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Random walks on random planar triangulations via the circle packing theorem

Koebe's circle packing theorem ('36) asserts that any planar map can be drawn as a circle packing, that is, the vertex set is drawn in the plane as a set of circles with disjoint interiors such that pairs of circles corresponding to edges of the graph are tangent.

This canonical way of drawing planar maps can be used to study the behavior of the simple random walk on the map. For instance, a beautiful theorem of He and Schramm ('95) states that when the map is a simply connected infinite triangulation with bounded degrees, the random walk is recurrent (i.e, it returns to the starting vertex with probability 1) if and only if the circle packing of the map has no accumulation points. We will explain how all this relates to electric networks and complex analysis.

Most of this classical theory collapses without the assumption of bounded vertex degrees and hence cannot be applied to random planar maps. We will discuss some recent results (obtained jointly with Angel, Hutchcroft and Ray and with Gurel-Gurevich) showing how to "average out" the defects caused by vertices of high degree and to recover most of the classical theorems.

Auteur principal: NACHMIAS, Asaf (Department of Mathematical Sciences, Tel Aviv University)

Orateur: NACHMIAS, Asaf