

Computer Vision
2024/2025

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Efficient Anomaly Detection in Industrial Images using Transformers with Dynamic Tanh



The Challenge:



Developing an Efficient Anomaly Detection System

- Anomaly detection is required to guarantee high quality products
- Vision Transformers are computationally demanding
- Dynamic Tanh offers an easy way to increase efficiency

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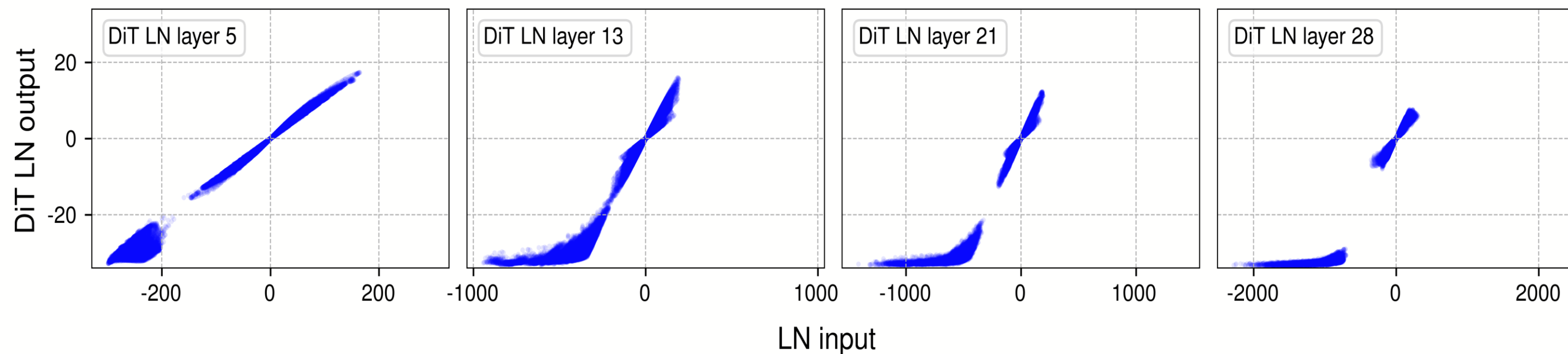
Tested Methods

1 – Better implementation of a model

- Use of VT-ADL¹
- Full re-implementation to have more hyperparameters available

2 - Use of Dynamic Tanh²

- This layer offers a faster alternative to layer normalization in transformers



[1] Mishra P., Verk R., Fornasier D., Piciarelli C., Foresti G. L. (2021, June). VT-ADL: A Vision Transformer Network for Image Anomaly Detection and Localization.

[2] Zhu J., Chen X., He K., LeCun Y., Liu Z. (2025). Transformers without Normalization.

The Model



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VT-ADL

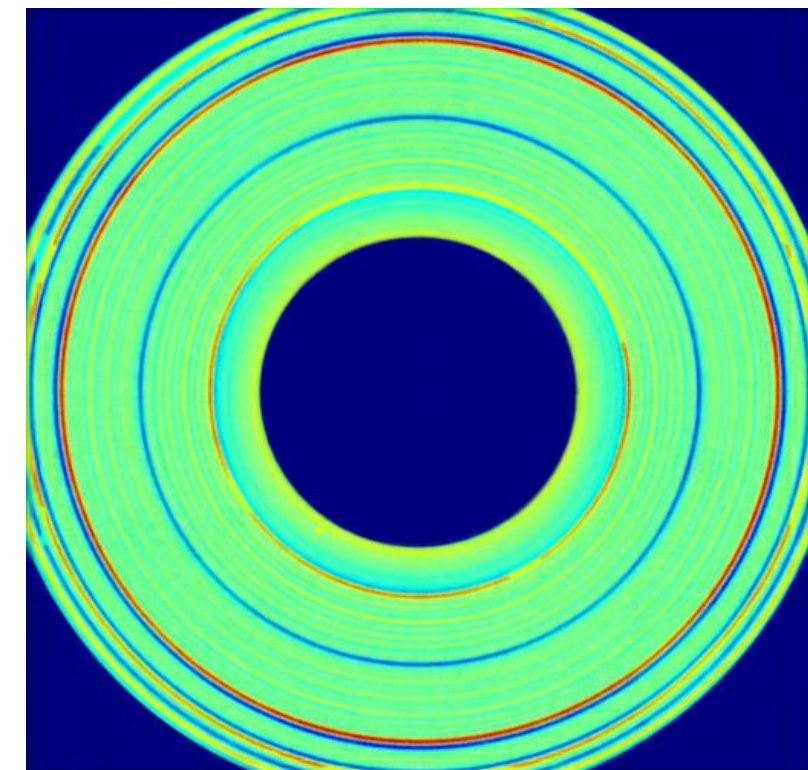
Structure:

