UPC

Lab3: Significance of Network Metrics

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4.1 Analytical estimation of the p-value

4.1.1 Erdös-Rényi Graph

Given our original graph with N vertices and E edges, the Erdös-Rényi graph has the same size and order but with its edges randomized. Of the two possible Erdös-Renyi models, we will use $G(N,p)$ where p will be such that the expected number of edges is E (which is $p = \frac{E}{\binom{N}{2}}$). This has the advantage that X_j the random variables that for every possible vertex indicate wether it exists (X_j=1) or not (X_j=0) are independent, which will be very useful later on. When working with large values of N and E (such as those we study in this lab session), the models $G(N,E)$ and $G(N,p)$ should give very similar random graphs. For X_j where j is the index of any vertex, we calculate its expectation and variance:

$$\mathrm{E}[X_j] = 0 \cdot (1-p) + 1 \cdot p = p$$

$$\mathrm{Var}(X_j) = \mathrm{E}[X^2] - (\mathrm{E}[X])^2 = p - p^2$$

Given a vertex v of the graph, it can have $N-1$ neighbours (each with probability p), which results in $\binom{N-1}{2}$ possible pairs of neighbours. The expected number of pairs. This gives an expected number of pairs of neighbours $p^2\binom{N-1}{2}$