# REDUCING ANOMALY DETECTION IN IMAGES TO DETECTION IN NOISE

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## What is anomalous?

Anomalies are regions **not conforming** with the rest of the image. The background can be complex, but we subtract its self-similar part and detect anomalies on the residual, which should be a noise.

## Claims, disclaimers

- Should work with **an arbitrary image**
- Should work with **only one** image
- Doesn't work with semantic anomalies

## Our algorithm in a nutshell

Our algorithm can be decomposed into three steps:

1. Remove self-similar content of the image
2. Model the residual as noise
3. Detect with a multiscale statistical approach

Detection can be done on CNN (VGG [1] features).

## References

[1] K. Simonyan and A. Zisserman, "Very deep convolutional networks for large-scale image recognition," in *ICLR*, 2015.

[2] G. Mishne and I. Cohen, "Multiscale anomaly detection using diffusion maps," *IEEE Journal of selected topics in signal processing*, 2013.

[3] L. Itti, C. Koch, and E. Niebur, "A model of saliency-based visual attention for rapid scene analysis," *IEEE Transactions on Pattern Analysis and Machine Intelligence*, , 1998.

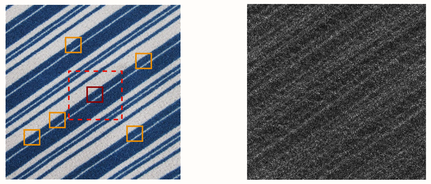
[4] H. Jiang, J. Wang, Z. Yuan, Y. Wu, N. Zheng, and S. Li, "Salient object detection: A discriminative regional feature integration approach," in *CVPR*, 2013.

[5] X. Huang, C. Shen, X. Boix, and Q. Zhao, "Salicon: Reducing the semantic gap in saliency prediction by adapting deep neural networks," in *ICCV*, 2015.

[6] A. Buades, B. Coll, and J-M Morel, "A non-local algorithm for image denoising," in *CVPR*, 2005.

[7] A. Desolneux, L. Moisan, and J.-M. Morel, *From gestalt theory to image analysis: a probabilistic approach*, vol. 34, Springer Science & Business Media, 2007.

## *Construction of the residual image*



Left: Nearest patches are searched outside an exclusion region. Right: Produced residual.

- For a ref. patch P, search similar ones $P_i$ outside a local exclusion region
- $\hat{P} = \frac{1}{Z}\sum_{i=1}^{n} \exp\left(-\frac{\|P-P_i\|_2^2}{h^2}\right) P_i$, Z normalizing constant
- Aggregate all estimates to create the **residual**
- Process all scales

## *Statistical detection by the a contrario approach*

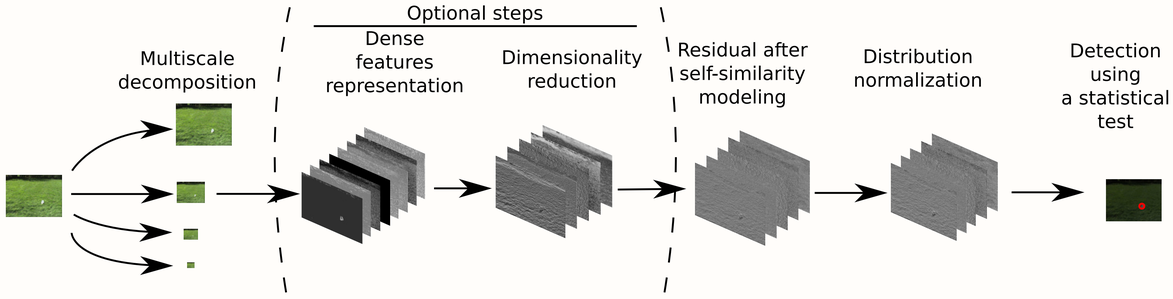
- **A contrario** approach: Gaussian noise hypothesis (after normalization)
- Detects at each scale
- Detection after convolution with small disks to take into account correlations
- Given pixel $i$, thresholding

$$f(i, x) = N\mathbb{P}(|X_i| \geq |x_i|)$$

by $\varepsilon$ gives a guarantee of maximum $\varepsilon$ false alarms in the **a contrario** model [7]

- Number of tests: $N = N_{kernel} \cdot N_{chan} \cdot \sum_{s=1}^{N_{scales}} |\Omega_s|$ where $\Omega_s$ is the residual pixels ($N_{chan}$ channels), $N_{scales}$ the num. of scales and $N_{kernel}$ the num. of kernels

## Processing pipeline




## Experimental validation