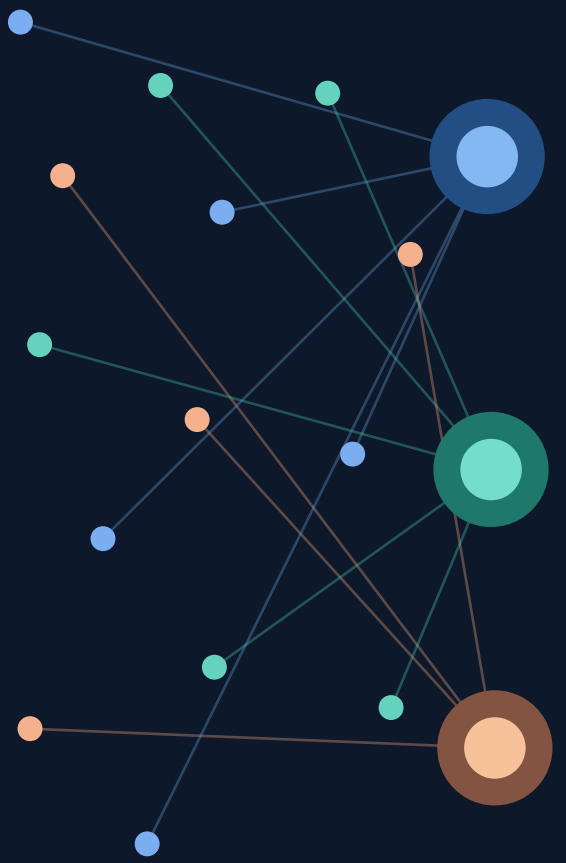
NEURIPS 2026 • 5-MIN TALK

Reliable Clustering and Quantization

via Distortion-Constrained Optimal Transport

Tianhao Wu · Wei Zhang · Haoran Pang · Hao Shi · Haoran Yang

Tianjin University · Tsinghua University · Kyoto University



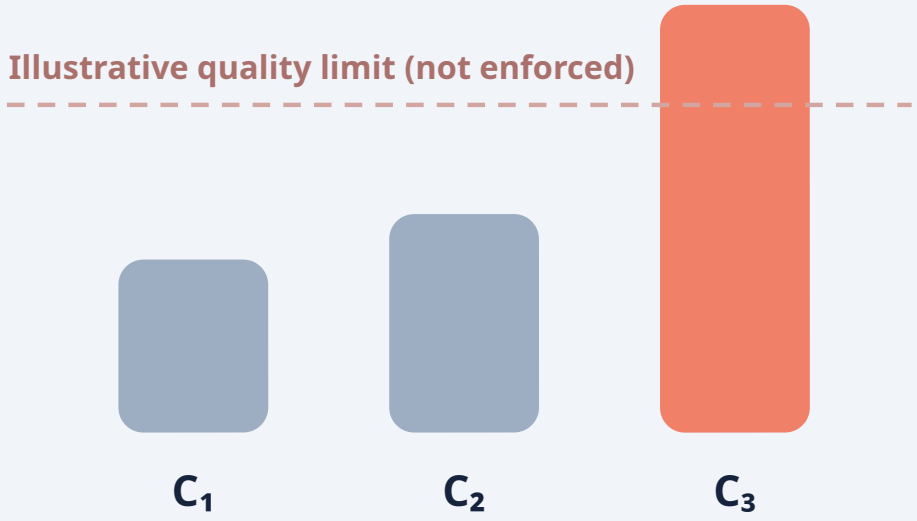
Per-cluster quality control

A good average can hide bad clusters

Global assignment objectives do not directly bound the distortion of each cluster.

