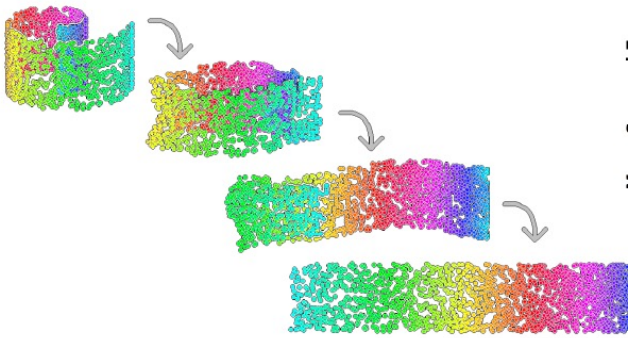


Manifold Sculpting

Presented By: Vishal Nigam
SM3800014

Problem Statement

PRECISION LOSS IN EXISTING DIMENSIONALITY REDUCTION ALGORITHMS

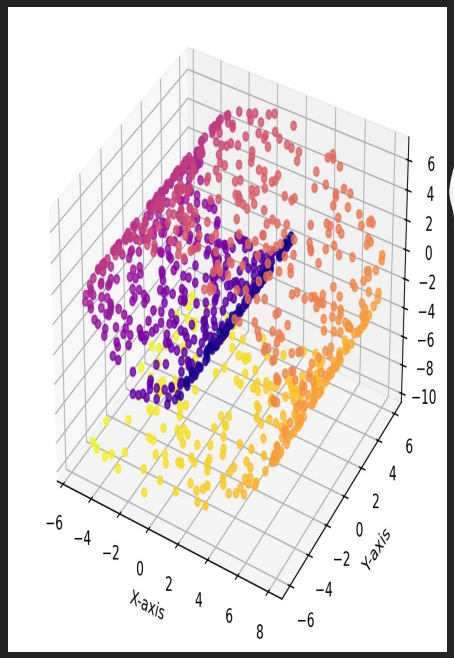
BALANCING TRANSFORMATION & PROJECTION

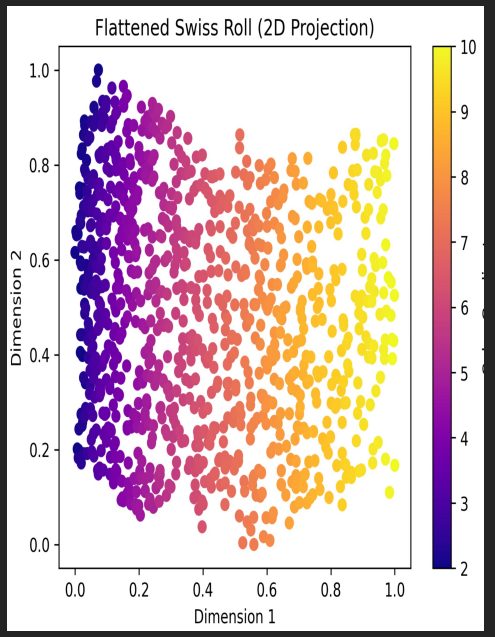
COMPLEXITY OF NON-LINEAR TRANSFORMATIONS

NEED FOR MORE ACCURATE MANIFOLD LEARNING APPROACHES

So what’s NEXT?

