The height of random k-trees and related branching processes

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The construction of a random k-tree begins with a single k-clique. The tree is built as a process, by extending a randomly selected $(k-1)$-dimensional face of a randomly selected k-clique with an additional vertex; thus adding a new k-clique at each step.

A random k-tree generalizes a tree constructed by preferential attachment. The case of preferential attachment trees corresponds to picking a random endpoint of an random edge.

We describe a method to estimate the height of the breadth first search tree rooted at a vertex of the starting clique used for the construction of the tree. In the limit as k becomes large, the height of the BFS tree after t steps tends to $(\log t)/(k \log 2)$ with high probability.

The technique seems to have a range of applications, one of which is the height of generalized random Apollonian triangulations.