FRE: A Fast Method For Anomaly Detection And Segmentation
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Abstract
This work proposes a fast and principled method for unsupervised anomaly detection and segmentation. Our method operates under the assumption of having access solely to anomaly-free training data while aiming to identify anomalies of an arbitrary nature on test data. We make our code available at: https://intellabs.github.io/dtm

Contributions
The principal contributions of the work include:
- a generalized approach that utilizes a shallow linear autoencoder as a principled out-of-distribution detection method operating in the feature space produced by a pre-trained DNN.
- a solid theoretical foundation for the method establishing the feature reconstruction error (FRE) as a principled measure of uncertainty.
- simultaneous solving of image-level anomaly detection and pixel-level anomaly segmentation.
- multiple implementation strategies addressing concerns related to memory, computational complexity, and dataset size.
- extensive experimentation showing state-of-the-art quality, as well as speed, robustness and insensitivity to parameterization.

Preliminaries: linear auto-associative networks
The auto-associative network performs orthogonal projection onto the subspace spanned by the first principal eigenvectors of a covariance matrix associated with the training patterns.

How does a neural network perform when exposed to a pattern never seen previously?
In the auto-associative case, a precise quantitative answer can be given: the distortion on a new pattern is exactly given by its distance to the subspace generated by the first p eigenvectors of the data covariance matrix.

Anomaly detection results

Anomaly segmentation results

Performance study

Conclusion
This work presented a fast, generalized approach for visual anomaly detection and segmentation. We propose applying a shallow, linear autoencoder on the intermediate features produced by a pretrained DNN and computing the feature reconstruction error (FRE) for use as uncertainty score. Our method meets or exceeds the state of the art in quality, is fast and requires no tedious manual tuning of parameters.