Master Thesis Problem Statement

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March 2022

Given an antenna parameterization $\overline{\chi}$, the far field of an antenna can be represented by a complex vector field on a sphere

$$\boldsymbol{F}(\theta, \phi; \overline{\chi}) \in \mathbb{C}^2 \text{ for } \theta \in [0, \pi],\ \ \phi \in [0, 2\pi],\ \ \overline{\chi} \in \Omega_D \tag{1}$$

Where θ and ϕ are spatial coordinates on the sphere and $\overline{\chi}$ is a vector representing a physical parameterization of an antenna structure within a design space of N real design parameters $\Omega_D \in \mathbb{R}^N$.

In this project we can see this field as a response from a fine model $R_f(\overline{\chi})$ which has been obtained through numerical solvers, in our case provided by the TICRA software suite.

$$R_f(\overline{\chi}) = \boldsymbol{F}(\theta, \phi; \overline{\chi}) \tag{2}$$

The goal is then to investigate to what extent modern machine learning methods can find a coarse model response $R_c(\overline{\chi}_c)$ and a design parameter mapping, $P(\overline{\chi}) = \overline{\chi}_c$, to obtain a surrogate model fulfilling

$$R_c(P(\overline{\chi})) \simeq R_f(\overline{\chi}) \tag{3}$$

The main questions that the thesis will try to provide answers to are:

1. Which machine learning model architectures are most effective at becoming far-field surrogate models?

2. How do different electromagnetic field representations compare to each with regards to model performance?

3. Can domain knowledge be used to improve model performance?

4. How many evaluation of the fine model R_f, i.e how much data, is needed to train a model within a particular design space Ω_D?

The metrics for model performance are training time, model accuracy and model evaluation time.