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Imhomogeous graph signal estimation via a cardinality penalty

A challenge in signal estimation of piecewise smooth signals over a graph is to handle the inhomogeneous levels of smoothness of the signal over the clusters (i.e., communities) of the graph.

We propose a group ℓ_{2-0}-norm-like penalized Graph Trend Filtering (GTF) framework to tackle such inhomogeneity in the graph signal estimation. We prove that solving such penalized GTF is equivalent to jointly performing a k-means clustering on the graph signal (solely based on the signal on nodes, ignoring the graph) and finding a minimum graph cut (solely based on the graph structure, ignoring the signal on nodes), in which the clustering and the cut share the same assignment matrix, indicating that the solution of such GTF graph signal estimation problem is finding a trade-off between k-means clustering on the graph signal and a minimum cut on the graph.

We develop methods (a spectral method and a probabilistic method) to solve such proposed GTF model and present numerical results to support the effectiveness of the methods.