CAP 6617 ADVANCED MACHINE LEARNING

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LOCALLY LINEAR EMBEDDING

Key Ideas

- Other methods of dimensionality reduction fail to be successful on non-linear space.
- LLE takes advantage of the local geometry and pieces it together to preserve the global geometry on a lower dimensional space.

Assumptions

- The manifold is continuous.
- LLE fails on noisy data.

Procedure

- Compute K-nearest neighbors. K is the only parameter chosen and it should not be too big or too small.
- Compute a set of weights that can be used to construct a point. Each point is constructed from its neighbor. Weights cannot be 0. Rows of the weight matrix must equal to 1. This cost function is minimized.

$$e(W) = \sum_i |X_i - \sum_j W_{ij}X_j|^2$$

- Compute an embedding vector of Y with the weights that were previously defined in step 2. This cost function is minimized.

$$\phi(Y) = \sum_i |Y_i - \sum_j W_{ij}Y_j|^2$$

If we know the distance from the point to its nearest neighbors AND we also know the pairwise distances between those neighbors then we can apply LLE. In fact, the weights can be computed directly from the local distance matrix using a calculation similar to the one involving the local covariance matrix. The trick is simply to convert the local distance matrix into the local covariance matrix and then apply the algorithm as usual.