



SKIP ORTHOGONAL LIST FOR DYNAMIC OPTIMAL TRANSPORT

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PROBLEM

Optimal Transport is a multiple-source multiple-sink network flow problem. If the costs of the edges change, the optimal solution and its value might shift a little. Given the original optimal solution, how can we adjust it when there are minor changes, without starting over from scratch?

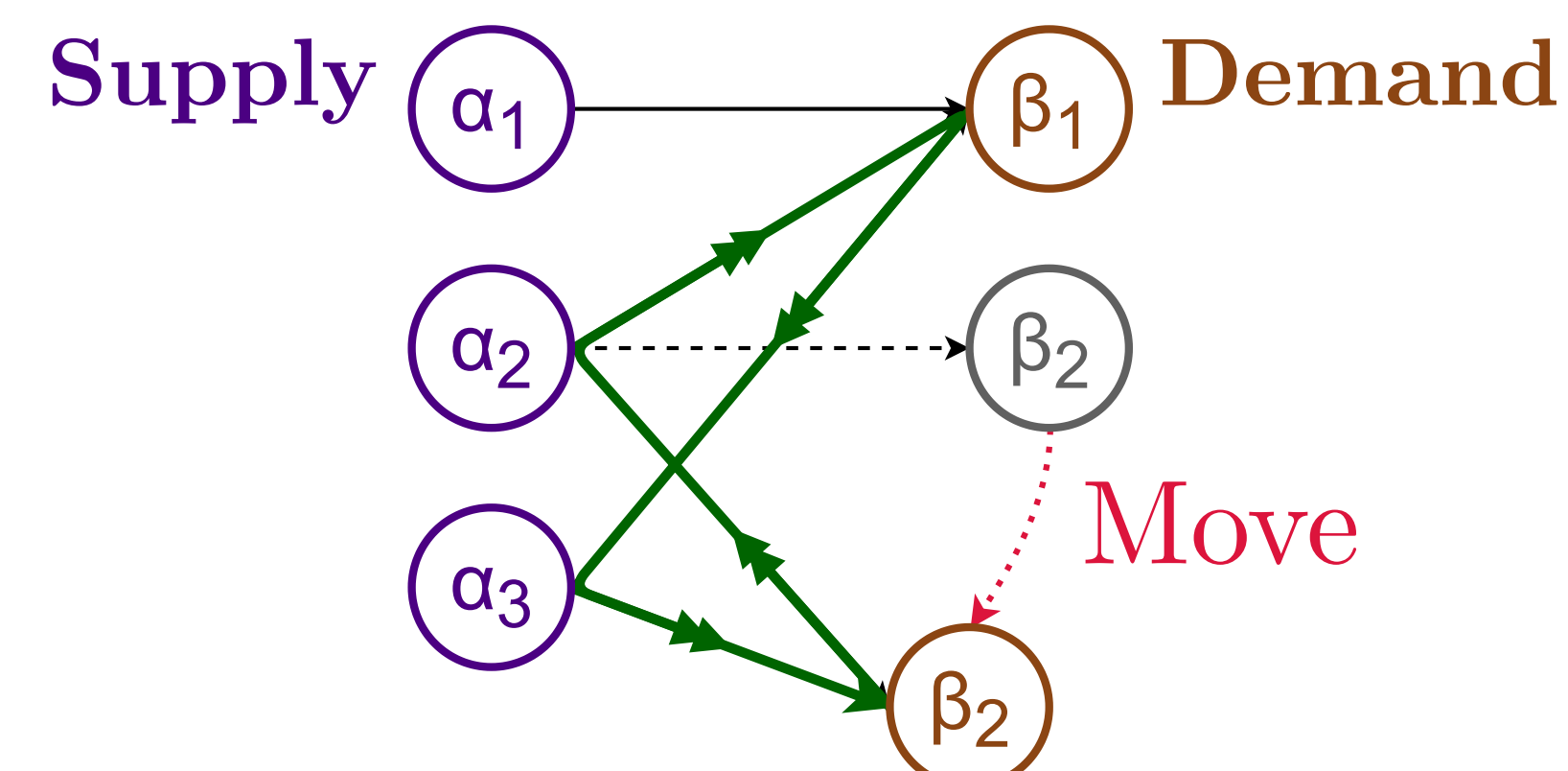


Figure 1: Spatial Position Modification

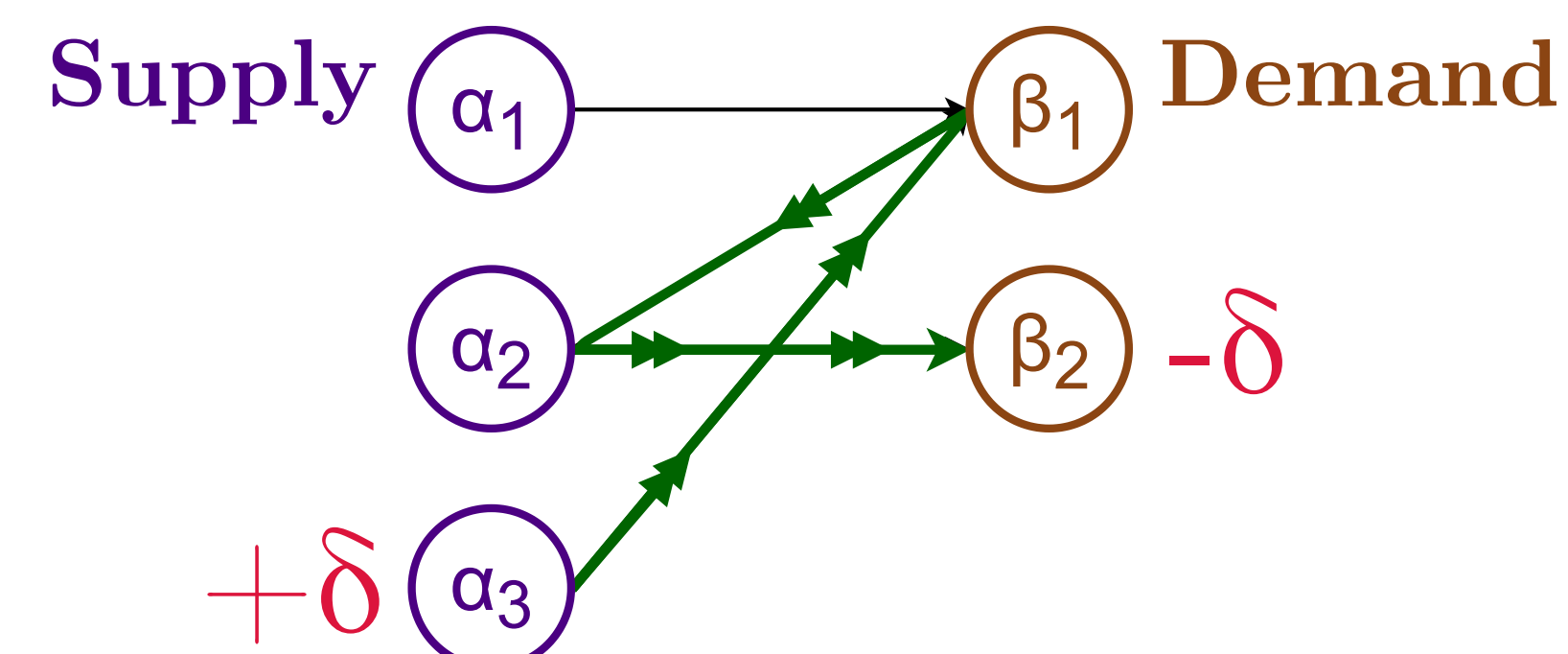


Figure 2: Weight Modification

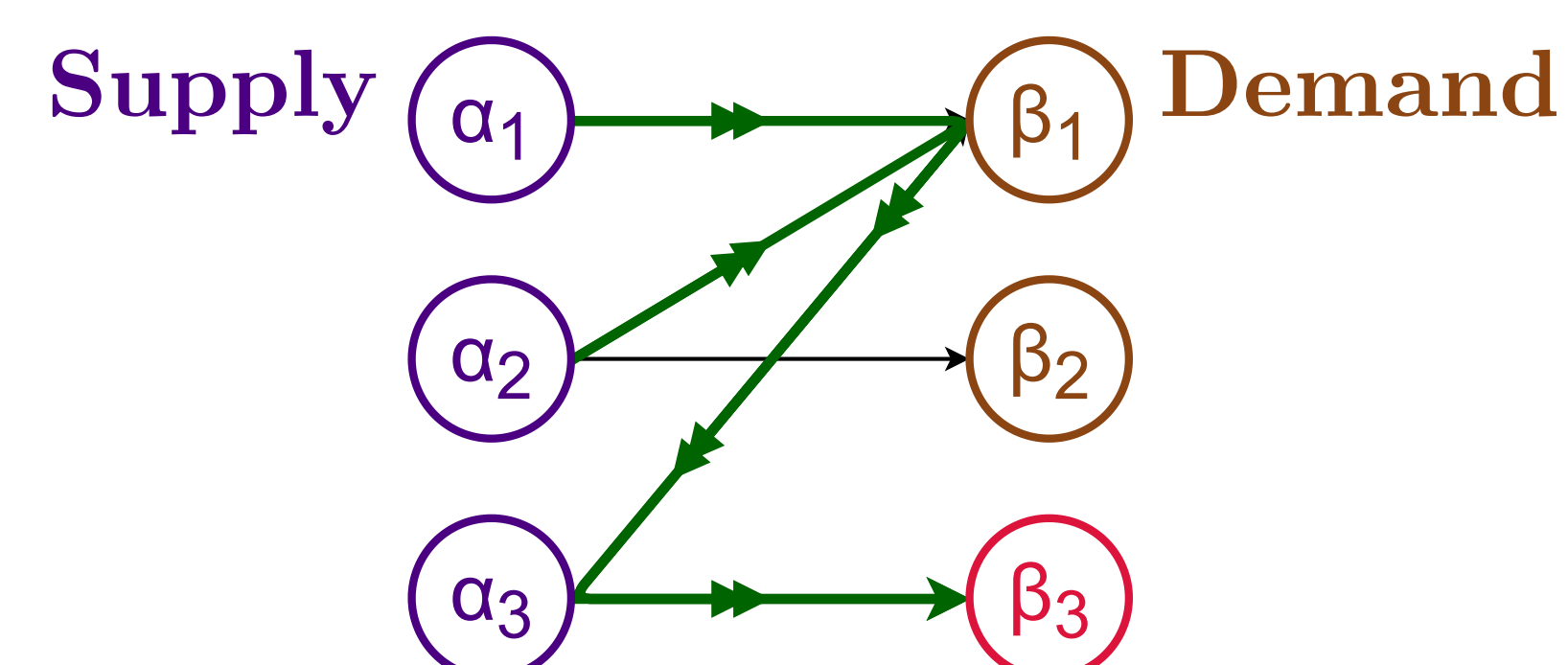