ITERATIVE NLDR

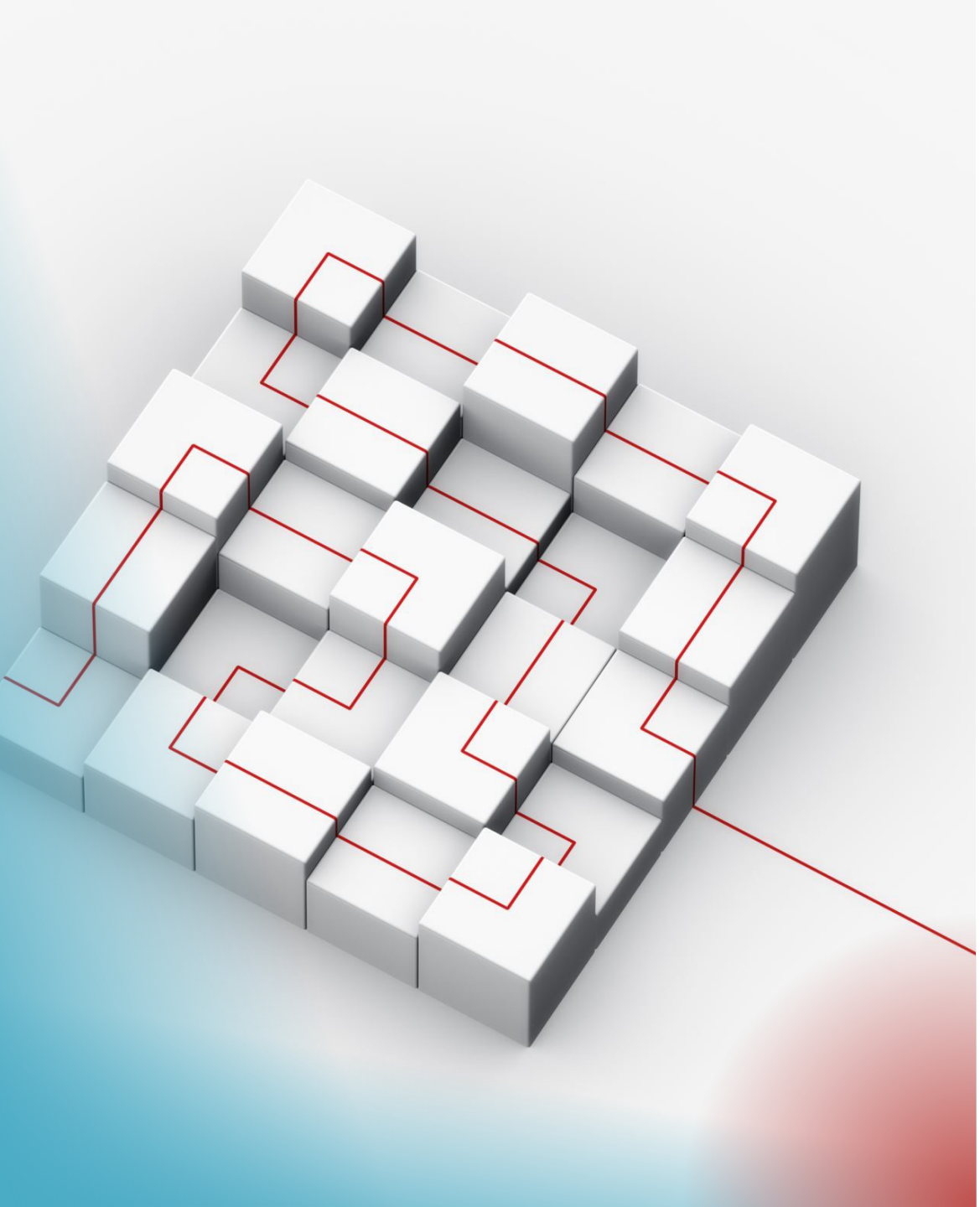




Another NLDR but different!!

- **Introducing Manifold Sculpting for Enhanced Accuracy**

- A **new iterative algorithm, Manifold Sculpting**, is proposed, which simulates **surface tension in local neighbourhoods**, achieving **higher accuracy** than traditional methods and **enhancing other NLDR techniques** as a post-processing step.



The Algorithm

- Construct a graph-like structure with neighbour relationships.
- Compute relationships between neighbours.
- Optionally pre-process data with PCA.
- Iteratively transform data until a stopping criterion is met.
- Project data by discarding irrelevant dimensions.

Algorithm Parameters

Key parameters influencing the algorithm:

- k_neighbours: Number of nearest neighbors per point
- scale: Scaling factor
- iterations: Number of iterations
- err: Error threshold for stopping
- patience: Maximum iterations to wait without improvement
- use_pca:for performing PCA or not

