2 Unsupervised AD

2.1 Feature-Embedding-based Methods

2.1.1 Teacher-Student

- Contextual Affinity Distillation for Image Anomaly Detection [WACV 2024]
- Revisiting Reverse Distillation for Anomaly Detection [CVPR 2023] [code]
- Uninformed students: Student-teacher anomaly detection with discriminative latent embeddings [CVPR 2020]
- Multiresolution knowledge distillation for anomaly detection [CVPR 2021]
- Glancing at the Patch: Anomaly Localization With Global and Local Feature Comparison [CVPR 2021]
- Reconstruction Student with Attention for Student-Teacher Pyramid Matching [2021]
- Student-Teacher Feature Pyramid Matching for Anomaly Detection [2021][code]
- PFM and PEFM for Image Anomaly Detection and Segmentation [CASE 2022] [TII 2022][code]
- Reconstructed Student-Teacher and Discriminative Networks for Anomaly Detection [2022]
- Anomaly Detection via Reverse Distillation from One-Class Embedding [CVPR 2022][code]
- Asymmetric Student-Teacher Networks for Industrial Anomaly Detection [WACV 2022][code]
- Informative knowledge distillation for image anomaly segmentation [2022][code]
- Remembering Normality: Memory-guided Knowledge Distillation for Unsupervised Anomaly Detection [ICCV 2023]
- A Discrepancy Aware Framework for Robust Anomaly Detection [2023][code]
- Enhanced multi-scale features mutual mapping fusion based on reverse knowledge distillation for industrial anomaly detection and localization [TBD 2024]
- AEKD: Unsupervised auto-encoder knowledge distillation for industrial anomaly detection [JMS 2024]
- Masked feature regeneration based asymmetric student–teacher network for anomaly detection [Multimedia Tools and Applications 2024]

2.1.2 One-Class Classification (OCC)

- Patch svdd: Patch-level svdd for anomaly detection and segmentation [ACCV 2020]
- Anomaly detection using improved deep SVDD model with data structure preservation [2021]

- A Semantic-Enhanced Method Based On Deep SVDD for Pixel-Wise Anomaly Detection [2021]
- MOCCA: Multilayer One-Class Classification for Anomaly Detection [2021]
- Defect Detection of Metal Nuts Applying Convolutional Neural Networks [2021]
- Panda: Adapting pretrained features for anomaly detection and segmentation [2021]
- Mean-shifted contrastive loss for anomaly detection [2021]
- Learning and Evaluating Representations for Deep One-Class Classification [2020]
- Self-supervised learning for anomaly detection with dynamic local augmentation [2021]
- Contrastive Predictive Coding for Anomaly Detection [2021]
- Cutpaste: Self-supervised learning for anomaly detection and localization [ICCV 2021][unofficial code]
- Consistent estimation of the max-flow problem: Towards unsupervised image segmentation [2020]
- MemSeg: A semi-supervised method for image surface defect detection using differences and commonalities [2022][unofficial code]
- SimpleNet: A Simple Network for Image Anomaly Detection and Localization [CVPR 2023][code]
- End-to-End Augmentation Hyperparameter Tuning for Self-Supervised Anomaly Detection [2023]
- Anomaly Detection under Distribution Shift [ICCV 2023][code]
- Learning Transferable Representations for Image Anomaly Localization Using Dense Pretraining [WACV 2024][code]

2.1.3 Distribution-Map

- Anomaly Detection in Nanofibrous Materials by CNN-Based Self-Similarity [Sensors 2018]
- A Multi-Scale A Contrario method for Unsupervised Image Anomaly Detection [2021]
- Modeling the distribution of normal data in pre-trained deep features for anomaly detection [2021]
- Transfer Learning Gaussian Anomaly Detection by Fine-Tuning Representations [2021]
- PEDENet: Image anomaly localization via patch embedding and density estimation [2022]
- Unsupervised image anomaly detection and segmentation based on pre-trained feature mapping [2022]
- Position Encoding Enhanced Feature Mapping for Image Anomaly Detection [2022][code]
- Focus your distribution: Coarse-to-fine non-contrastive learning for anomaly detection and localization [ICME 2022]
- Anomaly Detection of Defect using Energy of Point Pattern Features within Random Finite Set Framework [2021][code]

