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Most recent common ancestors, Poisson cut-out random fractals,and coalescence-fragmentation

Abstract:
A natural question to ask about an asexually producing population is, "How far back in time do we have to go until we come to an individual who is an ancestor of every individual currently alive?" Beginning in the early 1990s, for example, there has been much interest in dating ``mitochondrial Eve"- the most recent female whose mitochondrial DNA is the ancestor of the mitochondrial DNA of all present day humans (mitochondrial DNA is inherited maternally, so its inheritance is effectively asexual).

If we follow the population through time, then the amount of time that has passed since the most recent common ancestor (MRCA) lived will change as time progresses. The resulting stochastic process has been studied independently by Simon & Derrida and Wakolbinger & Pfaffelhuber when the population has constant size and evolves via the standard Wright-Fisher dynamics. Peter Ralph and I have looked at the same question when the population varies in size and evolves according to a branching process conditioned on non-extinction. In this case, the age of the MRCA is an easily understood Markov process that can be constructed in a manner that is closely related to the Poisson cut-out random fractals introduced by Mandelbrot and later analyzed by Shepp and Fitzsimmons, Fristedt & Shepp.

A more detailed analysis of the genealogy of conditioned branching processes leads to the appearance of some interesting coalescence-fragmentation processes that have GEM distributions as their stationary distributions.