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Autoencoder-extended Conditional Invertible Neural Networks for Unfolding Signal Traces

When measuring cosmic ray induced air showers through radio waves, recovering the full three-dimensional electromagnetic field from the recorded two-dimensional voltage of an antenna is a major challenge. Antennas project the electromagnetic field into a lower dimensional space while applying a frequency dependent response and are subjected to noise contamination during measurement. We use conditional Invertible Neural Networks (cINNs) to learn posterior distributions, from which the most likely electromagnetic field given a measured voltage can be inferred. We extend the method with an autoencoder to further enhance robustness, reduce the parameter space, and decouple the cINN from data shape. Each time trace is condensed into a small number of abstract parameters in latent space on which the cINN operates. The presented method shows promising results and is easily transferable to other unfolding problems where recovering the pre-measurement state is of interest.

Significance

Conditional Invertible Neural Networks have been used for inference and unfolding problems before, but we apply them in a novel way. When reconstructing distributions with many bins, especially a strongly varying distribution in multiple time bins, compression of information is mandatory. Instead of a standard summary network, we incorporate the autoencoder concept in the network architecture to ensure optimal compression of information by unsupervised learning. With the autoencoder being adaptable to any distribution, the method becomes applicable for a wide range of unfolding challenges.

References

Speaker time zone

Compatible with Europe

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