Figure 3: Point Insertion

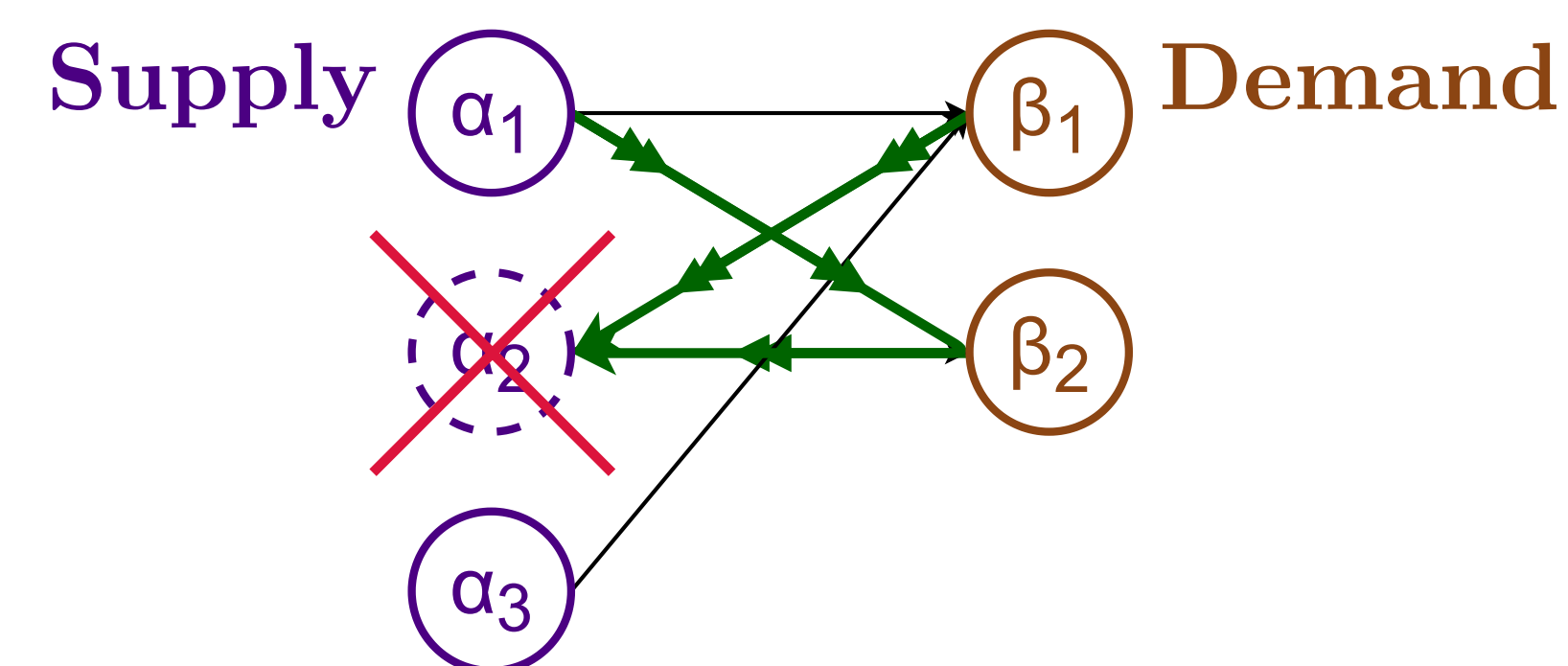


Figure 4: Point Deletion

MOTIVATIONS

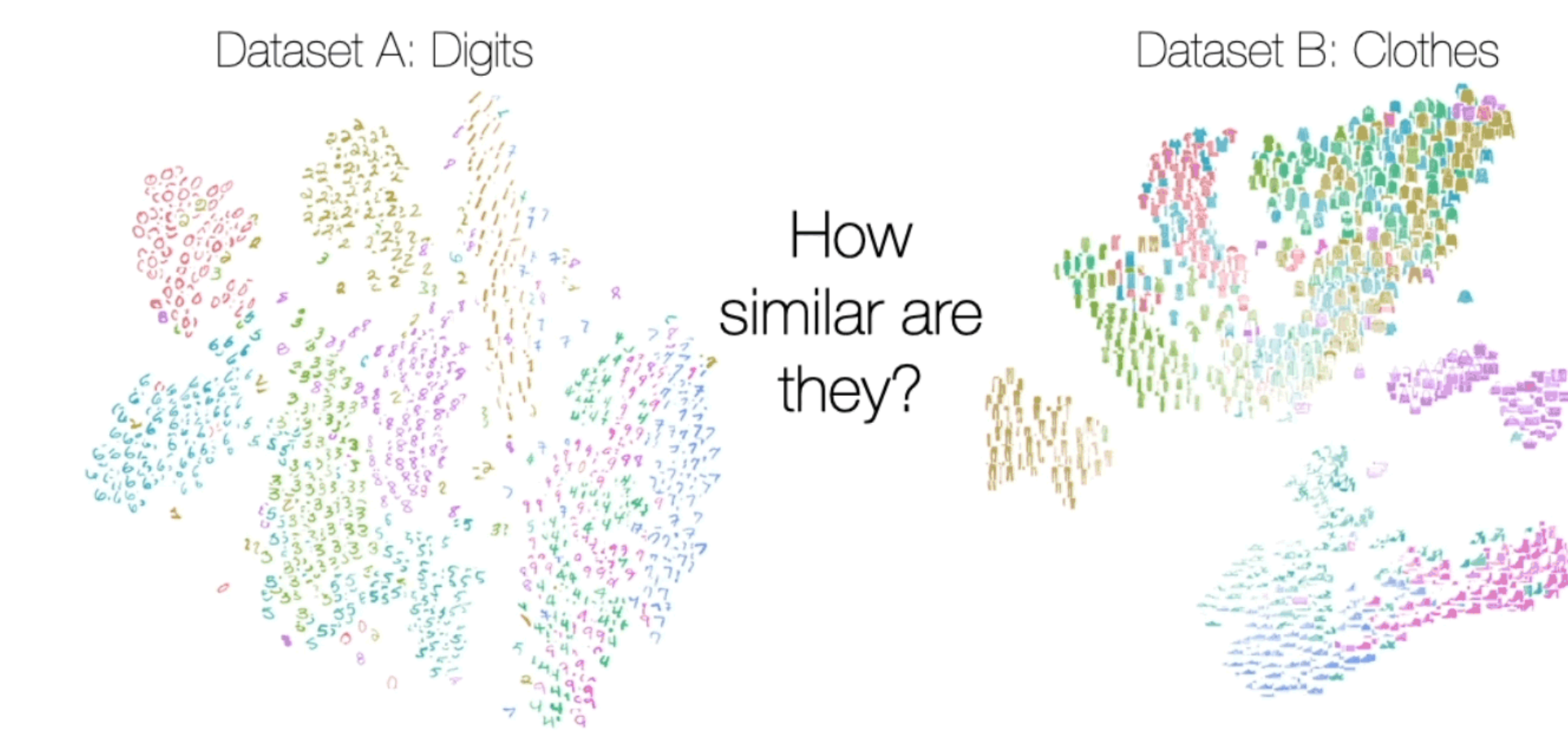


Figure 5: Dataset Similarity [1]

