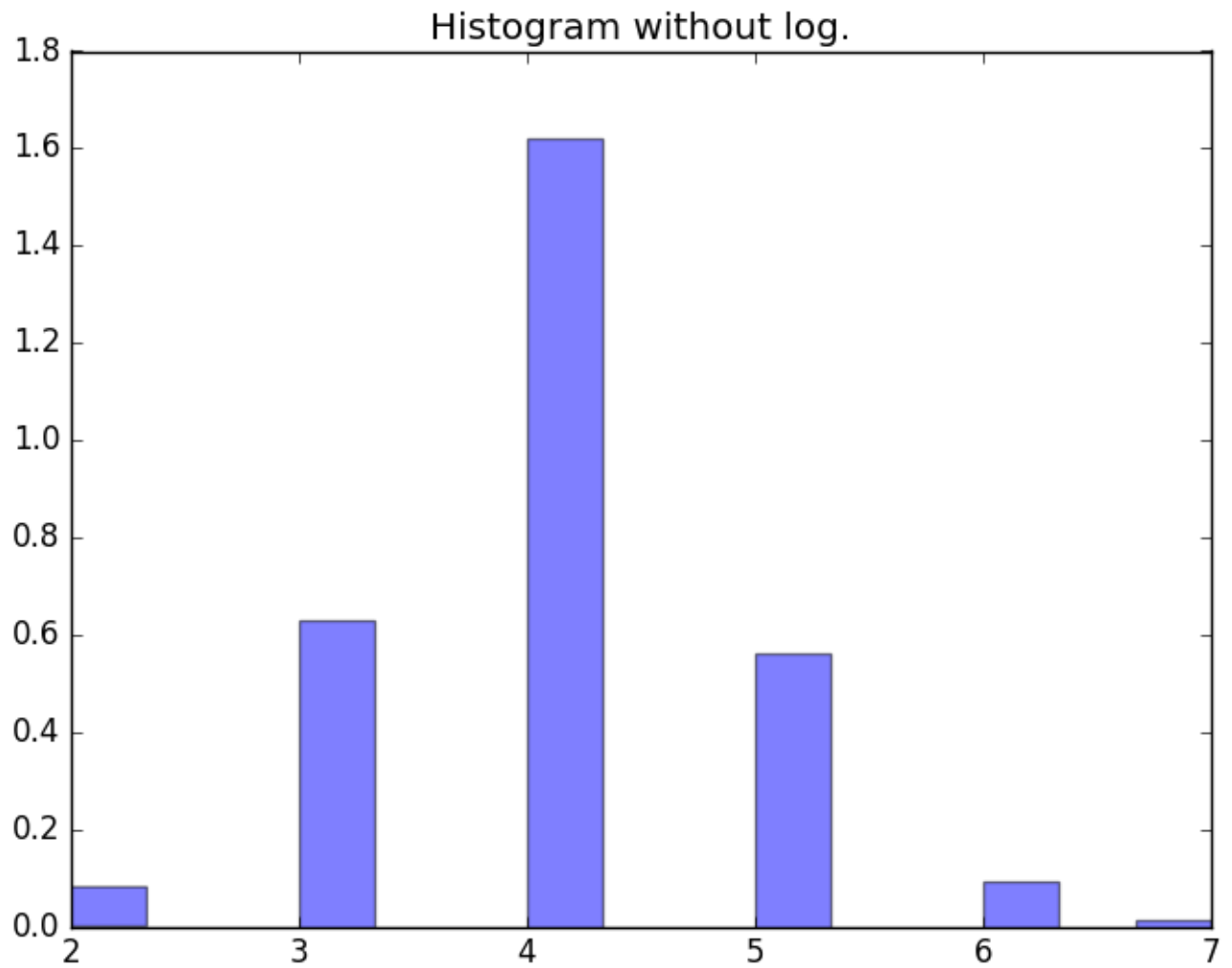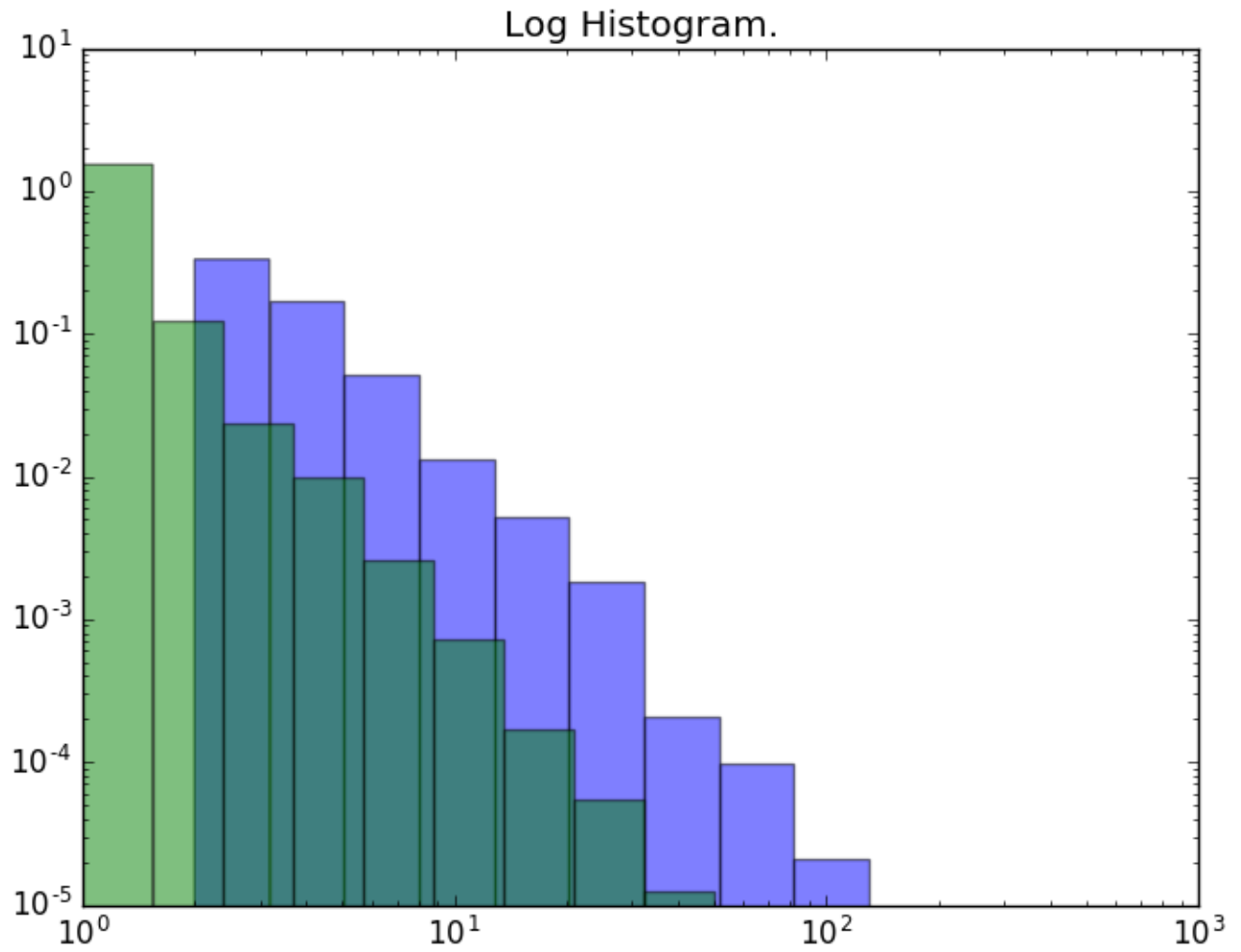Figure 7: Watts-Strogatz model probability distribution with $n = 50$ and $p = 0.5$.