- ViT encoder
- Add of noise
- Routing algorithm
- Decoder reconstruction
- Mixture Density Network
- Upscaling + smoothing

Loss:

Composed by:

- MDN loss
- SSIM loss
- Reconstruction loss (MAE)



VT-ADL re-implementation

Available efficiency-related hyperparameters:

Original Implementation:

- Routing iterations
- Number of gaussians
- Encoder depth
- Encoder feed forward dimension

Our Implementation:

- Image size
- Patch size
- Latent channels
- Encoder heads
- Encoder depth
- Encoder feed forward dimension
- Capsules per patch
- Capsule size
- Routing iterations
- Number of gaussians
- Use of dynamic tanh
- Matrix multiplication precision

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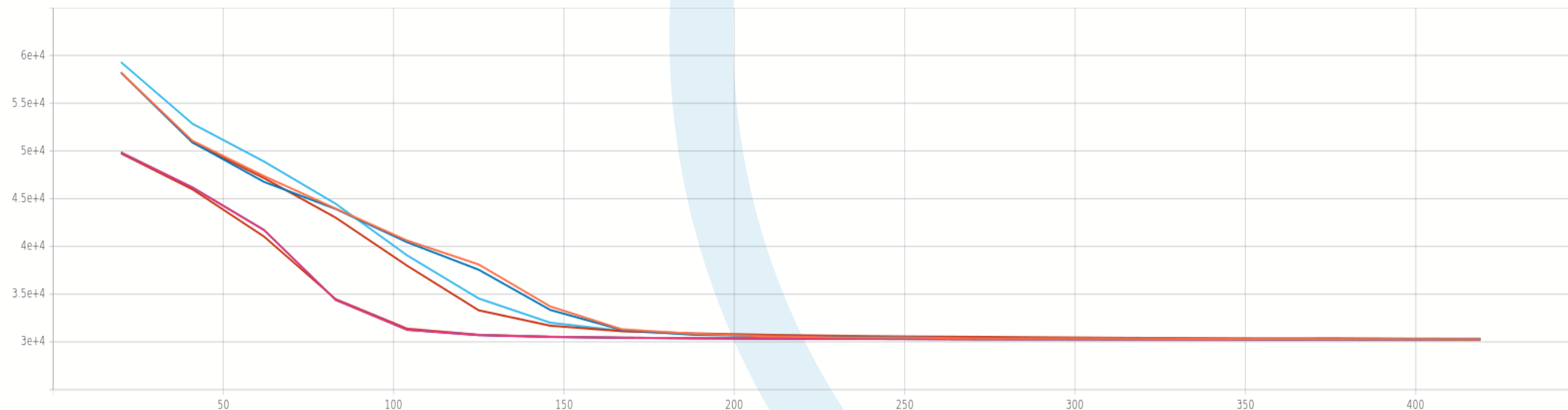
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Exploring Hyperparameters

- Changed one hyperparameter at the time
- Trained for 20 epochs
- Kept the new value if the cumulative loss was less than or almost equal to the previous one



