Thesis: Invertible Neural Networks for solving Inverse Problems

Problem description:
Recently, a special class of deep-learning has been suggested for solving parameter estimation problems, networks that are called invertible neural networks (INNs). These networks can be processed in two different directions and represent a one-to-one mapping between two different domains. Applying them for some inverse problems has shown excellent behavior, yet, it is not clear, whether they are robust resp. suffer from the inverse crime problem. Inverse crime means that a system trained on a given set of examples is not able to generalize for real problems.

Job tasks:
The thesis focuses therefore on an inverse filtering problem where the system model is formulated by g = h \otimes f + e, where h is the system response filter, \otimes the convolution operator and e a normal distributed random variable with zero mean and a given covariance matrix. g is the measurement and f the unknown parameter. This problem is optimally solved by a Wiener filter in the sense of the expectation of the mean squared error between true and approximated solution. Given the same dimensionality of g and f, the question is by how far trained INNs show the same properties as a Wiener filter in the sense of optimality, uncertainty and how the properties are related to the number of exposed training examples.

Requirements:
It would be preferrable if you had already a solid background in deep learning and programming in Python, in particular with one of the frameworks such as PyTorch.

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