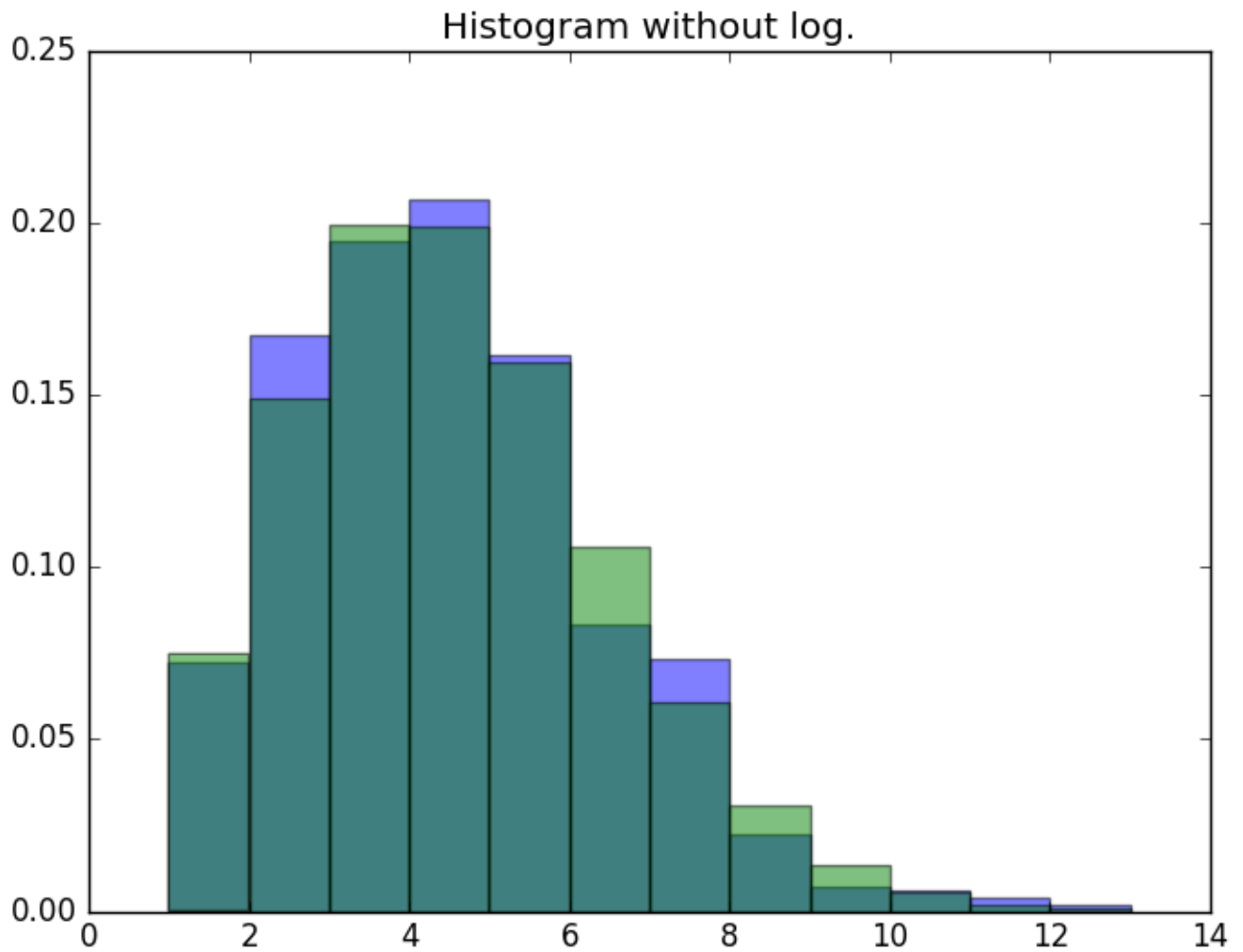Figure 8: Barabási & Albert model probability distribution for $n = 100$ and $k = 2$.

Figure 9: Configuration Model probability distribution for the Poisson distribution with $n = 100$ and $\lambda = 4$.
