S-parameter Modeling and Optimization using Deep Gaussian Processes

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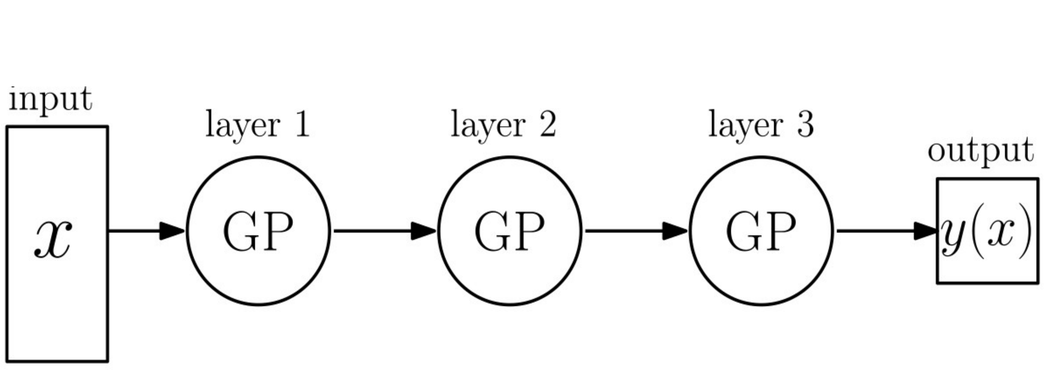
Reference: F. Garbuglia et al., *Bayesian Optimization for Microwave Devices using Deep GP Spectral Surrogate models*, IEEE Transactions on Microwave Theory and Techniques, Dec. 2022, doi:10.1109/TMTT.2022.3228951.

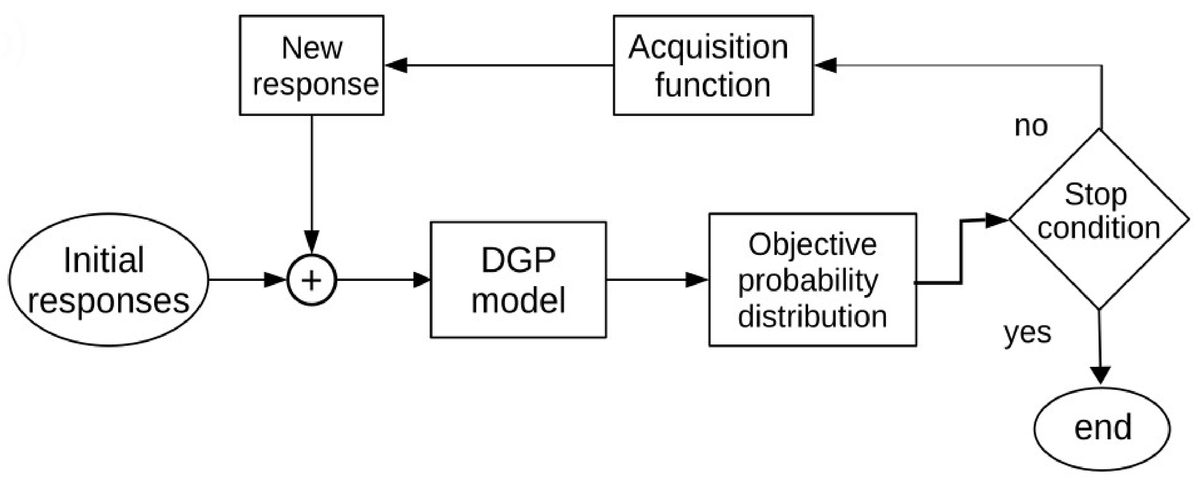
- Problem:
  - Find the design parameters that produce the **desired S-response** for a device under test
  - Run **expensive simulations** until the S-response is acceptable

- Standard Bayesian Optimization:
  - An **objective function** over the design parameters is modeled and maximized
  - The objective function model **predicts** the best parameters and is **updated sequentially** with new simulations.
  - **Drawback 1**: The objective function must be **simple to model** while incorporating many frequency specifications.
  - **Drawback 2:** Standard **Gaussian Process (GP)** struggle to model the frequency dependency.

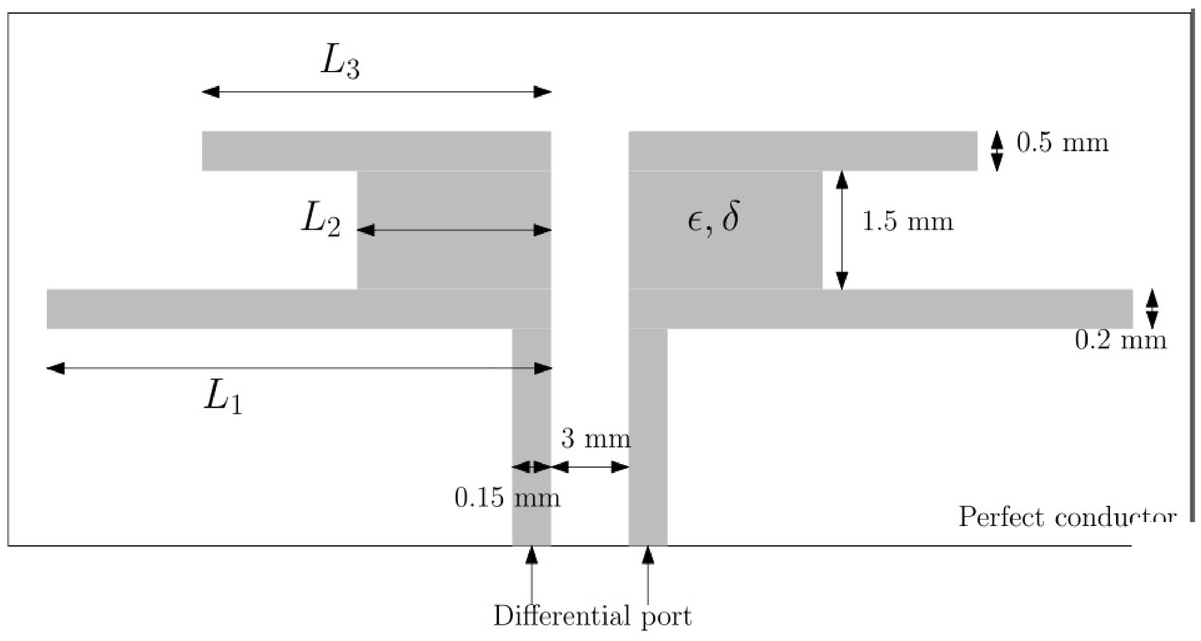
- **New** Bayesian strategy:
  - **Direct model** of the S-parameter over frequency with **Deep GP:**