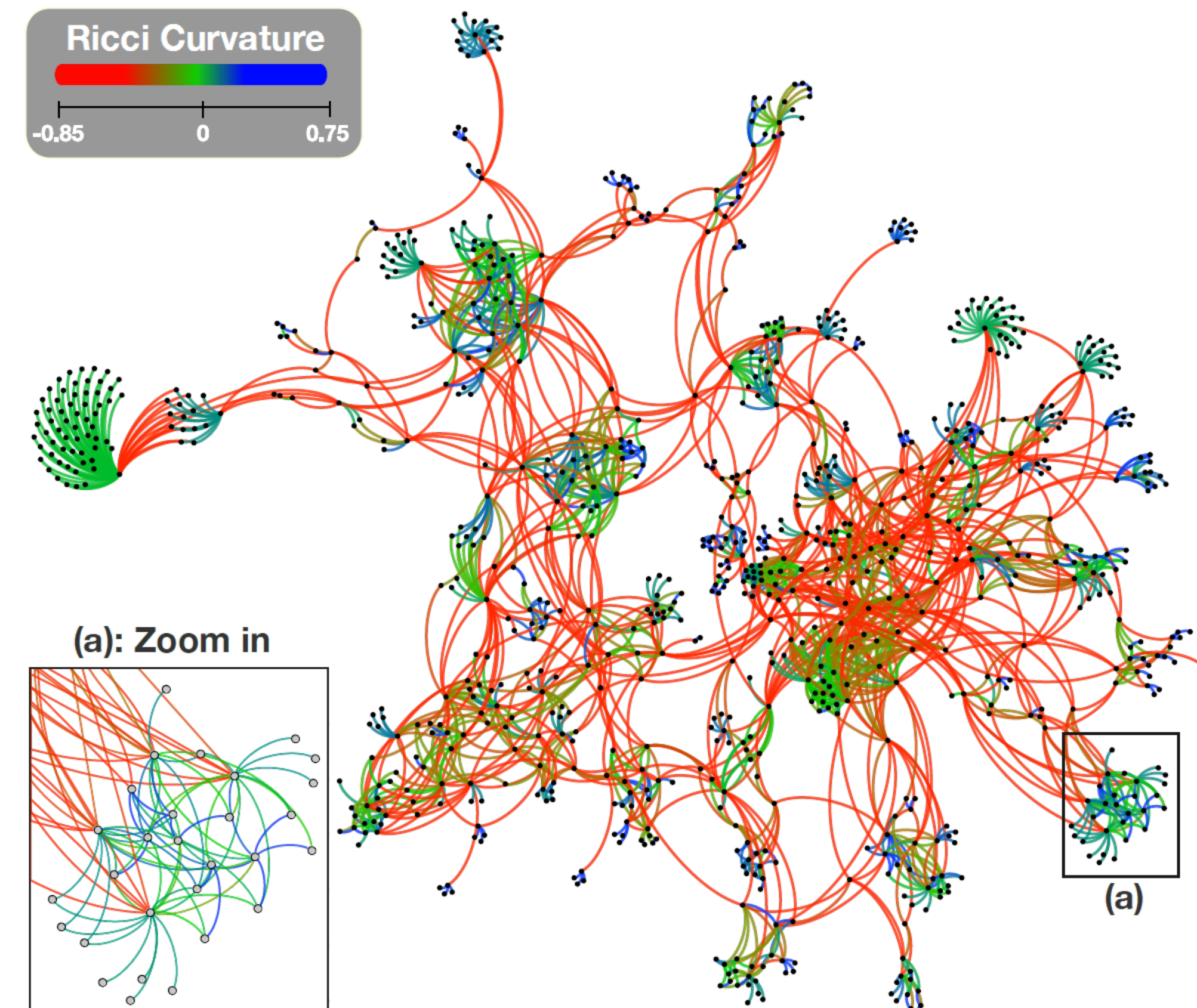


Figure 6: Ricci Curvature & Ricci Flow [2]

INTUITION & KEY IDEA

- Use Simplex iterations and its variants to update optimal solution.
- Under limited modification scale, the number of simplex iterations is not large.
- Break each simplex iteration into 4 subroutines on a 2D dynamic tree.
- Use **Skip Orthogonal List** to finish each operation in expected **linear** time to the number of nodes, breaking the quadratic barrier.

