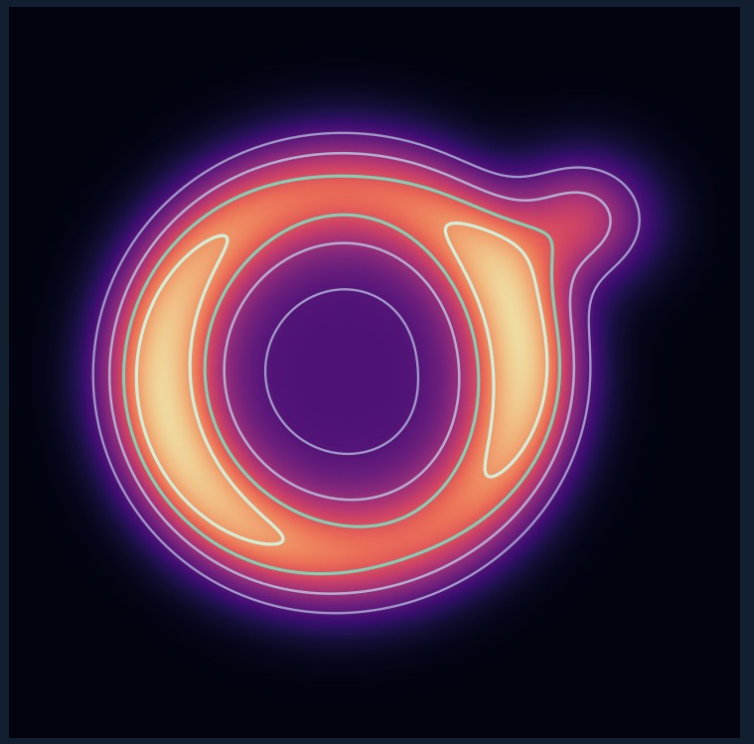
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Topology-Aware Optimal Transport for Source-Free Test-Time Adaptation in Anomaly Segmentation

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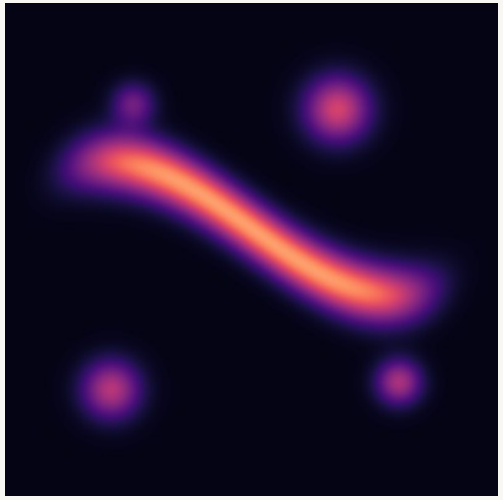


Score levels in an illustrative anomaly map

Why a fixed threshold can fail when scores shift

At deployment, we have a frozen backbone and unlabelled target images.

Before score shift



Score map



Mask at threshold 0.62

After adding 0.19 to the scores



Score map



Mask at threshold 0.62

The same threshold produces a wider mask and three extra regions.

Illustrative score maps on the same colour scale

Topology across score levels

A score sweep shows when components and holes appear or disappear.

