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A random walk proof of the matrix tree theorem

The matrix tree theorem, also called Kirchhoff's theorem after the 19th century German physicist Gustav Kirchhoff, relates the number of spanning trees in a graph to the determinant of a matrix derived from the graph. Although there are a number of proofs of Kirchhoff's theorem known, most are combinatorial in nature. In this talk we will present a relatively elementary random walk-based proof of Kirchhoff's theorem which follows from Greg Lawler's proof of David Wilson's 1996 algorithm for generating spanning trees uniformly at random. Since Wilson's algorithm is interesting in its own right and easily understood, we will spend some time discussing his technique for generating uniform spanning trees. As a curious side note, most other algorithms for generating spanning trees do not yield the matrix tree theorem as a consequence; Wilson's algorithm does! Moreover, these same ideas can be applied to other computations related to general Markov chains and processes on a finite state space. Based on joint work with Larissa Richards (Toronto) and Dan Stroock (MIT).