XCI Encuentro anual de la Sociedad de Matemática de Chile

18 al 21 de Diciembre de 2023.

Departamento de Matemáticas, Facultad de Ciencias, Universidad de Chile.

Santiago, Chile.

# Label propagation on binomial random graphs

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**Abstract**

We study the behavior of a label propagation algorithm (LPA) on the Erdős-Rényi random graph $\mathcal{G}(n,p)$. Initially, given a network, each vertex starts with a random label in the interval $[0,1]$. Then, in each round of LPA, every vertex switches its label to the majority label in its neighborhood (including its own label). At the first round, ties are broken towards smaller labels, while at each of the next rounds, ties are broken uniformly at random. The algorithm terminates once all labels stay the same in two consecutive iterations. LPA is successfully used in practice for detecting communities in networks (corresponding to vertex sets with the same label after termination of the algorithm).

Perhaps surprisingly, LPA's performance on dense random graphs is hard to analyze, and so far convergence to consenus was known only when $np \geq n^{3/4+\epsilon}$ [**?**]. By a very careful multi-stage exposure of the edges, we break this barrier and show that, when $np \geq n^{5/8+\epsilon}$, a.a.s. the algorithm terminates with a single label. Moreover, we show that, if $np \gg n^{2/3}$, a.a.s. this label is the smallest one, whereas if $n^{5/8+\epsilon} \leq np \ll n^{2/3}$, the surviving label is a.a.s. not the smallest one.

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*Partially supported by grant GrHyDy ANR-20-CE40-0002 and BASAL funds for centers of excellence from ANID-Chile (FB210005), e-mail: `mkiwi@dim.uchile.cl`

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