Superlevel sets at three score cutoffs



Cutoff 0.86
Separate regions

Cutoff 0.61
A loop forms

Cutoff 0.31
The hole fills

H_0

Connected components

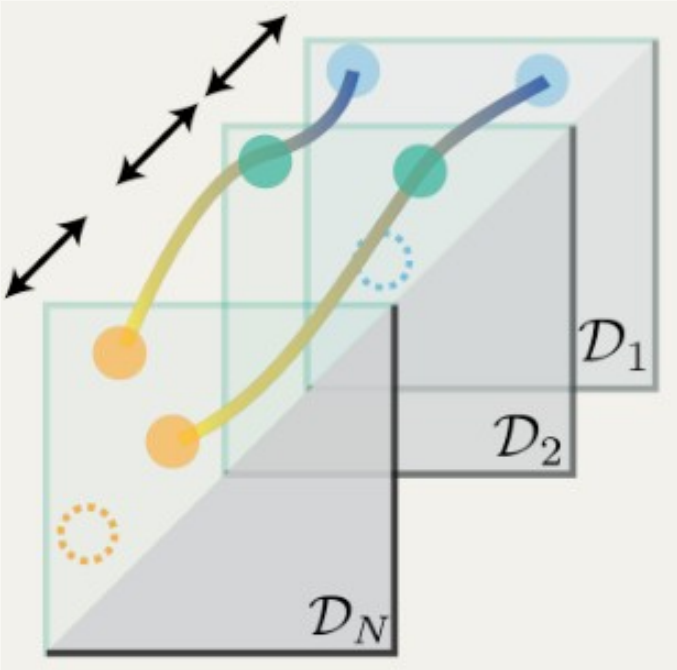
H_1

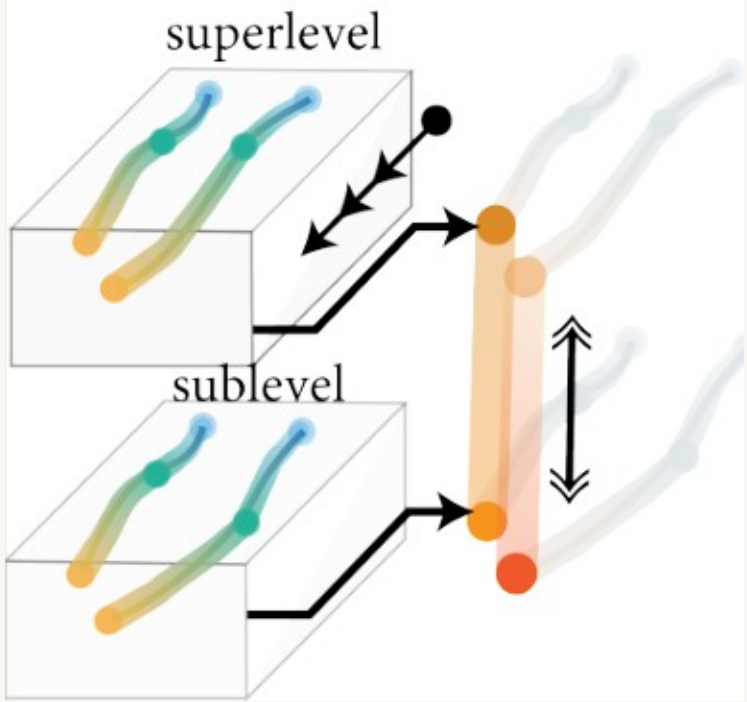
Loops or holes

Persistence records when each feature appears and dies.

Optimal transport chaining

Each point records a feature’s birth and death scores.





Within each score sweep

Match features across score levels.

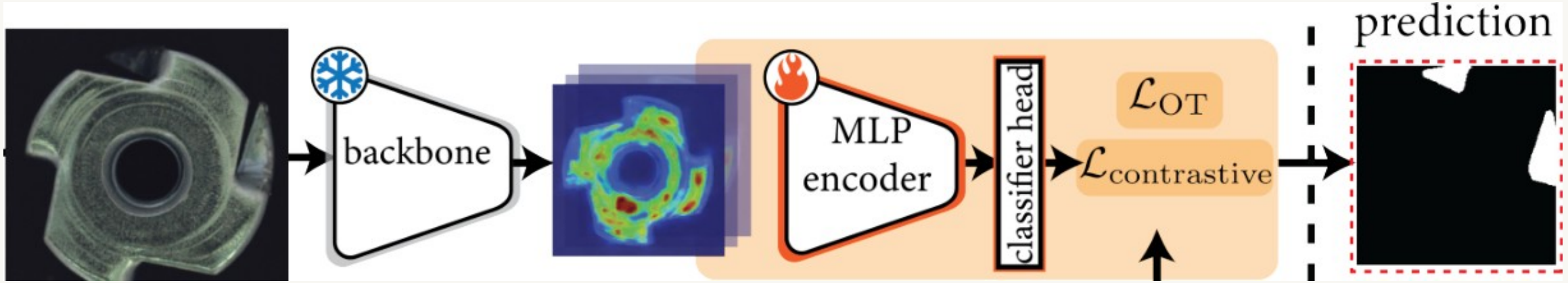
Between the two score sweeps

Align candidates from the two directions.

Stability rewards persistence and strong, low-cost matches.

Stable structures supervise a lightweight head

Only the head updates at test time.





OT-derived pseudo-label

Stable structures projected back to pixels

OT consistency

Fit the stable pseudo-label.

Contrastive separation

Separate anomalous and nominal embeddings.