- Fastflow: Unsupervised anomaly detection and localization via 2d normalizing flows [2021] [unofficial code]
- Same same but differnet: Semi-supervised defect detection with normalizing flows [WACV 2021] [code]
- Fully convolutional cross-scale-flows for image-based defect detection [WACV 2022][code]
- Cflow-ad: Real-time unsupervised anomaly detection with localization via conditional normalizing flows [WACV 2022][code]
- CAINNFlow: Convolutional block Attention modules and Invertible Neural Networks Flow for anomaly detection and localization tasks [2022]
- AltUB: Alternating Training Method to Update Base Distribution of Normalizing Flow for Anomaly Detection [2022]
- Collaborative Discrepancy Optimization for Reliable Image Anomaly Localization [TII 2023][code]
- PyramidFlow: High-Resolution Defect Contrastive Localization using Pyramid Normalizing Flow [CVPR 2023][code]
- Attention Modules Improve Image-Level Anomaly Detection for Industrial Inspection: A DifferNet Case Study [WACV 2024]
- Fascinating Supervisory Signals and Where to Find Them: Deep Anomaly Detection with Scale Learning [ICML 2023]
- FRAnomaly: flow-based rapid anomaly detection from images [Applied Intelligence 2024]
- Image alignment-based patch distribution framework for anomaly detection [ICCVDM 2024]

2.1.4 Memory Bank

- ReConPatch: Contrastive Patch Representation Learning for Industrial Anomaly Detection [WACV 2024]

+ Sub-image anomaly detection with deep pyramid correspondences [[2020]](https://arxiv.org/pdf/2005.02357.pdf) + Semi-orthogonal embedding for efficient unsupervised anomaly segmentation [[2021]](https://arxiv.org/pdf/2105.14737.pdf) + Anomaly Detection Via Self-Organizing Map [[2021]](http://arxiv.org/pdf/2107.09903) + PaDiM: A Patch Distribution Modeling Framework for Anomaly Detection and Localization [[ICPR 2021]](https://link.springer.com/chapter/10.1007/978-3-030-68799-1_35)[[unofficial code]](https://github.com/xiahaifeng1995/PaDiM-Anomaly-Detection-Localization-master) + Industrial Image Anomaly Localization Based on Gaussian Clustering of Pretrained Feature [[2021]](https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9479740) + Towards total recall in industrial anomaly detection[[CVPR 2022]](http://arxiv.org/pdf/2106.08265)[[code]](https://github.com/amazon-science/patchcore-inspection) + CFA: Coupled-Hypersphere-Based Feature Adaptation for Target-Oriented Anomaly Localization[[2022]](https://arxiv.org/pdf/2206.04325.pdf)[[code]](https://github.com/sungwool/

