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# Downscaling Tomographic Images with Generative Neural Networks

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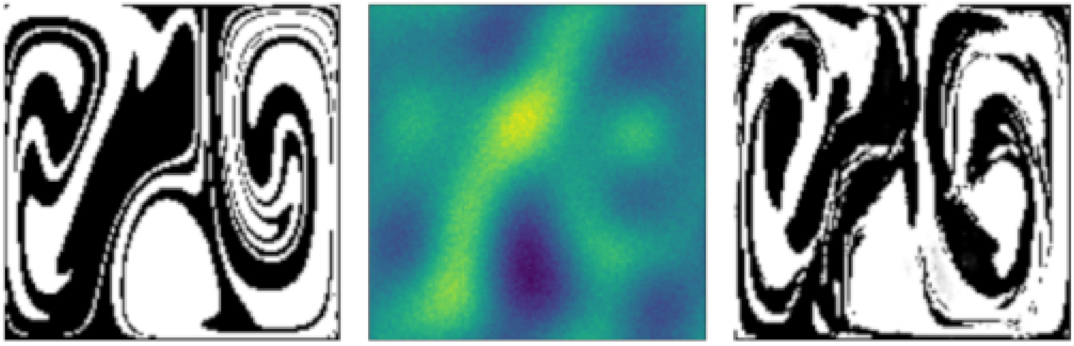
In seismic tomography, only waveforms up to a minimum period are observed, preventing to resolve scales smaller than a minimum wavelength. As a result, seismic tomography is only able to recover effective mediums, which are smoothed versions of the studied structures. A true small-scale structure can be related to its corresponding effective medium through the homogenization theory of wave propagation.

Geodynamics is able to model small-scales structures, providing useful a priori information about the Earth structures. In this study, we aim to combine small-scale a priori information and the homogenization theory to downscale tomographic images, i.e. find the small-scale realistic models equivalent to the observed smooth images. It requires an appropriate parametrization of the small-scale models, that takes into account the a priori information.

We propose to carry out this parametrization with a Generative Neural Network. After the training, the network can generate models that are statistically similar to the training set – in this context, a set of small-scale models, corresponding to the a priori structures. This parameterization integrates the prior, as it is learned during the training. It also has the advantages to be low-dimensional, computationally quick, and avoid strong non-linearities relationships between parameters and the data.

The network is then utilized in an inverse framework to dowscale a given tomographic image.

To test this methodology, we train the network on geodynamical simulations of the mantle, the marble-cake models. For a given synthetic smoothed effective tomographic image, we plug the network into a Bayesian framework, using a McMC to explore the space of marble-cake models that are equivalent to the tomographic image for long period waves.



Target model Observations Recovered model