Industrial inspection under input shift

MVTec AD metal nut under Gaussian noise

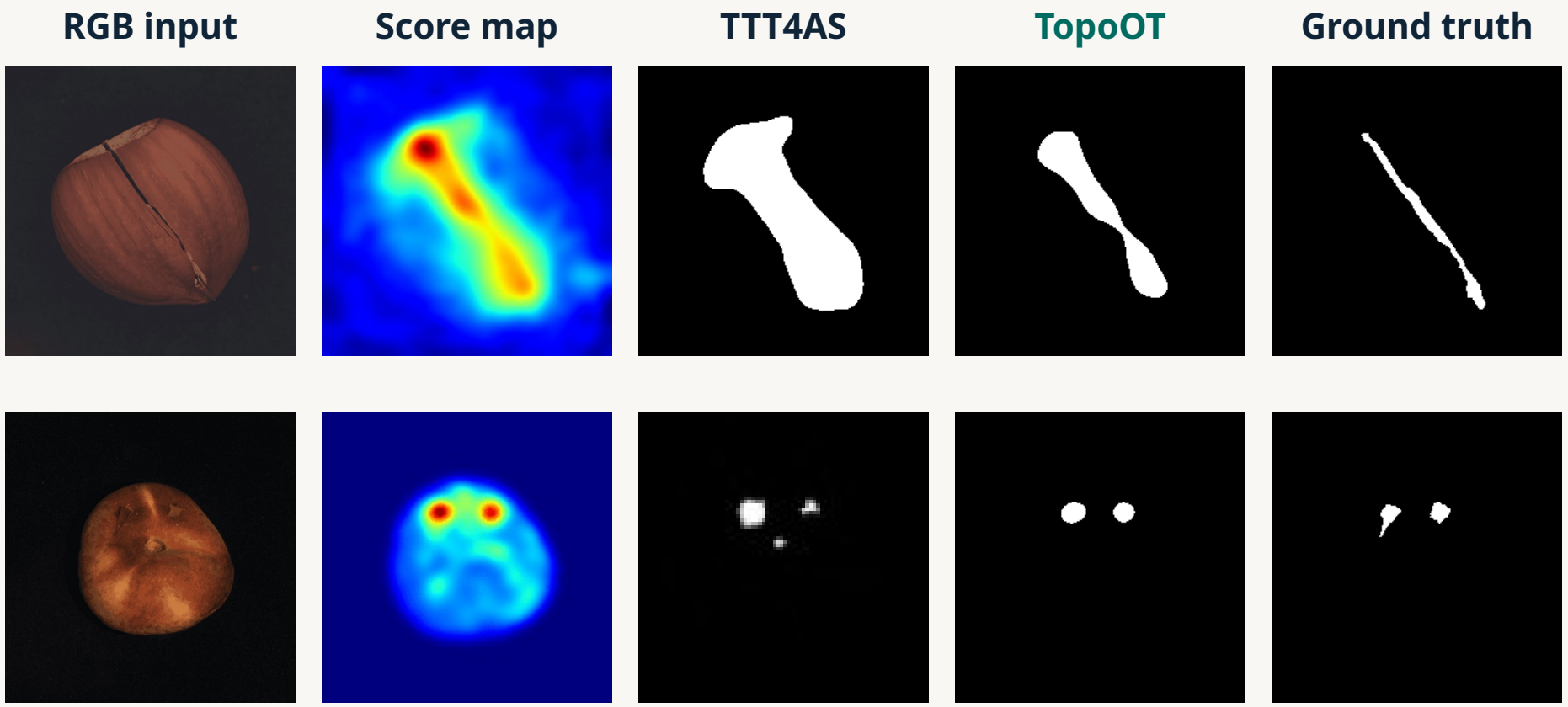


Original RGB | Perturbed score map | TTT4AS | **TopoOT** | Ground truth

26.7% with TTT4AS 60.1% with TopoOT

Mean mask F1 on MVTec AD with Gaussian noise and the PatchCore backbone

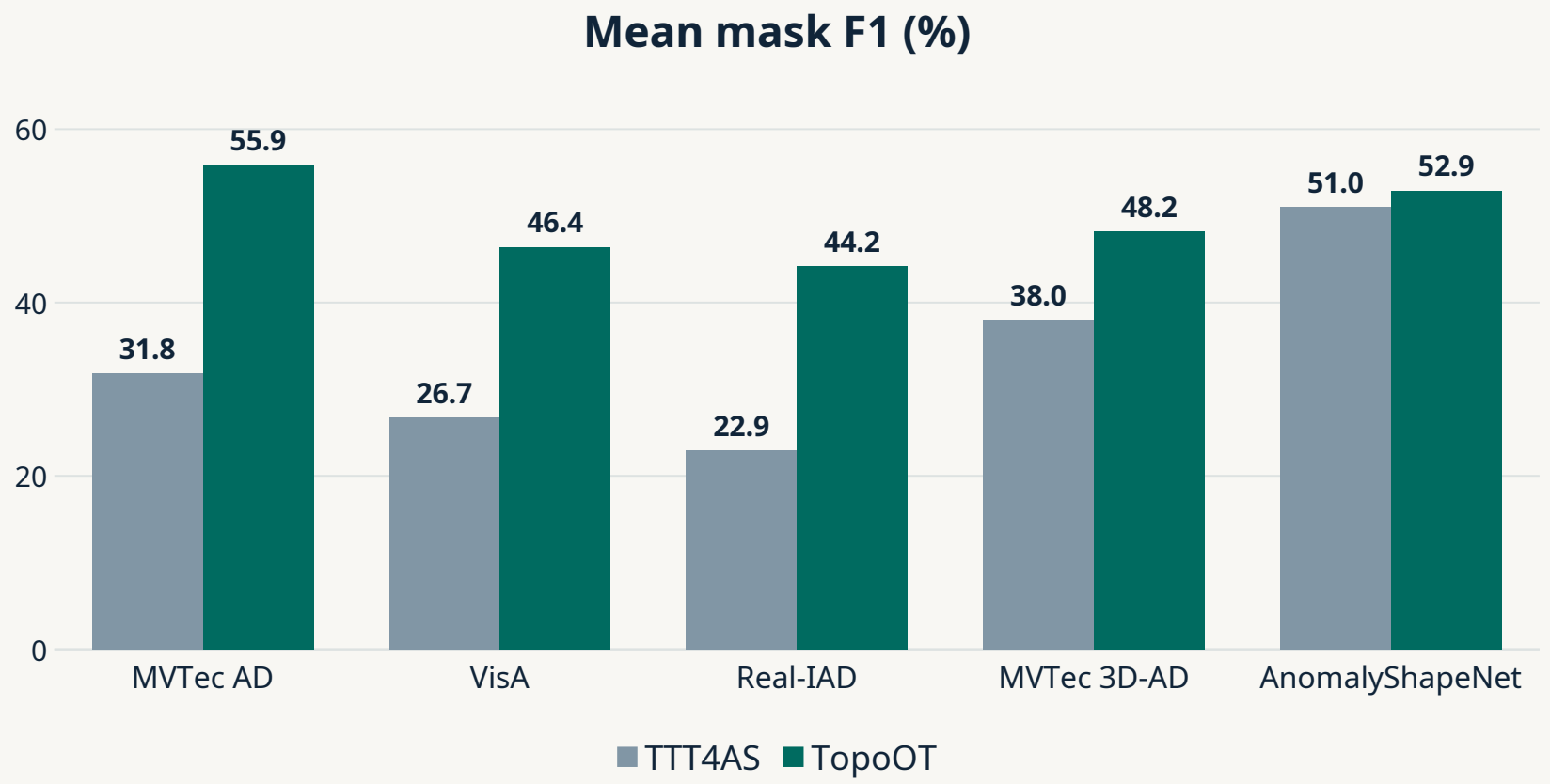
Defect masks in 2D and 3D



TopoOT narrows the crack mask and removes a spurious region on the peach.

Higher mask F1 across five benchmarks

One backbone shown per benchmark



+24.1 pp

MVTec AD with PaDiM

+10.2 pp

MVTec 3D-AD with CMM

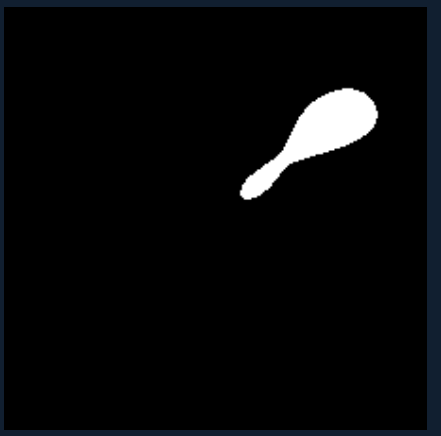
F1 gains over TTT4AS

Backbones shown in order are PaDiM, Dinomaly, Dinomaly, CMM and PO3AD.

Stable structure supervises adaptation



Leather defect



TopoOT mask

Runtime with PatchCore

568 ms per image end to end

331 ms for persistence diagrams, 8 ms for the head

topoot.github.io

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