Loss evolution on MVTech with different hyperparameters

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VT-ADL re-implementation

What achieved:

Changed Parameter	Original Value	New MVTech Value	New BTAD Value
Encoder Heads	8	8	2
Encoder depth	6	2	2
Encoder feed forward dimension	1024	512	1024
Capsules per patch	64	32	64
Capsule dimension	8	8	2
Routing iterations	3	1	1
Number of gaussians	150	50	50
Precision	Full	bf16-mixed	bf16-mixed

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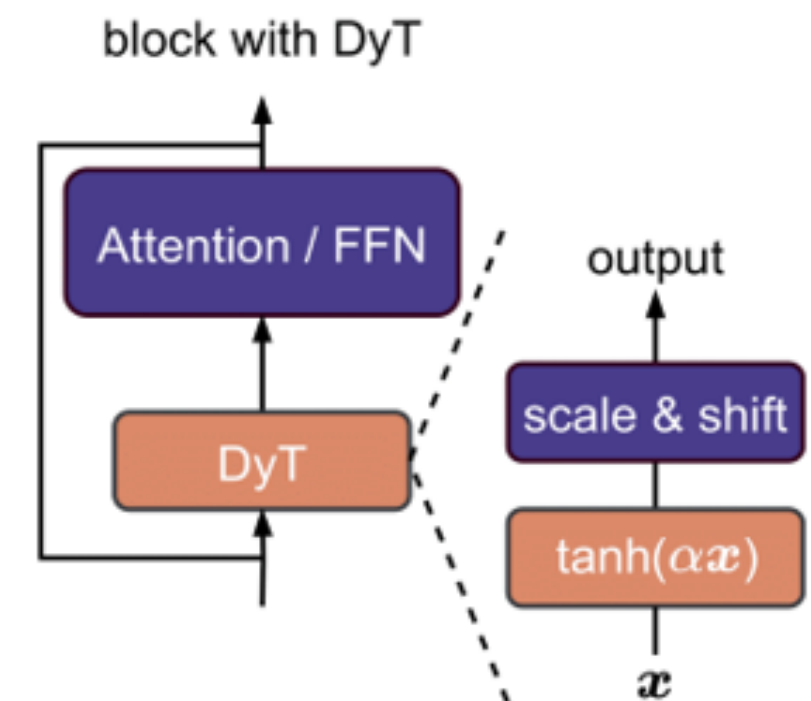
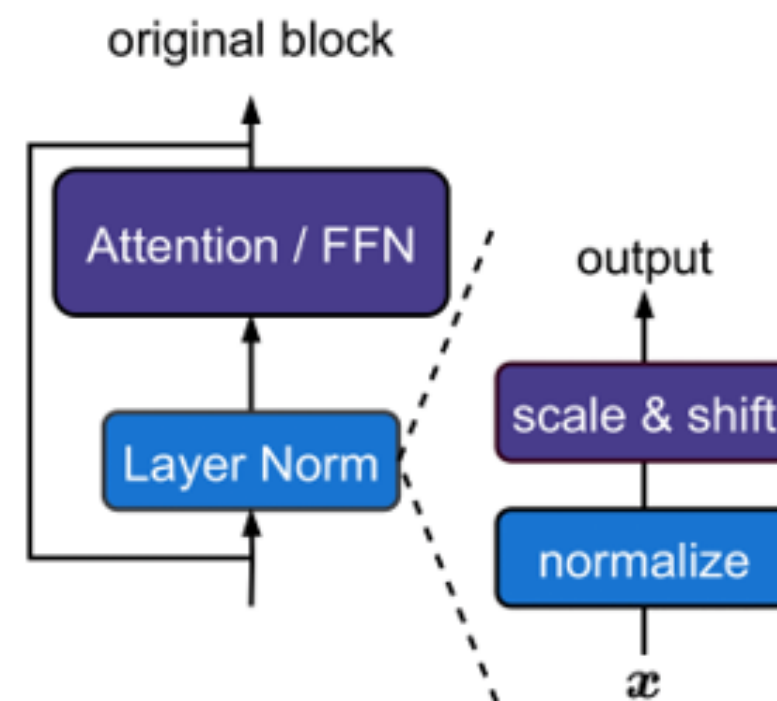
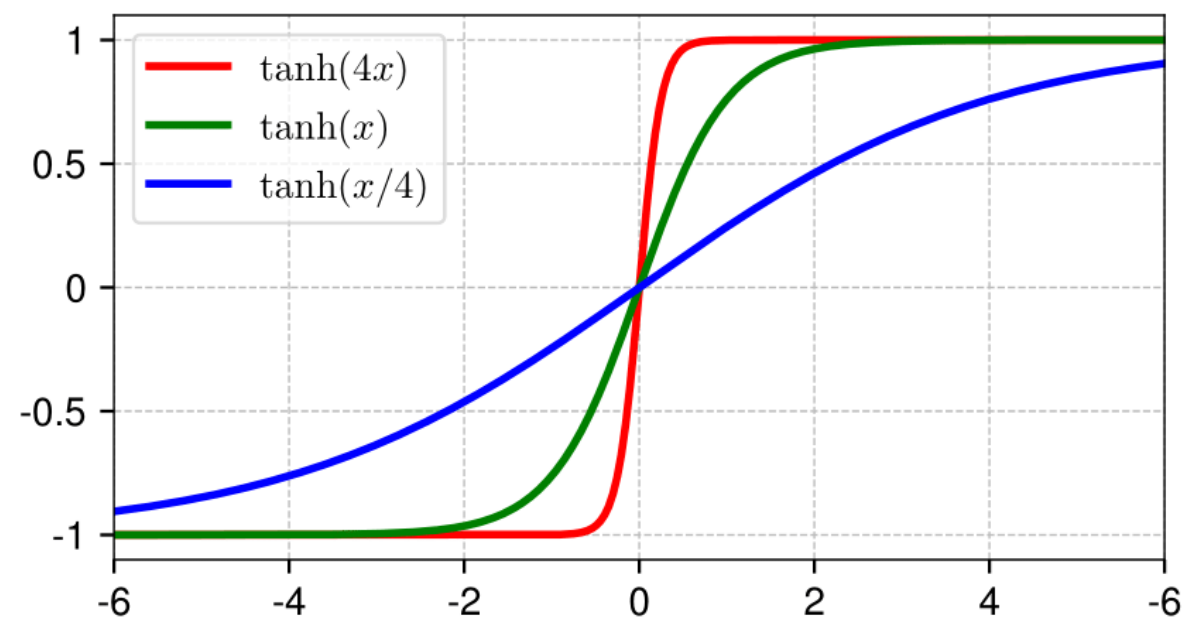
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Use of Dynamic Tanh

