Semi-Supervised Classification Based on Graph Filtering

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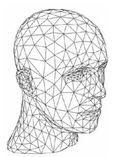
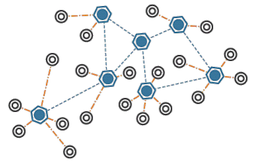
MOTIVATION

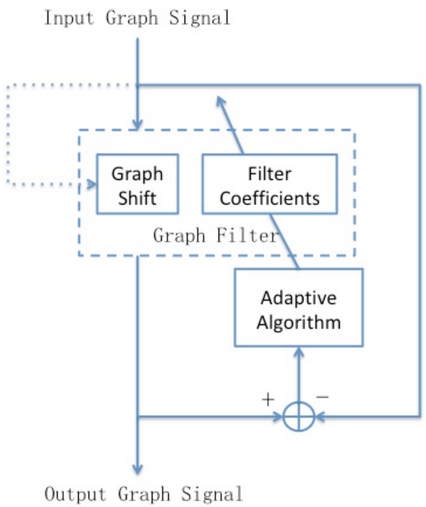
- Graphs can capture complex relational characteristics.
- Signal processing on graphs extends the classical discrete signal processing theory to signals indexed by vertices of a graph.

POTENTIAL APPLICATIONS

- A classifier for data labeling.
- An error detector for network analysis.
- A simple representation for images in computer vision.
- A pre-process of neural networks for reducing computation and mitigating overfitting risk.

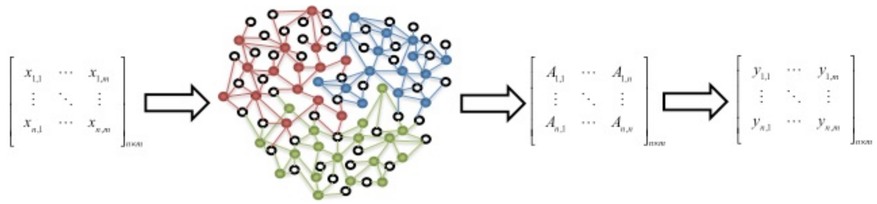




GRAPH FILTER DIAGRAM



PROBLEM STATEMENT

- A partially labeled dataset with graph encoded inner interaction.
  Graph vertices: data points.
  Graph edges: relationships among the vertices.
- A graph shift matrix is generated from the dataset.
- The features of vertices is not completely collected.
- Eigenvalues and eigenvectors need to be updated.



GRAPH FILTERING PROCEDURE

- Graph Filtering:

$$Y = H \cdot X = \left(Q \Lambda Q^{-1}\right) \cdot X$$

- Conventional Graph Filter Design Method:

$$A_{i,j} = \frac{\exp\left(-\left\|X_i - X_j\right\|_2 / \sigma\right)}{\sum_i \exp\left(-\left\|X_i - X_j\right\|_2 / \sigma\right)}$$

$$H = Q\left(h_0 + h_1\Lambda + h_2\Lambda^2 + \cdots + h_L\Lambda^L\right)Q^{-1}$$

- Proposed Graph Filter Design Method:

$$R_k = f\left(X, H_k\right) \qquad H_{k+1} = H_k \circ R_k$$

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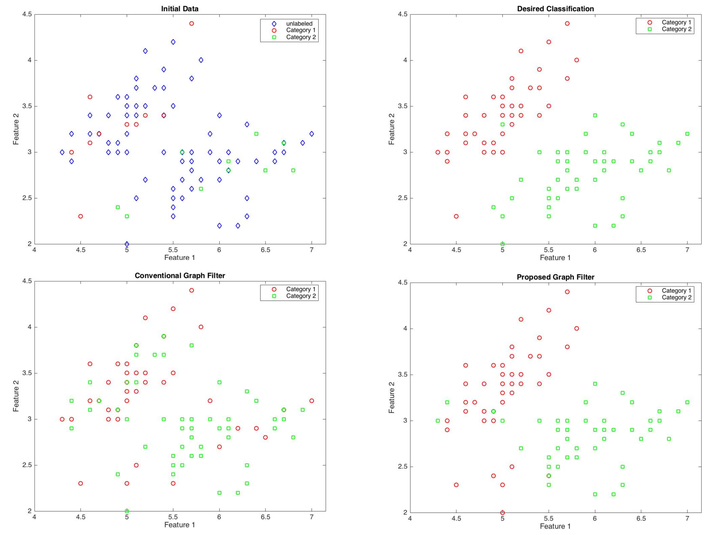
MONTE CARLO SIMULATION RESULTS



CONCLUSION

- A well designed graph filter works as a semi-supervised classifier.
- The proposed filter designing method provides lower error rate than the conventional one when feature data is incomplete.
- Our method is especially suitable for practical application that the initial information is insufficient or quite correct due to privacy policies and measuring difficulties.

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