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Novel scaling limits for random discrete structures

Based on empirical arguments, statistical physicists conjectured in the early 2000s that for random graph models on n vertices with degree exponent $\tau \in (3,4)$, typical distance both at criticality and in the strong disorder regime scales like $n^{\frac{\tau-3}{\tau-1}}$. This stands in stark contrast to the behavior of the classical Erdos-Renyi random graph model where the scaling is known to be $n^{1/3}$. Only very recently, this conjecture has been verified mathematically for a number of models. We discuss a general approach to this problem that relies on coupling random graph processes with the multiplicative coalescent, and how this method can be applied to prove the conjecture for the inhomogeneous random graph model, graphs with given degree sequence, and the configuration model.