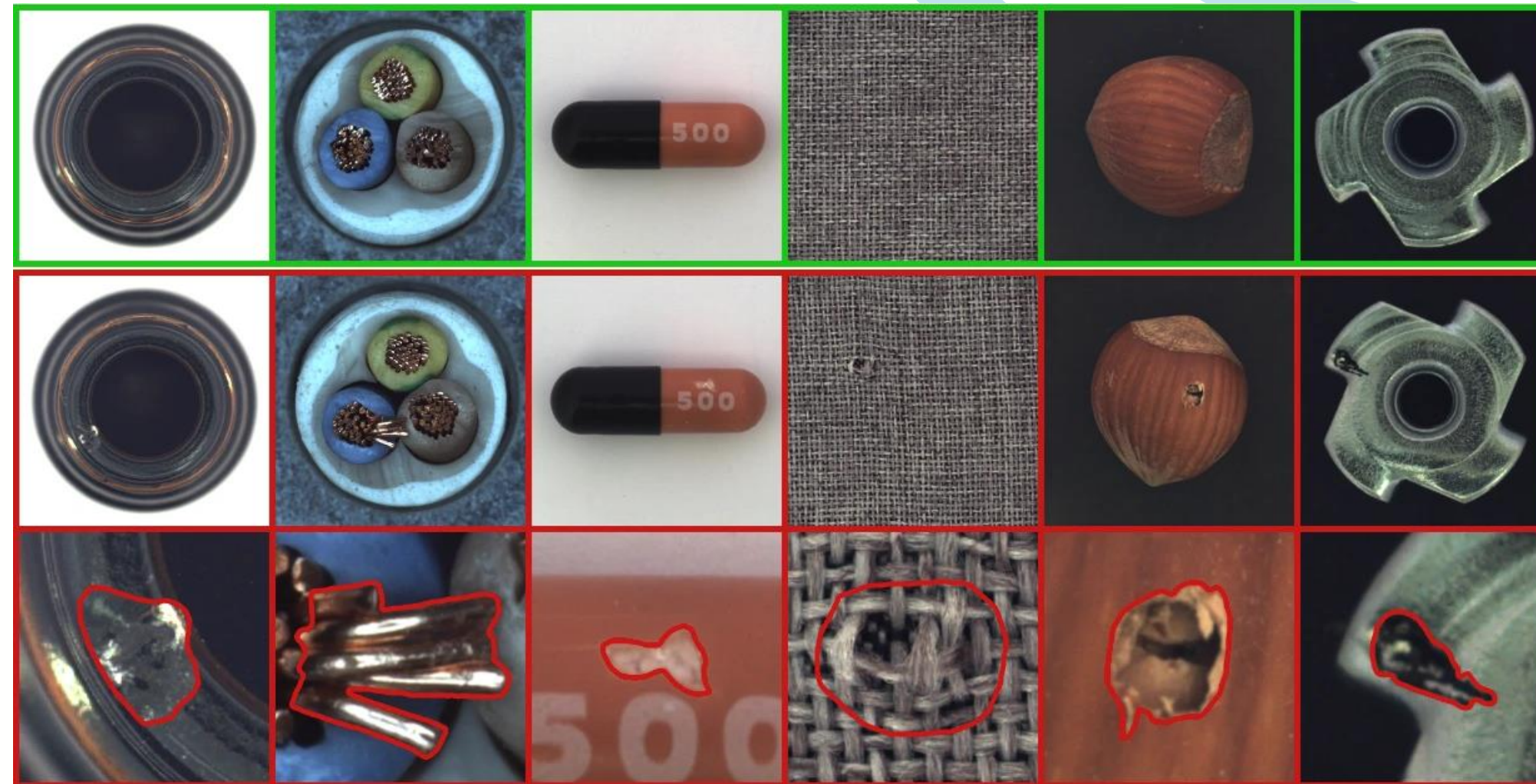
- Replaces the LayerNorm in the transformer encoder
- Initialized with $\alpha = 0.5$