CFA_for_anomaly_localization) + FAPM: Fast Adaptive Patch Memory for Real-time Industrial Anomaly Detection[[2022]](https://arxiv.org/pdf/2211.07381.pdf) + N-pad: Neighboring Pixel-based Industrial Anomaly Detection [[2022]](https://arxiv.org/pdf/2210.08768.pdf) + Multi-scale patch-based representation learning for image anomaly detection and segmentation [[2022]](https://openaccess.thecvf.com/content/WACV2022/papers/Tsai_Multi-Scale_Patch-Based_Representation_Learning_for_Image_Anomaly_Detection_and_Segmentation_WACV_2022_paper.pdf) + SPot-the-Difference Self-supervised Pre-training for Anomaly Detection and Segmentation [[ECCV 2022]](https://arxiv.org/pdf/2207.14315.pdf) + Diversity-Measurable Anomaly Detection [[CVPR 2023]](https://arxiv.org/abs/2303.05047) + SelFormaly: Towards Task-Agnostic Unified Anomaly Detection[[2023]](https://arxiv.org/abs/2307.12540) + REB: Reducing Biases in Representation for Industrial Anomaly Detection [[2023]](https://arxiv.org/abs/2308.12577)[[code]](https://github.com/ShuaiLYU/REB) + PNI : Industrial Anomaly Detection using Position and Neighborhood Information [[ICCV 2023]](https://openaccess.thecvf.com/content/ICCV2023/papers/Bae_PNI__Industrial_Anomaly_Detection_using_Position_and_Neighborhood_Information_ICCV_2023_paper.pdf)[[code]](https://github.com/wogur110/PNI_Anomaly_Detection) + Inter-Realization Channels: Unsupervised Anomaly Detection Beyond One-Class Classification [[ICCV 2023]](https://openaccess.thecvf.com/content/ICCV2023/papers/McIntosh_Inter-Realization_Channels_Unsupervised_Anomaly_Detection_Beyond_One-Class_Classification_ICCV_2023_paper.pdf)[[code]](https://github.com/DeclanMcIntosh/InReaCh) + Grid-Based Continuous Normal Representation for Anomaly Detection [[2024]](https://arxiv.org/abs/2402.18293)[[code]](https://github.com/tae-mo/GRAD) + PointCore: Efficient Unsupervised Point Cloud Anomaly Detector Using Local-Global Features [[2024]](https://arxiv.org/abs/2403.01804) + DMAD: Dual Memory Bank for Real-World Anomaly Detection [[2024]](https://arxiv.org/abs/2403.12362)

2.1.5 Vison Language AD

- Random Word Data Augmentation with CLIP for Zero-Shot Anomaly Detection [BMVC 2023]
- AnomalyCLIP: Object-agnostic Prompt Learning for Zero-shot Anomaly Detection [ICLR 2024] [code]
- WinCLIP: Zero-/Few-Shot Anomaly Classification and Segmentation [CVPR 2023]
- ClipSAM: CLIP and SAM Collaboration for Zero-Shot Anomaly Segmentation [2023]
- CLIP-AD: A Language-Guided Staged Dual-Path Model for Zero-shot Anomaly Detection [2023]
- AnoVL: Adapting Vision-Language Models for Unified Zero-shot Anomaly Localization [2023] [code]
- AnomalyGPT: Detecting Industrial Anomalies using Large Vision-Language Models [AAAI 2024] [code][project page]
- Anomaly Detection by Adapting a pre-trained Vision Language Model [2024]

- Customizing Visual-Language Foundation Models for Multi-modal Anomaly Detection and Reasoning [2024][code]

2.2 Reconstruction-Based Methods

2.2.1 Autoencoder (AE)

- Improving unsupervised defect segmentation by applying structural similarity to autoencoders [2018]
- Automatic Fabric Defect Detection with a Multi-Scale Convolutional Denoising Autoencoder Network Model [Sensors 2018]
- An Unsupervised-Learning-Based Approach for Automated Defect Inspection on Textured Surfaces [TIM 2018]
- Unsupervised anomaly detection using style distillation [2020]
- Unsupervised two-stage anomaly detection [2021]
- Dfr: Deep feature reconstruction for unsupervised anomaly segmentation [Neurocomputing 2020]
- Unsupervised anomaly segmentation via multilevel image reconstruction and adaptive attention-level transition [2021]
- Encoding structure-texture relation with p-net for anomaly detection in retinal images [2020]
- Improved anomaly detection by training an autoencoder with skip connections on images corrupted with stain-shaped noise [2021]
- Unsupervised anomaly detection for surface defects with dual-siamese network [2022]
- Divide-and-assemble: Learning block-wise memory for unsupervised anomaly detection [ICCV 2021]
- Reconstruction from edge image combined with color and gradient difference for industrial surface anomaly detection [2022][code]
- Spatial Contrastive Learning for Anomaly Detection and Localization [2022]
- Superpixel masking and inpainting for self-supervised anomaly detection [BMVC 2020]
- Iterative image inpainting with structural similarity mask for anomaly detection [2020]
- Self-Supervised Masking for Unsupervised Anomaly Detection and Localization [2022]
- Reconstruction by inpainting for visual anomaly detection [PR 2021]
- Draem-a discriminatively trained reconstruction embedding for surface anomaly detection [ICCV 2021][code]
- DSR: A dual subspace re-projection network for surface anomaly detection [ECCV 2022][code]

