

There is a series of Erdos-Renyi papers on the subject, but the most concise formulation I found was in the 1961 paper (attached, page 3 bottom). Here the authors state:

$$N(n) \sim cn, cn < 1/2 \Rightarrow |S| \approx \frac{1}{\alpha} \left(\log(n) - \frac{5}{2} \log(\log(n)) \right) \quad (1)$$

$$N(n) \sim n/2, (i.e., c = 1/2) \Rightarrow |S| \approx n^{2/3} \quad (2)$$

$$N(n) \sim cn, cn > 1/2 \Rightarrow |S| \approx G(c)n \quad (3)$$

Where $N(n)$ is the (expected?) number of edges of a random graph with n vertices, $|S|$ is the size of the largest connected component, c is some constant, $0 \leq c \leq 1$, $alpha = 2c - 1 - \log(2c)$, and $G(c)$ is the function

$$G(c) = 1 - \frac{1}{2c} \sum_{k=1}^{\infty} \frac{k^{k-1}}{k!} (2ce^{-2c})^k$$

To translate from c to ϵ , I think we can take $N(n) = \binom{n}{2}p$, where p is the probability of an edge between two vertices. Letting $p = p_c(1 + \epsilon)$, with $p_c = 1/(n-1)$, we then get $N(n) = n \cdot (1 + \epsilon)/2$. Or, in other words, $c = (1 + \epsilon)/2$.

Then the above set of equations becomes

$$\epsilon < 0 \Rightarrow |C| \approx \frac{\log(n) - \frac{5}{2} \log(\log(n))}{\epsilon - \log(1 + \epsilon)} \quad (4)$$

$$\epsilon = 0 \Rightarrow |C| \approx n^{2/3} \quad (5)$$

$$\epsilon > 0 \Rightarrow |C| \approx G(\epsilon)n \quad (6)$$

Of course with $G(\epsilon)$ the appropriate substitution of c to ϵ .

I did a few trials using these approximations and the results seem much better (ratios approx 0.7 to 1.2), but I'm not sure how much better, in the long run, because I was only able to do some trials with relatively small numbers.

For calculating G , I evaluated in maple with $k = 1..1000$ since I couldn't find a better way to do it.