Standard OT assignment

Good overall average ≠ uniform cluster quality



DCOT assignment

Explicit quality control for every cluster



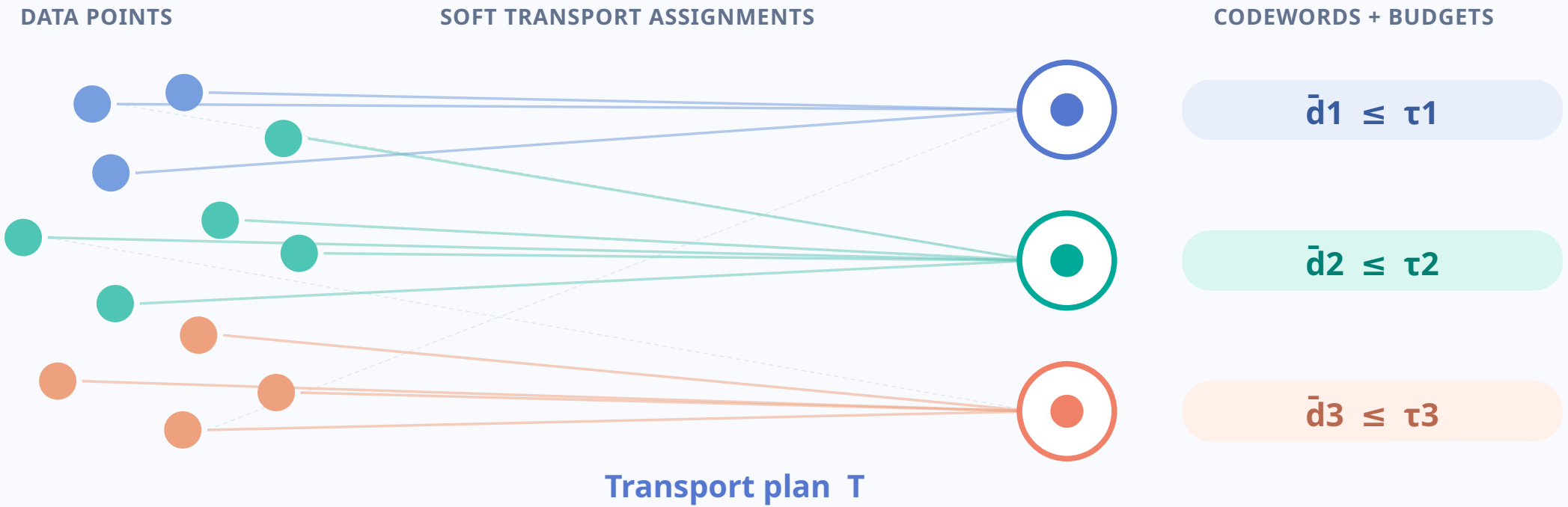
One weak cluster can be masked by a low average

Schematic illustration — not measured data

The DCOT idea: a budget for every cluster

Constrain the average assignment distortion, separately for each codeword.

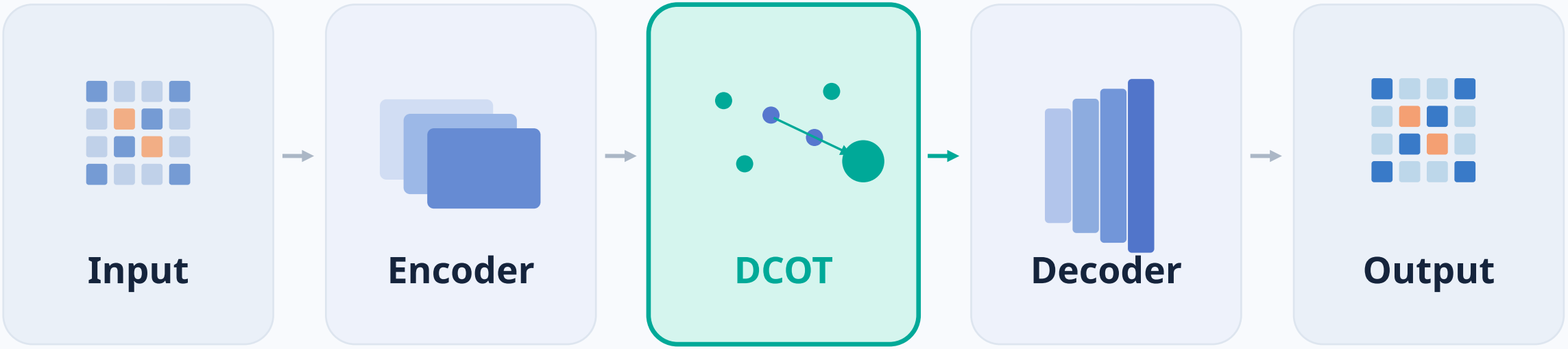
Average distortion of cluster j $\leq \tau_j$



A drop-in assignment module

DCOT can replace the assignment step without redesigning the VQ backbone.