The Datasets

2 datasets have been used:

- MVTech³: a benchmark dataset focused on industrial inspection
- BTAD: an industrial anomaly dataset with real data from the beanTech company

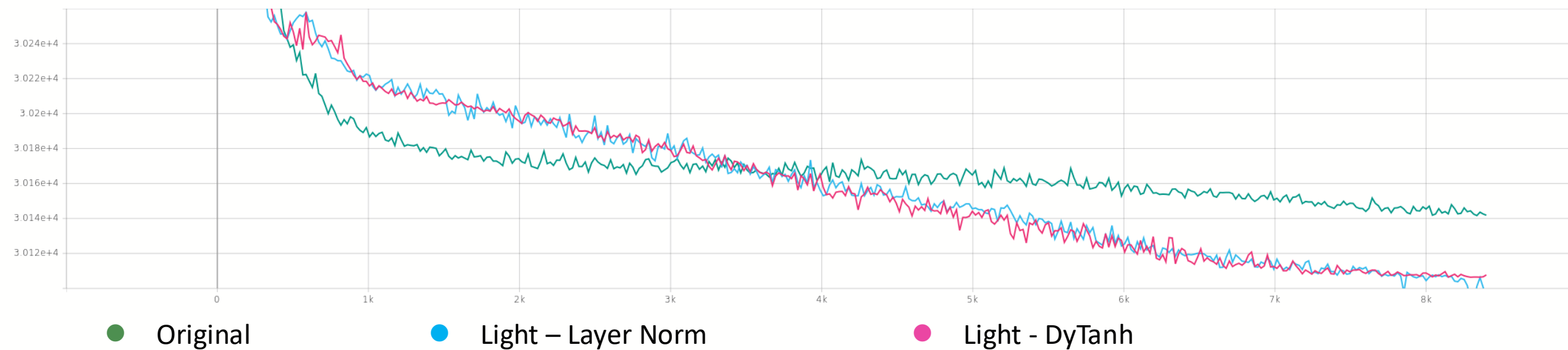


[1] Bergmann P., Fauser M., Sattlegger D., Steger C. (2021). MVTec AD — A Comprehensive Real-World Dataset for Unsupervised Anomaly Detection

Results

MVTech

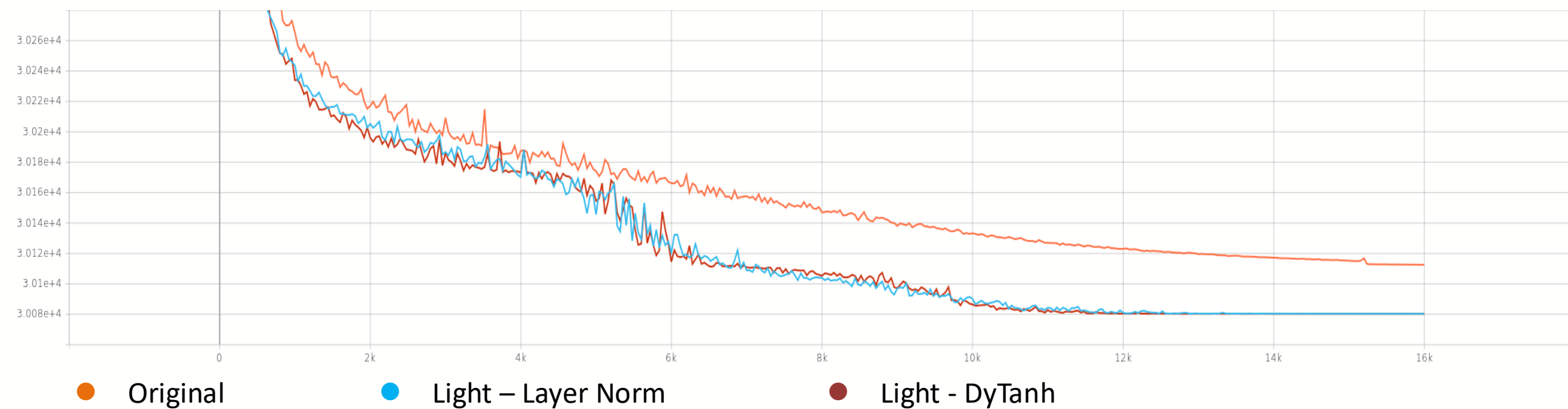
	Original	Light – Layer Norm	Light - DyTanh
Pro-Score	0.3603	0.4472	0.4394
Training time (min.)	16.98	11.70	11.70
Inference time	23.74	23.00	23.05
GFLOPS	91.73	81.64	81.64
GMACS	128.93	126.24	126.24
# Parameters (M)	12.75	7.49	7.48



