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HyperWorks

HS-4205: Multi-Objective Optimization Study Using an Excel Spreadsheet

This tutorial demonstrates how to perform a multi-objective optimization with HyperStudy.

Before running this tutorial, you must complete HS-1035: Optimization Study Using an Excel Spreadsheet or you can import the archive file `HS-1035.hstx`, available in `<hst.zip>/HS-4205/`.

In the initial optimization problem, as stated in tutorial HS-1035, the objective is to find the cross-sectional dimensions (width and height) of a beam that minimize the beam volume while keeping the tip deflection below 0.53 mm.

In this tutorial, both the beam volume and tip deflection will be considered as objective functions to be minimized. The constraint in the tip deflection is not applied in an effort to understand the trade-off associated with this condition. Using a Global Response Search Method (GRSM), a series of solutions (called non-dominated solutions), will be found. These solutions form a Pareto front in which users can do trade-off analysis.

Step 1: Start from Tutorial HS-1035

1. Start HyperStudy.
2. Perform all steps in tutorial HS-1035.

Step 2: Add an Approach and Run a Multi-Objective Optimization Study

1. In the **Explorer**, right-click and select **Add** from the context menu.
2. In the **Add - HyperStudy** dialog, select **Optimization** and click **OK**.
3. Go to the **Select Input Variables** step.
4. For both input variables, change the lower, initial, and upper bounds to the values indicated in the image below.

	Active	Label	Varname	Lower Bound	Nominal	Upper Bound
1	<input checked="" type="checkbox"/>	Width (m)	dv_1	0.0450000 ...	0.0500000 ...	0.0600000 ...
2	<input checked="" type="checkbox"/>	Height (m)	dv_2	0.0900000 ...	0.1000000 ...	0.1100000 ...

5. Go to the **Select Output Responses** step.
6. Add two objectives.
 - a. Click the **Objectives** tab.
 - b. Click **Add Objective**.
 - c. In the **Add - HyperStudy** dialog, add two objectives.
 - d. Define **Objective 1** and **Objective 2** by selecting the options indicated in the image below from the **Type** and **Apply On** columns.

	Active	Label	Varname	Type	Apply On	Evaluate From	Target Value
1	<input checked="" type="checkbox"/>	Objective 1	obj_1	Minimize	Deflection at the tip (mm) (r_1)	SOLVER	1.0000000
2	<input checked="" type="checkbox"/>	Objective 2	obj_2	Minimize	Beam Volume (m^3) (r_2)	SOLVER	1.0000000

- Click **Apply**.
- Go to the **Specifications** step.
- In the work area, set the **Mode** to **Global Response Search Method (GRSM)**.
Note: Only the methods that are valid for the problem formulation are enabled.
- Click **Apply**.
- Go to the **Evaluate** step.
- Click **Evaluate Tasks** to launch the Optimization.
- Optional. HyperStudy also allows you to perform multi-objective Optimizations using a Weighted Sum approach. Add and activate multiple objectives amongst the output responses, set a weight respectively for each objective in the Weighted Sum field, and select an algorithm (SQP, MFD, GA, ARSM) in the Specifications table. Proceed with the optimization.
- Go to the **Post processing** step.

Step 3: Post-Process the Multi-Objective Optimization Results

- Click the **Optima** tab.
- Using the **Channel** selector, select **Objective 1** for the **X Axis** and **Objective 2** for the **Y Axis**.

The Optima tab plots the trade-off between competing objectives. One objective cannot improve without the other competing objective getting worse.

