

# Model corrected primal-dual deep equilibrium models for photoacoustic tomography

Jenni Poimala (a), Andreas Hauptmann (a,b)

(a): Research Unit of Mathematical Sciences, University of Oulu, Oulu, Finland, (b): Department of Computer Science, University College London, London, UK

## Abstract

Photoacoustic tomography is a hybrid imaging modality that combines optical contrast with ultrasonic detection, and it has shown the potential in a variety of biomedical applications. In these applications, real-time imaging is usually in demand and fast reconstruction algorithms are required. Learned iterative reconstruction shows great promise for acceleration of tomographic reconstructions and shows empirical robustness to model perturbations. Nevertheless, an adoption for photoacoustic tomography is hindered by the need to repeatedly evaluate the computationally expensive forward model. Computationally feasibility can be obtained by the use of fast approximate models, but a need to compensate model errors arises. We address this in a primal-dual framework, where a model correction is learned in data space and a learned proximal operator in image space. Following the successful deep equilibrium models, we train a fixed point iteration both in data and image space to obtain robust and convergent reconstructions. Results are presented for two-dimensional simulations and in-vivo measurements in full three dimensions.