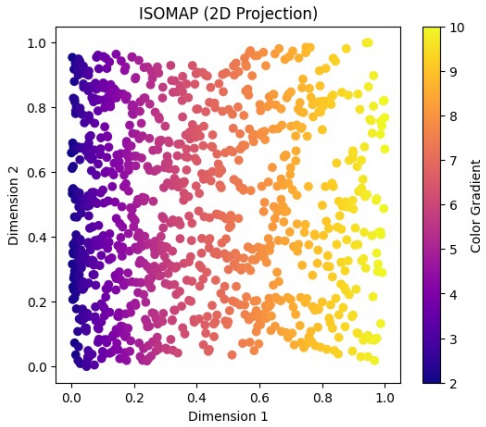
Comparison with Other Techniques

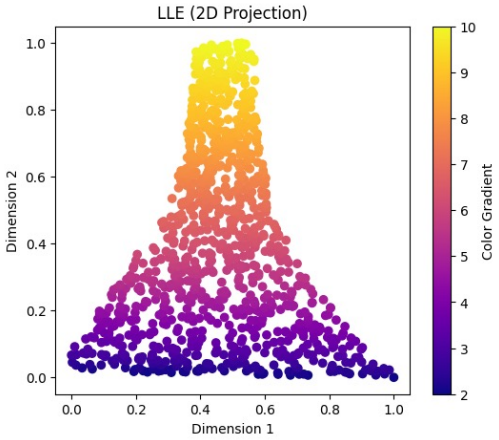
- The algorithm is compared against other dimensionality reduction techniques –(LLE,HLLE,ISOMAP) on qualitative and quantitative aspects.

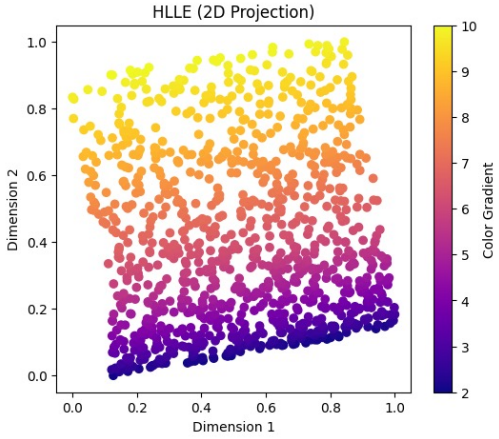
Datasets and parameters used:

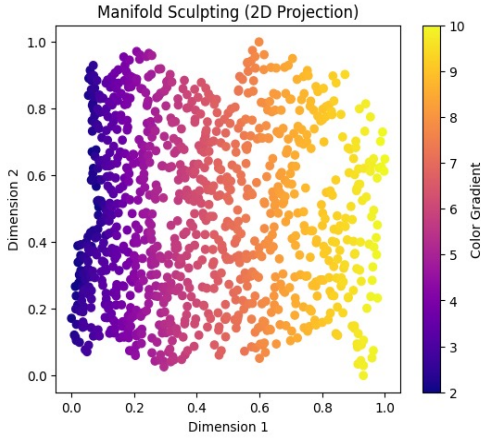
- Swiss Roll manifold (1000 samples, varying neighborhood sizes)
- S-curve manifold (neighborhood size = 25, varying sample data points)
- Entwined Spiral Manifold(2000 samples, neighbours=20)
- Results are centered, aligned with principal components, and min-max normalized for a fair comparison.

