Traces left by random walk in the neighbourhood of a vertex

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Abstract

We analyse the visits of a random walk to the neighbourhood of a fixed root vertex. One typically sees the following behaviour in large graphs. When a random walk visits a fixed root vertex it may have further visits on a time scale of order one. Once it leaves the root "significantly" the return time will be of the order of the number of vertices of the graph. In that case we will call the return to the root vertex a new *macroscopic visit*. In the limit one can distinguish between macroscopic and microscopic visits and we will provide convergence results for a point process that keeps track of the indicidual macroscopic visits including information on each visit on the natural time scale. A standard tool for the analysis of random graphs is local convergence in the sense of Benjamini and Schramm. We show how this concept has to be adapted in order to derive results in our context. Roughly speaking, our results may be applied whenever the mixing time of the random walk is smaller than the number of steps that we can run an exploration algorithm without finding differences to a limitting graph model, with high probability. We mention that our results may be applied for general sparse random graph models. As an example we consider the random graph with fixed degree sequence. Moreover, we discuss related work, in particular, on vacant set percolation.