Working Title: Reverse Design of Meta-surface Stacks via Neural Network

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1 Abstract

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2 Physical Background

2.1 Meta Surfaces

2.2 The S-Matrix Formalism

$$\hat{S} = \begin{pmatrix} \hat{T}^f & \hat{R}^b \\ \hat{R}^f & \hat{T}^b \end{pmatrix} \tag{1}$$

2.3 SASA and the Star Product

2.4 (Convolutional) Neural Networks

Artificial Neural Networks (ANN's or short NN's) are a kind of data structure inspired by the biological Neurons found in Nature. They can be used to find a wide range of input output relations. One classic example is mapping pictures of hand written digits to the actual digits. Rather then explicitly program the relation NN's are trained on a dataset (X, Y) of correct input output pairs.

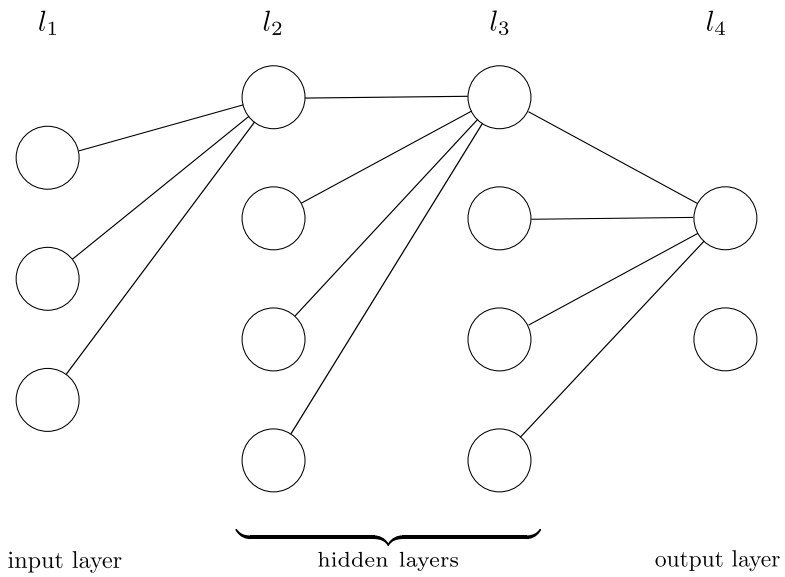

Figure 1: The most simple kind of NN is called densely connected. For clarity only connections to the top most nodes of each layer are shown.

A NN consist of single nodes which are organized into layers where every node is connected to all the nodes of the previous and next layer. Each node holds a value called activation where the activation to the first layer is the input to the network, here: (x_1, x_2, x_3). To calculate the activation of a node one has to multiply all the previous activations with their respective weights, add the bias and finally apply a non-linear activation function σ. For the example in 1 that means:

$$a = \sigma\left(b + \sum_i w_i \, x_i\right) \tag{2}$$

3 The Algorithm

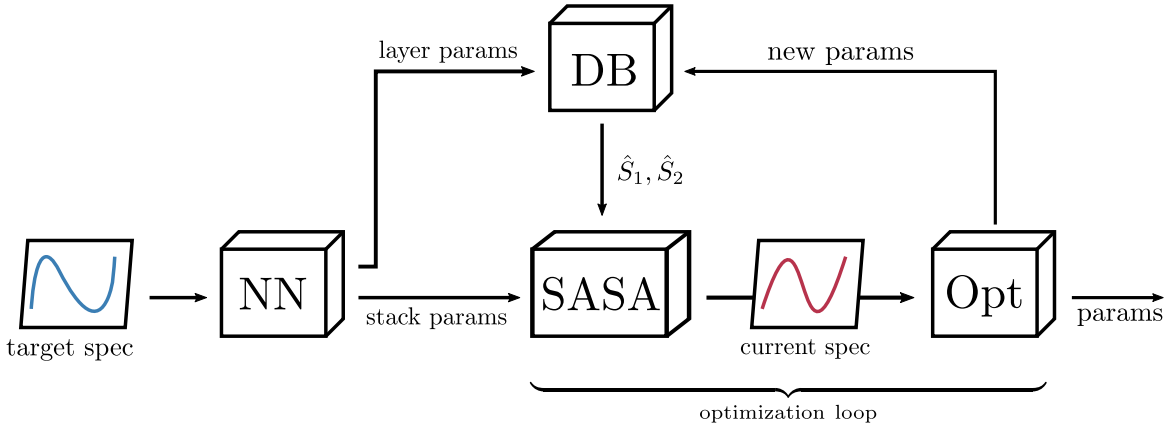

Figure 2: A Flowchart of the Algorithm

NN	convolutional neural ntwork trained to map spectra to stack and layer parameters
DB	database of FMM simulated single layers
SASA	algorithm calculating $\hat{S}_{\text{stack}} = \hat{S}_{\text{stack}}(\hat{S}_1, \hat{S}_2, ...)$
Opt	optimizer changing parameters to minimize the difference between the current and target spectrum
$\hat{\boldsymbol{S}}_{\mathbf{1}}, \hat{\boldsymbol{S}}_{\mathbf{2}}$	S-matrices of the top and bottom layer
layer params	these include the geometry of the periodic meta surface cell and the kind of material used
stack params	the rotation angle of the layers to one another and the distance between
new params	the Opt. only changes the continuous parameters, the discrete ones , e.g. material, remain unchanged
optimization loop	this loop is repeated until the target accuracy is reached

4 The Neural Network

5 The Optimizer

6 Results

7 Literaturverzeichnis

sources.bib

8 Anhang