Qualitative Comparison

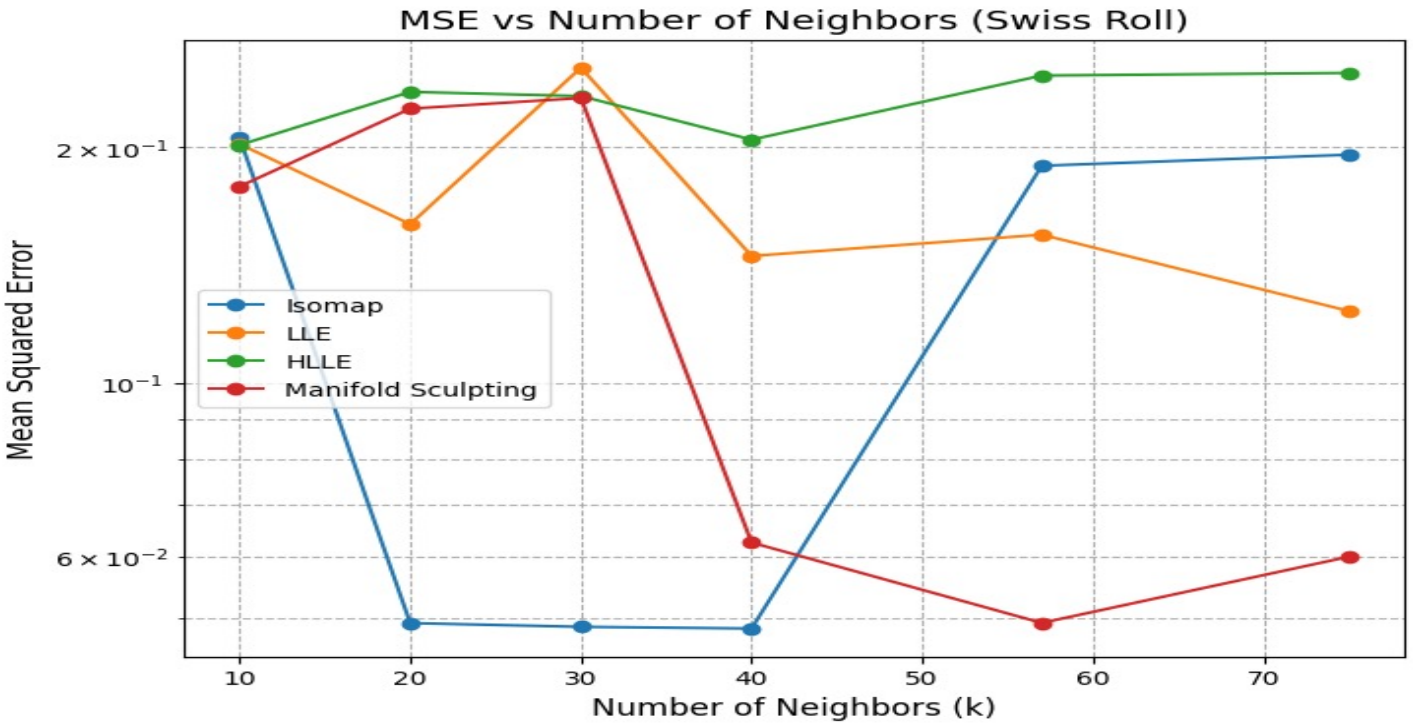




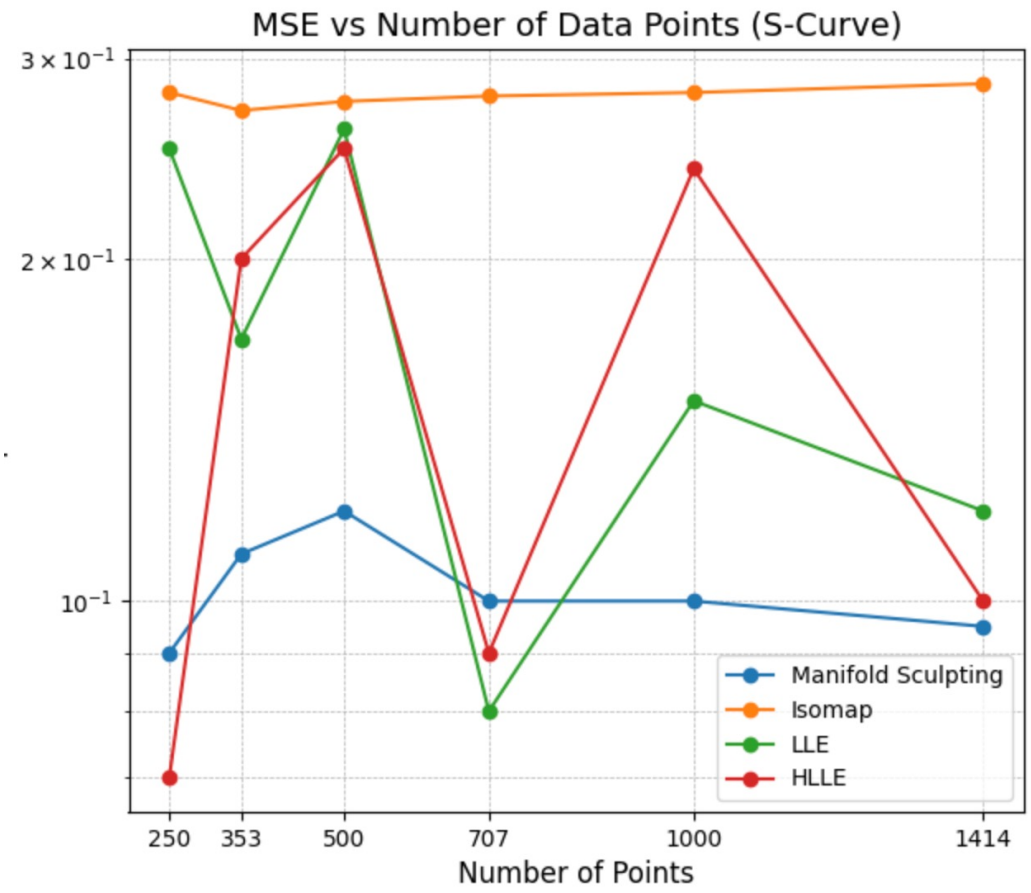




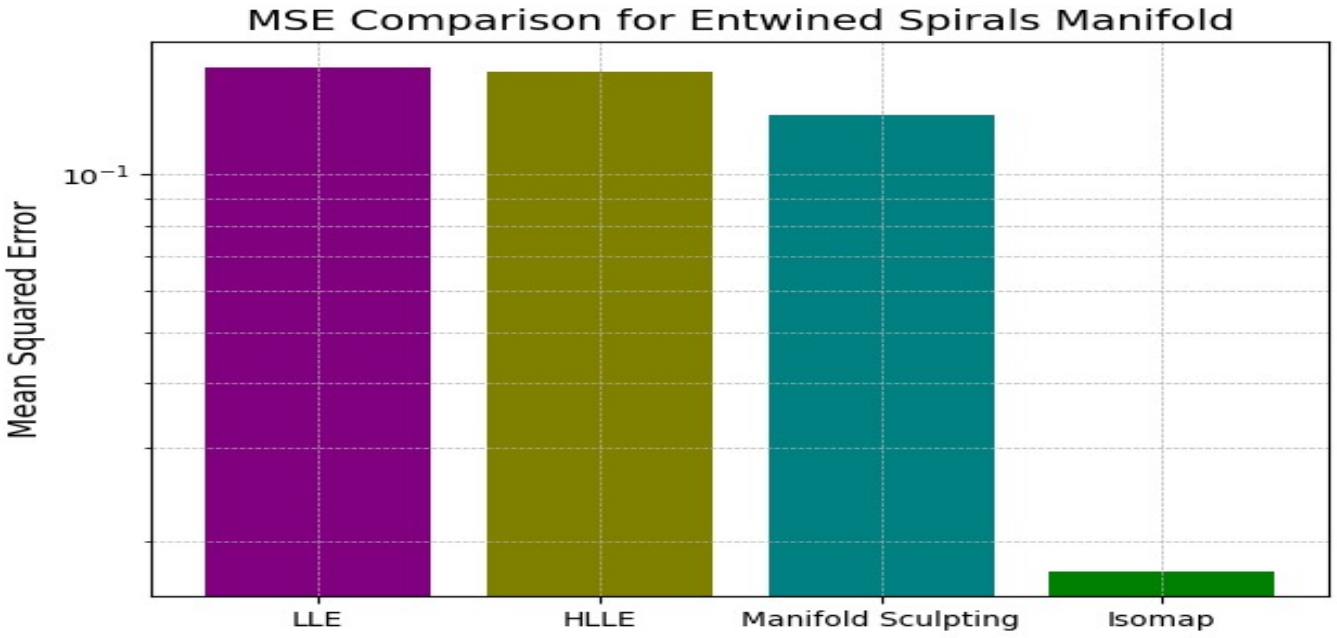
Quantitative Comparison-I



Quantitative Comparison-II



Quantitative Comparison-III



Conclusion

Strengths:

- Higher Accuracy & Robustness
- Effective for Sparse & Dense Data
- Scalability & Efficiency
- PCA & Preprocessing Benefit

Limitations:

- Highly sensitive to hyperparameters.
- Slower due to iterative unfolding process.

- Overall, the method provides a unique approach to NLDR with potential for improvements.

Thank You for Your Attention!