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Fast Plasma Tomography using De-convolutional and DNN methods

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For fusion diagnostics implementing line-integrated measurement, tomography problem has to be addresses in order to reconstruct a spatially resolved 2D imagine by inverting a limited number of line-integrated data. However, most routinely used inversion methods are still not eligible for real-time application due to the time costing algorithms (i.e. iteration) adopted in these classical methods. As Deep Learning (DL) has become the state-of-the-art technique in many fields, DL based surrogate models for a fast plasma tomography can be envisioned as a potential candidate with comparable computing time required for real-time applications. In practice, it can be implemented in two different manners. The first one aims at developing a Deconvolutional Network which takes the low-dimensional line-integrated data as input and produce a high-dimensional imagine as output [1]. Such a network needs to be trained by minimizing the discrepancy between the output and the reconstruction samples that are computed by an inversion method, e.g. Gaussian Process Tomography method [2, 3] from many experimental pulses. The second approach is focused on exploring the pseudo-inverse matrix of the projection matrix, which is derived from the forward modelling of the diagnostic system and used for the prediction of the data, using a Deep Neural Network (DNN) [4]. Such a DNN can be simplified to the model with a single hidden layer and linear activation functions since the model itself amounts to the pseudo inverse matrix of the projection matrix. Accordingly, the input set and the target set were respectively the projection matrix and the identity matrix. Furthermore, an effective and feasible strategy will be devised to incorporate physics knowledge into the learning process for further improvement the machine learning algorithms in terms of better accuracy and faster training.

References:
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