- Natural Synthetic Anomalies for Self-supervised Anomaly Detection and Localization [ECCV 2022] [code]
- Self-Supervised Training with Autoencoders for Visual Anomaly Detection [2022]
- Self-supervised predictive convolutional attentive block for anomaly detection [CVPR 2022 oral] [code]
- Self-Supervised Masked Convolutional Transformer Block for Anomaly Detection [TPAMI 2022] [code]
- Iterative energy-based projection on a normal data manifold for anomaly localization [2019]
- Towards visually explaining variational autoencoders [2020]
- Deep generative model using unregularized score for anomaly detection with heterogeneous complexity [2020]
- Anomaly localization by modeling perceptual features [2020]
- Image anomaly detection using normal data only by latent space resampling [2020]
- Noise-to-Norm Reconstruction for Industrial Anomaly Detection and Localization [2023]
- Patch-wise Auto-Encoder for Visual Anomaly Detection [2023]
- FAIR: Frequency-aware Image Restoration for Industrial Visual Anomaly Detection [2023][code comming soon]
- Template-guided Hierarchical Feature Restoration for Anomaly Detection [ICCV 2023]
- FastRecon: Few-shot Industrial Anomaly Detection via Fast Feature Reconstruction [ICCV 2023] [code comming soon]
- Produce Once, Utilize Twice for Anomaly Detection [2023]
- RealNet: A Feature Selection Network with Realistic Synthetic Anomaly for Anomaly Detection [CVPR 2024][code]

2.2.2 Generative Adversarial Networks (GANs)

- Omni-frequency Channel-selection Representations for Unsupervised Anomaly Detection [TIP 2023][code]
- Learning semantic context from normal samples for unsupervised anomaly detection [AAAI 2021]
- Anoseg: Anomaly segmentation network using self-supervised learning [2021]
- A Surface Defect Detection Method Based on Positive Samples [PRICAI 2018]
- Few-shot defect image generation via defect-aware feature manipulation [AAAI 2023][code]

2.2.3 Transformer

- VT-ADL: A vision transformer network for image anomaly detection and localization [ISIE 2021]

- ADTR: Anomaly Detection Transformer with Feature Reconstruction [2022]
- AnoViT: Unsupervised Anomaly Detection and Localization With Vision Transformer-Based Encoder-Decoder [2022]
- HaloAE: An HaloNet based Local Transformer Auto-Encoder for Anomaly Detection and Localization [2022]
- Inpainting transformer for anomaly detection [ICIAP 2022]
- Masked Swin Transformer Unet for Industrial Anomaly Detection [2022]
- Masked Transformer for image Anomaly Localization [TII 2022]
- Focus the Discrepancy: Intra- and Inter-Correlation Learning for Image Anomaly Detection [ICCV 2023][code]
- AMI-Net: Adaptive Mask Inpainting Network for Industrial Anomaly Detection and Localization [TASE 2024]

2.2.4 Diffusion Model

- AnoDDPM: Anomaly Detection With Denoising Diffusion Probabilistic Models Using Simplex Noise [CVPR Workshop 2022]
- Unsupervised Visual Defect Detection with Score-Based Generative Model[2022]
- DiffusionAD: Denoising Diffusion for Anomaly Detection [2023][code]
- Anomaly Detection with Conditioned Denoising Diffusion Models [2023]
- Unsupervised Surface Anomaly Detection with Diffusion Probabilistic Model [ICCV 2023]
- Removing Anomalies as Noises for Industrial Defect Localization [ICCV 2023]
- TransFusion -- A Transparency-Based Diffusion Model for Anomaly Detection [2023]
- LafitE: Latent Diffusion Model with Feature Editing for Unsupervised Multi-class Anomaly Detection [2023]
- DiAD: A Diffusion-based Framework for Multi-class Anomaly Detection [AAAI 2024][code]
- D3AD: Dynamic Denoising Diffusion Probabilistic Model for Anomaly Detection [2024]

2.2.5 Others

- Anomaly Detection using Score-based Perturbation Resilience [ICCV 2023]