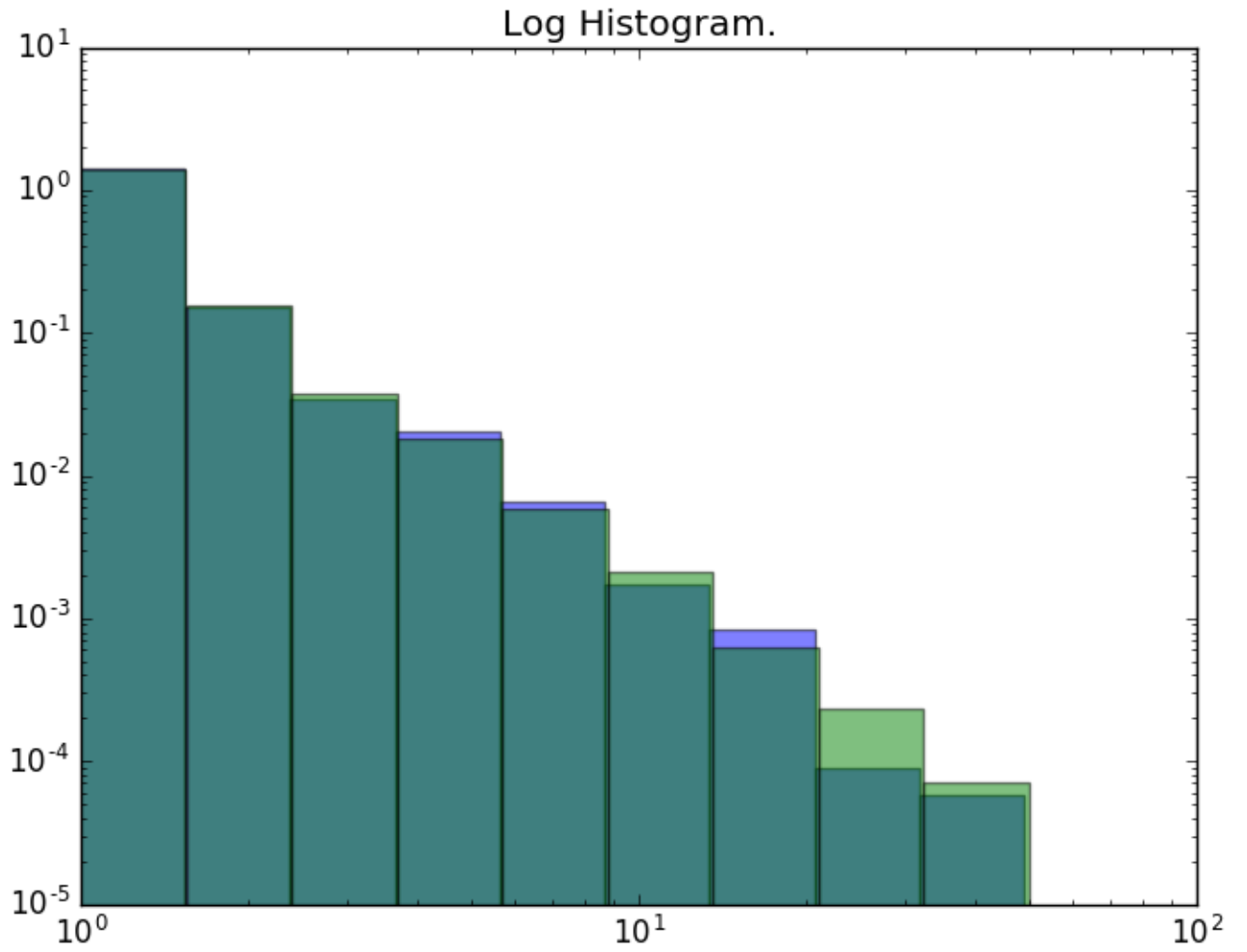
Figure 10: Configuration Model probability distribution for the Power Law distribution with $n = 100$ and $\gamma = 2.5$.