FROM HEAVY-TAILED BOOLEAN MODELS TO SCALE-FREE GILBERT GRAPHS

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Define the scale-free Gilbert graph based on a Boolean model with heavy-tailed radius distribution on the d-dimensional torus by connecting two centers of balls by an edge if at least one of the balls contains the center of the other. We investigate two asymptotic properties of this graph as the size of the torus tends to infinity. First, we determine the tail index associated with the asymptotic distribution of the sum of all power-weighted incoming and outgoing edge lengths at a randomly chosen vertex. Second, we study the behavior of chemical distances on scale-free Gilbert graphs and show the existence of different regimes depending on the tail index of the radius distribution. Despite some similarities to long-range percolation and ultra-small scale-free geometric networks, scale-free Gilbert graphs are actually more closely related to fractal percolation and this connection gives rise to different scaling limits. We also propose a modification of the graph, where the total number of edges can be reduced substantially at the cost of introducing a logarithmic factor in the chemical distances.