Boosting self-supervised blind-spot networks via transfer learning

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Problem Statement

Self-supervised blind-spot networks remove the requirement of labelled training data but can *only* suppress fully random noise. Adaptations have been proposed for targetting noise types with a specific, constant correlation however until now none tackle the noise field as a whole.

Objective

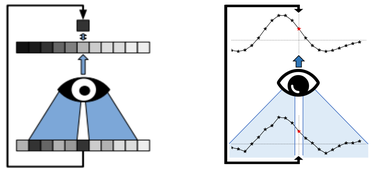
In the presence of minorly correlated noise, self-supervised blind-spot networks learn to replicate the noise as well as the signal [1]. In this study, we investigate if transfer learning can increase the networks ability to accurately replicate the signal prior to learning to also replicate the noise field.

Key Findings

Despite pre-training on simplistic synthetic datasets with different signal and noise properties, significantly more noise is removed from the field data following the transfer learning workflow, as opposed to the standard self-supervised blind-spot approch. Similarly, significantly less signal leakage is observed in comparison to using only the supervised network.

Blind-spot Networks

Predict the active pixels value based on the surrounding pixels. Typically self-supervised.

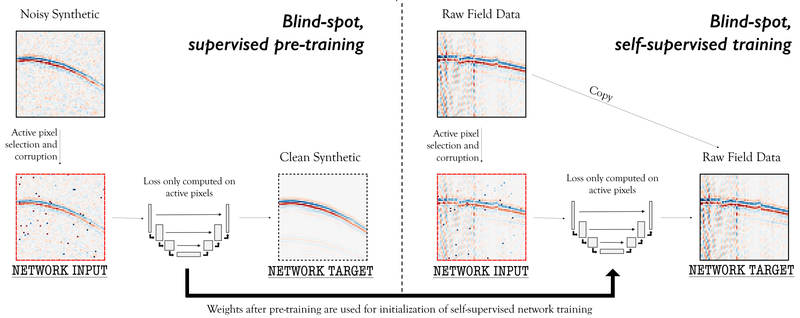


Implemented in this study following the N2V methodology [2] of corrupting (i.e., replacing) active pixels from noisy input data and only computing the loss at the active pixels.

$$\mathcal{L} = \frac{1}{N_s N_p} \sum_{j=1}^{N_s} \sum_{i=1}^{N_p} |x_i^j - \hat{x}_i^j|_1$$

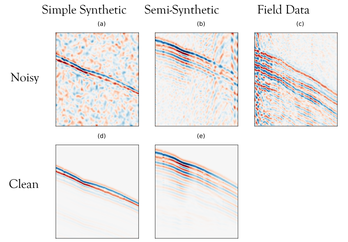
Proposed Workflow

The proposed workflow incorporates a supervised, blind-spot network pre-training step on simplistic, synthetic data. The weights derived during this pre-training step are then used in the initiailisation of a self-supervised, blind-spot network trained directly on field data.



For benchmarking purposes, both a supervised, blind-spot network and a separate self-supervised, blind-spot network are trained on the synthetic and field data, respectively.

Data & Experiments



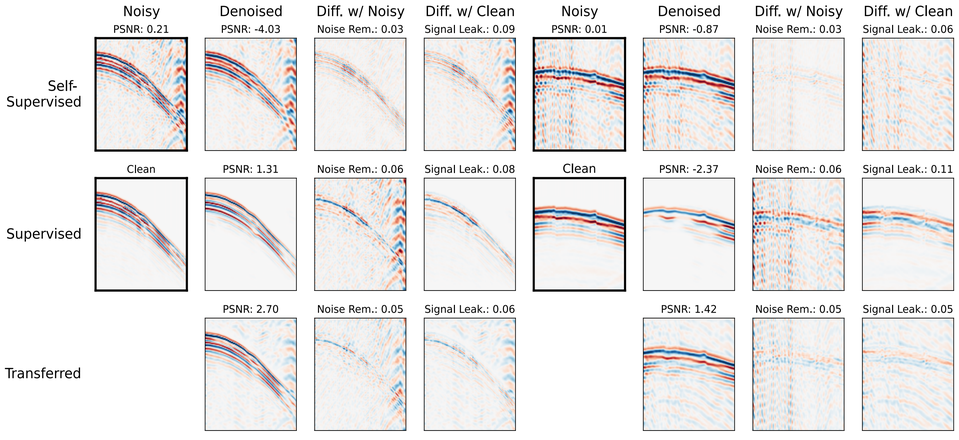
Experiment 1: Semi-synthetic

Pre-train network on simple synthetic dataset (a,d). Fine-tune network on realistic, semi-synthetic dataset (b,e).

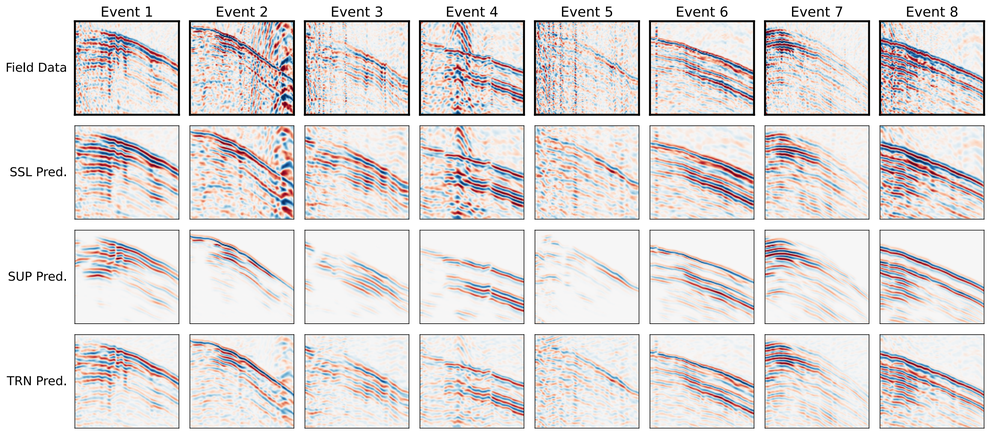
Experiment 2: Field

Pre-train network on simple synthetic dataset (a,d). Fine-tune network on raw, noisy field data (c).

Semi-Synthetic Test



Field Data Application



References:
[1] Birnie, C., Ravasi, M., Liu, S. and Alkhalifah, T., 2021. The potential of self-supervised networks for random noise suppression in seismic data. Artificial Intelligence in Geosciences, 2, pp.47-59.
[2] Krull, A., Buchholz, T.O. and Jug, F., 2019. Noise2void-learning denoising from single noisy images. In Proceedings of the IEEE/CVF conference on computer vision and pattern recognition (pp. 2129-2137).

Code *Abstract*

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