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Eulerian Magnitude Homology in Erdős-Rényi Random Graphs: Substructures and Torsion

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Abstract
Magnitude was first introduced by Leinster in 2008 [1]. It is a notion analogous to the Euler characteristic of a category, and it captures the structure and complexity of a metric space. Magnitude homology was defined in 2014 by Hepworth and Willerton [2] as a categorification of magnitude in the context of simple undirected graphs, and although the construction of the boundary map suggests that magnitude homology groups are strongly influenced by the graph substructures, it is not straightforward to detect such subgraphs. In this talk, I introduce eulerian magnitude homology [3]. I will do this by defining the eulerian magnitude chain complex, a subcomplex of the magnitude chain complex exhibiting a more explicit connection to the combinatorics of the graph. I will illustrate how eulerian magnitude homology enables a more accurate analysis of graph substructures and then apply these results to Erdős-Rényi random graphs and obtain an asymptotic estimate for the Betti numbers of the eulerian magnitude homology groups on the diagonal. Finally, I will discuss the regimes where an Erdős-Rényi random graph has torsion-free eulerian magnitude homology groups [4].

References

[1] T. Leinster,The Euler characteristic of a category, Documenta Mathematica (13) (2008) 21–49.
[2] R. Hepworth, S. Willerton, Categorifying the magnitude of a graph. Homotopy, Homology and Applications 16(2) (2014) 1–30.
[3] C. Giusti, G. Menara, Eulerian magnitude homology: subgraph structure and random graphs. arXiv: 2403.09248 (2024).
[4] G. Menara, On torsion in eulerian magnitude homology of Erdos-Renyi random graphs. arXiv: 2409.03472 (2024).

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