

Homework Assignment 1

Due Date: 6pm on Tuesday Feb 28th

1. Reading summary (6 points)

Please summarize the reading material **in your own words**. This exercise will help you comprehend the main objectives in the reading besides the technical details. Your summary should consist of three parts:

1. One-sentence summary
2. One-paragraph summary
3. Half-page summary

2. Questions (4 points)

Please select **one** question to answer in each of the following four question sets. (A total of four questions.)

Section 1-2

- What are the main assumptions of the Laplacian Eigenmaps method? How does it differ from other dimension reduction methods (such as PCA and MDS)?
- What is the significance of the eigenvectors and eigenvalues of the Laplacian matrix in Laplacian Eigenmaps?

Section 3-4

- In Section 3.1, what are the purpose of the constraints $\mathbf{y}^T \mathbf{D} \mathbf{I} = 0$ and $\mathbf{y}^T \mathbf{D} \mathbf{y} = 1$ and why?
- What are the common properties of the graph Laplacian and the Laplace Beltrami operator on a manifold?
- What are the connections between laplacian eigenmaps and spectral clustering?

Section 6

- In the "swiss roll" example, how do the number of nearest neighbors N and kernel parameter σ affect the quality of low-dimensional representations generated by laplacian eigenmaps?
- In the linguistic example, which phenomenon further demonstrates the connections between laplacian eigenmaps and spectral clustering?

Open questions

- Recall Chapter 3 in last week's reading, what general priors or characteristics of representation learning were employed in Laplacian Eigenmaps?
- What are some advantages and limitations of Laplacian Eigenmaps?