Optimising the optimisers – what is the right image and data model?

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When assigned with the task of reconstructing an image from given data the first challenge one faces is the derivation of a truthful image and data model. Such a model can be determined by the a-priori knowledge about the image, the data and their relation to each other. The source of this knowledge is either our understanding of the type of images we want to reconstruct and of the physics behind the acquisition of the data or we can thrive to learn parametric models from the data itself. The common question arises: how can we optimise our model choice?

Starting from the first modelling strategy this talk will lead us from the total variation as the most successful image regularisation model today to non-smooth second- and third-order regularisers, with data models for Gaussian and Poisson distributed data as well as impulse noise. Applications for image denoising, inpainting and surface reconstruction are given. After a critical discussion of these different image and data models we will turn towards the second modelling strategy and propose to combine it with the first one using a bilevel optimisation method. In particular, we will consider optimal parameter derivation for total variation denoising with multiple noise distributions and optimising total generalised variation regularisation for its application in photography.