How to run a MATLAB based optimization in ANSYS Electronics Desktop

Problem/Description:
It is possible to run an optimization in the ANSYS Electronics Desktop using MATLAB optimization algorithms. Described is a workflow that shows how this can be done.

Solution:
This workflow requires a MATLAB installation including the MATLAB Optimization Toolbox, and the ANSYS Electronics Desktop.
First, configure ANSYS Electronics Desktop to use MATLAB by going to Tools > Options > General Options > General > Miscellaneous > and entering the path to the MATLAB installation:

![Configure MATLAB link in ANSYS Electronics Desktop](Figure 1: Configure MATLAB link in ANSYS Electronics Desktop)

This example demonstrates the optimization of an edge coupled filter in the Circuit interface. The steps shown are same for the other tools in the Desktop (i.e. HFSS, Q3D, Maxwell).

The MATLAB function used is the fmincon() function, which finds the minimum of the objective function with constraints.

Do the following to setup the optimization:
1) Define the variables to be used in the optimization by going to the menu bar > Circuit > Design Properties > Local Variables tab > Optimization/Design of Experiments radio button > check the Include check box for all required variables > OK.

2) In the Project Manager window, right mouse click on Optimetrics > Add > Optimization > select MATLAB in the Optimizer field:

![Figure 2: Select MATLAB as optimizer](image)

3) Setup optimization goal by clicking on the Setup Calculations button to add the required calculations. In this example, the following calculations are added for optimizing transmission and return loss within specific frequency ranges. The maximum number of iterations is set to 400:

![Figure 3: Set optimization goal](image)

4) By default, the fmincon() function is used. To view/change this, click on the Setup button next to the Optimizer field. In the pop-up window, the Script field entry is Optimization algorithm, and this algorithm, which is the fmincon(), is displayed in the text field. Below is the fmincon() line which is used:
\[x, \text{fval}, \text{exitflag}, \text{output}\] = \text{fmincon}(\text{wrapperfunc}, \text{startingpoint}, [], [], [], [], \text{ANS\_MINVAL}, \text{ANS\_MAXVAL}, \text{nlcon}, \text{options})

**Figure 4:** View/edit optimization algorithm

**Note:** other algorithms can be used by simply replacing the default `fmincon()` entry in the text field with the intended algorithm. For example, if the intention is to use the `fminsearch()` function, which can be very useful for handling small changes within the explored space (but doesn’t account for constraints), the following line should be used to replace the default line in the text field:

\[x, \text{fval}, \text{exitflag}, \text{output}\] = \text{fminsearch}(\text{wrapperfunc}, \text{startingpoint}, \text{options})

Click OK to accept all changes. An OptimizationSetup1 is added in the Optimetrics folder in the Project Manager window.

5) Right mouse click on OptimizationSetup1 > Analyze.

Once the optimization starts, the MATLAB executable will be called, and MATLAB will request for the objective function values for different variations of the design. MATLAB will at the same time explore the design space for the optimum design. The MATLAB command window pops up, showing progress in MATLAB:
When the optimum is found (this condition varies depending on the MATLAB function chosen), the MATLAB script notifies the ANSYS code, and then the script exits.

The behavior of the cost function can be seen in the ANSYS Electronics Desktop by right mouse clicking OptimizationSetup1 > View Analysis Result:
6) When the optimization stops, click on the design name in the Project Manager window > view the Properties window to see the optimized values of the variables:

![Properties Comparison](image1)

**Figure 7: Optimized variables**

7) A plot of the transmission and return loss shows that the S parameters fall within the expected ranges defined in optimization goal:

![FilterResponse](image2)

**Figure 8: Optimized S parameters**

**Attachments:**

Example project 2049217.aedtz is attached