Only the assignment changes



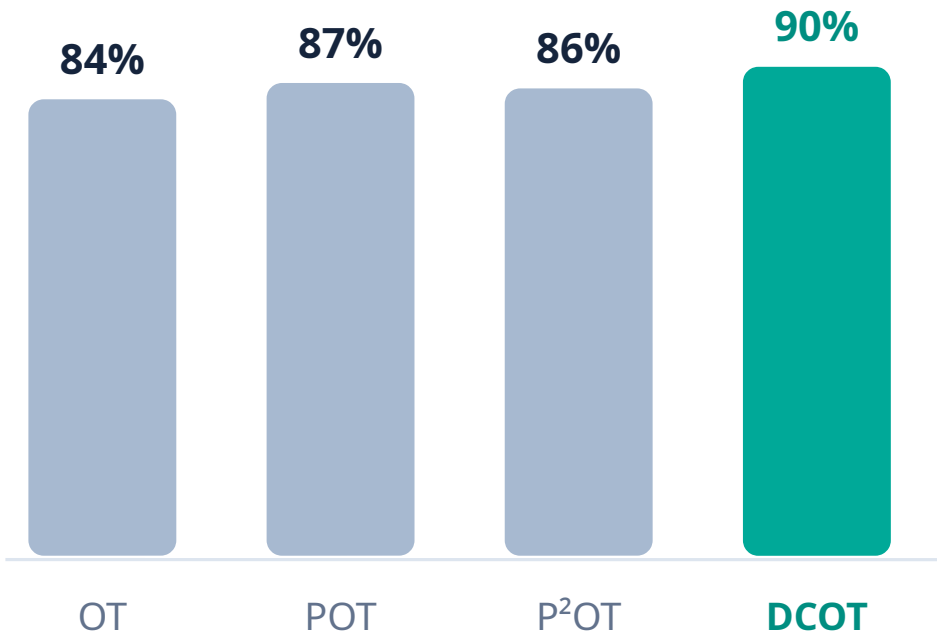
- **Same backbone**
- **Same training objective**
- **Compatible with VQ models**

Solver: alternate updates of assignments, codewords, and distortion dual variables

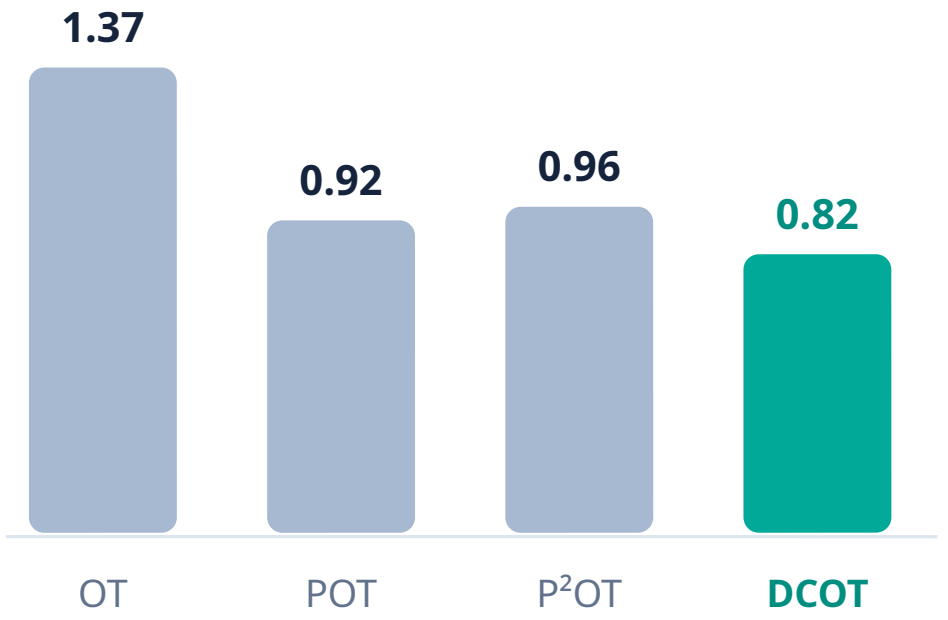
More reliable clustering

CIFAR-10 on frozen DINO ViT-B/16 features · 10% feature-space outliers

Clustering accuracy ↑



Maximum cluster distortion ↓



Higher accuracy

Lower worst-cluster distortion

Better reconstruction across VQ backbones

CIFAR-10 · PSNR gain over the original backbone (dB)



Improves all 8 / 8 VQ settings across MNIST and CIFAR-10

Global OT assignment alone improved only 3 / 8 settings.