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Harmonic classes and data analysis

Younng-Jin Kim, Woong Kook
Department of Mathematical Sciences, Seoul National University

Discrete harmonic classes for a finite complex are the kernel of its combinatorial Laplacians, and they are isomorphic to the homology groups over a field by combinatorial Hodge decomposition. In our work, we will analyze geometric contents of these classes closely and explore their potential as a new method for data analysis. The main idea is that harmonic classes are supported typically by a larger collection of oriented cells than homology classes, and are helpful for local and global visualization. As a demonstration of this property, we unveil an intriguing combinatorial relation in discrete harmonic classes. To be specific, there are interpretations about coefficients of discrete harmonic classes in dimension 1 with the language of graph theory and combinatorics. Also, We will suggest application methods; a network embedding method, called harmonic mirroring, and an analysis on winding number, called harmonic winding analysis.