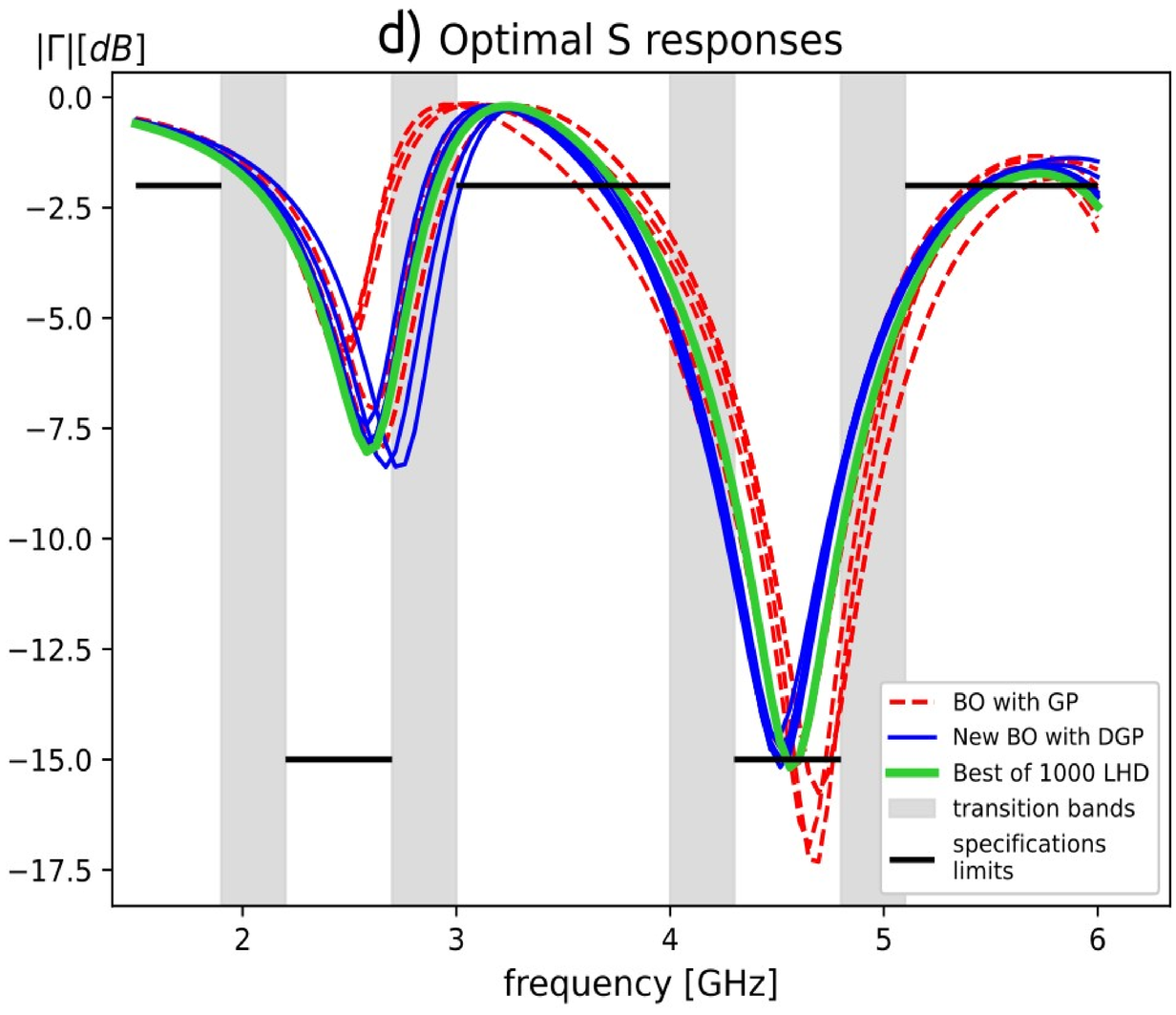


  - Definition and maximization of an **objective distribution** on the Deep GP:



- **Results**
  - Better S-response identified
  - Higher flexibility for the objective
  - Higher data-efficiency, but slower model training
  - Tested on the reflection coefficient of a dual-band slot antenna:
  - $x = [L_1, L_2, L_3, f],\ y = |\Gamma(x)|$





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