ALGORITHM PROCEDURE

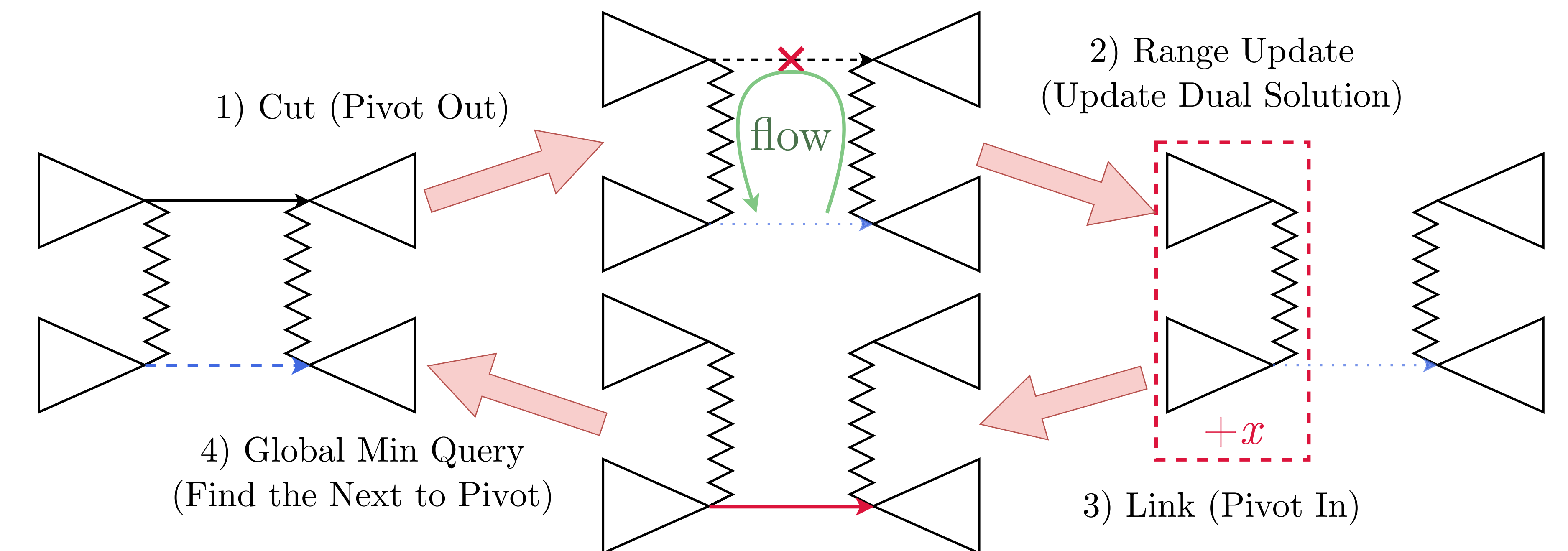


Figure 7: Simplex Iteration Overview

DATA STRUCTURE MANIPULATION

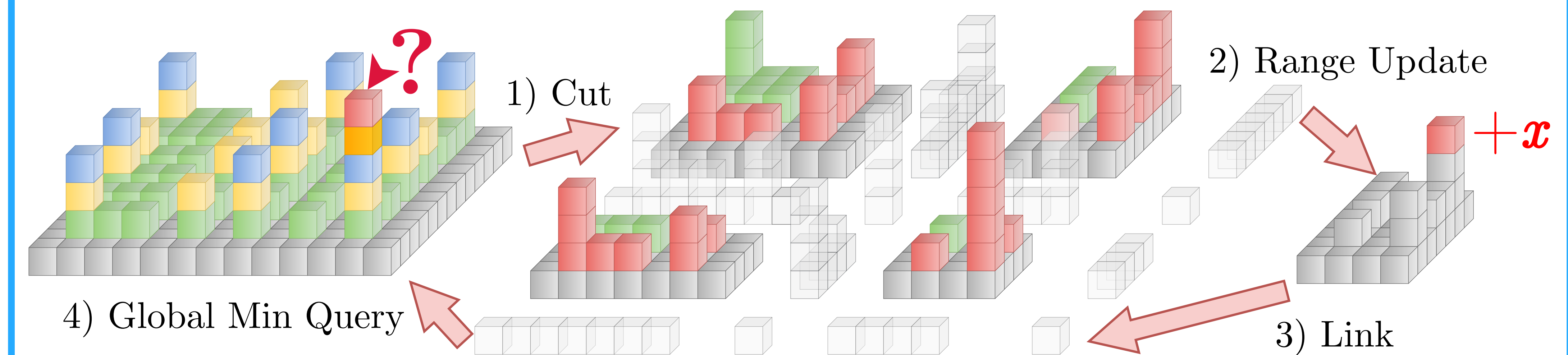


Figure 8: Data Structure Manipulation

EXPERIMENT

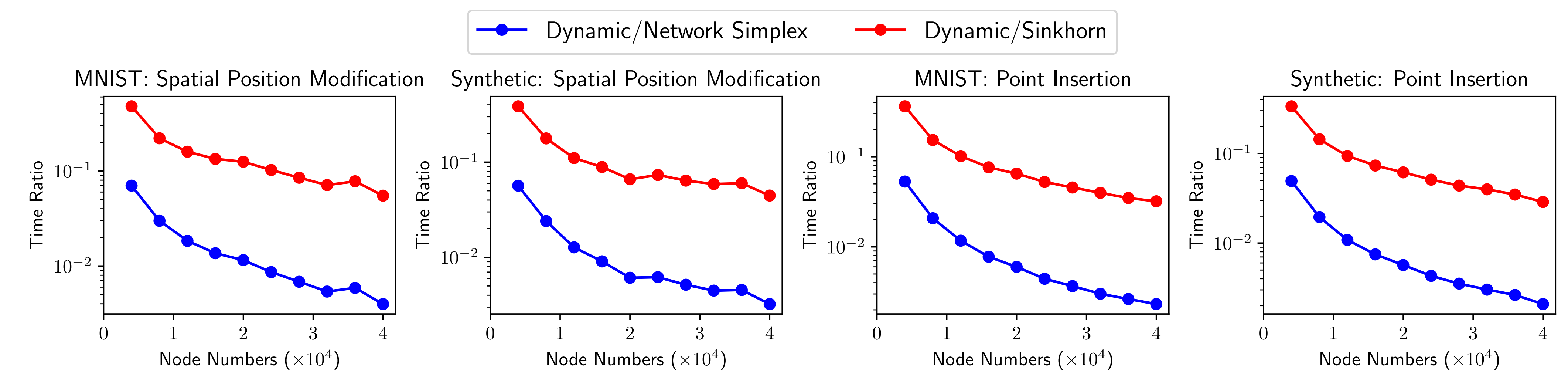


Figure 9: The ratio of the execution time of our dynamic algorithm to that of the static algorithms.

REFERENCES

- [1] David Alvarez-Melis and Nicolo Fusi. Geometric dataset distances via optimal transport. In *NeurIPS 2020*. ACM, February 2020.
- [2] Chien-Chun Ni, Yu-Yao Lin, Jie Gao, Xianfeng David Gu, and Emil Saucan. Ricci curvature of the internet topology. In *2015 IEEE Conference on Computer Communications (INFOCOM)*, pages 2758–2766, 2015.

FUTURE RESEARCH

- Reduce space consumption in practice.
- Improve cache hit rate.
- Explore approximation algorithms.
- Adapt to more dynamic scenarios.

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