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On superdiffusive processes on graphs using a regularized fractional Laplacian

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The fractional graph Laplacian, defined as a fractional power of the standard graph Laplacian, is one of the most popular tools for modeling non-local diffusion on graphs. However, it is known to induce dynamics that, in some cases, are incompatible with the topology of the original network. To address this limitation, a regularized fractional Laplacian obtained through a combination of the standard and fractional Laplacians, was recently introduced with the aim of restoring compatibility while preserving the spectral richness of the fractional operator.

In this talk, we explore the spectral and diffusion properties of the regularized fractional Laplacian. Contrary to the fractional Laplacian and other non-local Laplacian variants, we show that it consistently produces superdiffusive behavior, regardless of whether the underlying graph is weighted or unweighted. We also present an efficient Boolean–Hadamard–based construction of the regularized operator that improves its computational practicality in real-life scenarios.

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