Results

BTAD

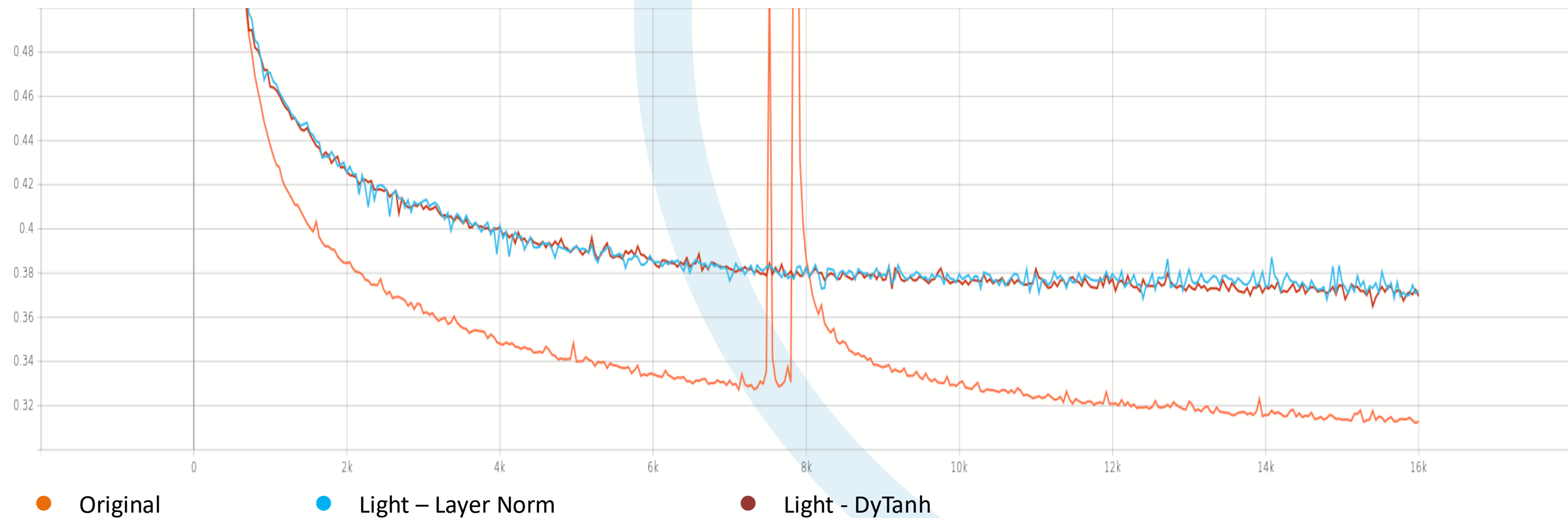
	Original	Light – Layer Norm	Light - DyTanh
Pro-Score	0.7007	0.6039	0.4369
Training time (min.)	31.24	20.76	20.92
Inference time	23.76	23.00	23.06
GFLOPS	91.73	82.73	82.73
GMACS	128.93	126.78	126.77
# Parameters (M)	12.75	8.54	8.53



What Happened?

The cumulative loss is not everything:

- The original implementation has higher loss
- But lower SSIM loss!



Conclusions



- Hyperparameter tuning for efficiency matters
- Dynamic Tanh didn't show notable results
 - Maybe in future (optimized) implementations

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- Zhu, J., Chen, X., He, K., LeCun, Y., & Liu, Z. (2025). Transformers without Normalization
- Liu J., Xie G., Wang J., Li S., Wang C., Zheng F., Jin Y. (2024). Deep Industrial Image Anomaly Detection: A Survey
- Bergmann P., Fauser M., Sattlegger D., Steger C. (2021). MVTec AD — A Comprehensive Real-World Dataset for Unsupervised Anomaly Detection
- Sabour S., Frosst N., Hinton G. E. (2017). Dynamic Routing Between Capsules

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Thanks for your time

