GLOBAL OPTIMIZATION OF GRAPH FILTERS WITH MULTIPLE SHIFT MATRICES

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MOTIVATION

- Graphs can capture complex relational characteristics.
- Graph signal processing has advantage in dealing with datasets with irregular and complex structures.
- Adopting multiple shift matrices provides more flexibility in graph filter design.

POTENTIAL APPLICATIONS

- A classifier for data labeling.
- An error detector for network analysis.

PROBLEM STATEMENT

- A partially labeled dataset with graph encoded inner interaction.
- Graph vertices: data points.
- Graph edges: similarities among the vertices.
- The feature qualities of vertices are uneven.
- Graph shift matrices are generated from the dataset.
- Graph parameters are decided through branch and bound optimization method.
- A graph filter is designed as the classifier.

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GRAPH FILTERING PROCEDURE

- **Graph Filtering:**
  \[ S^{\text{cla}} = Q(S^{\text{ini}}) = HS \]

- **Conventional Graph Filter Design Method:**
  \[ A_{ij} = \exp \left( -\frac{\| x_i - x_j \|^2}{\sigma} \right) \]
  \[ H = h_0 + h_1 A + h_2 A^2 + \cdots + h_L A^L \]

- **Proposed Graph Filter Design Method:**
  \[ A(d)_{ij} = \exp \left( -\frac{(x_i - x_j)^2}{2\sigma} \right) \]
  \[ H = \sum_{d=0}^{D} w_d A(d)^j \]
  subject to \( h \in \Theta_h, w \in \Theta_w \)

- **Convex Relaxation**
  \[ L = \arg \min \| \sum_{d=1}^{D} y_{d,j}(RA(d)S) - S \|_F \]
  \[ y_{d,j} \geq \max \{ w_{d,0} h_0 + h_1 w_{d,1} h_0 + h_2 w_{d,2} h_0 + \cdots + h_L w_{d,L} h_0 \} \]
  \[ y_{d,j} \leq \min \{ w_{d,0} h_0 + h_1 w_{d,1} h_0 + h_2 w_{d,2} h_0 + \cdots + h_L w_{d,L} h_0 \} \]

BRANCH AND BOUND

REFERENCES