Altair

HyperWorks

Altair HyperStudy 2019 Tutorials

HS-1710: Simple Optimization Study

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This tutorial demonstrates how to optimize a simple function defined using a Templex template. The base input template defines two input variables, DV1 and DV2, labeled X and Y, respectively. The objective of the optimization is to minimize X + Y with the constraint 1/X + 1/Y – 2 < 0.

Before running this tutorial, you must complete tutorial HS-1010: Simple DOE Study (or HS-1700: Simple DOE Study, HS-1705: Simple Fit Study) or you can import the archive file `HS-1705.hstx`, available in `<hst.zip>/HS-1710/`.

Step 1: Run an 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. Review the input variable's lower and upper bound ranges.
5. Go to the **Select Output Responses** step.
6. Click ***Add Objective***.
7. In the **Add - HyperStudy** dialog, add one objective.
8. Define the objective.
   a. Set **Type** to ***Minimize***.
   b. Set **Apply On** to ***Response 1 (r_1)***.

	Active	Label	Varname	Type	Apply On	Evaluate From
1	☑	Objective 1	obj_1	Minimize	Response 1 (m_1_r_1)	SOLVER

9. Click the ***Constraint*** tab.
10. Click ***Add Constraint***.
11. In the **Add - HyperStudy** dialog, add one constraint.
12. Define the constraint.
    a. Set **Apply On** to ***Response 2 (r_2)***.
    b. Set **Bound Type** to **<=** (greater than or equal to).
    c. In the **Bound Value** column, enter `0.0`.

	Active	Label	Varname	Type	Apply On	Bound Type	Bound Value
1	☑	Constraint 1	c_1	Deterministic	Response 2 (m_1_r_2)	<=	0.0000000

13. Click ***Apply***.
14. Go to the **Specifications** step.

15. In the work area, set the **Mode** to ***Adaptive Response Surface Method (ARSM)***.

    Note: Only the methods that are valid for the problem formulation are enabled.

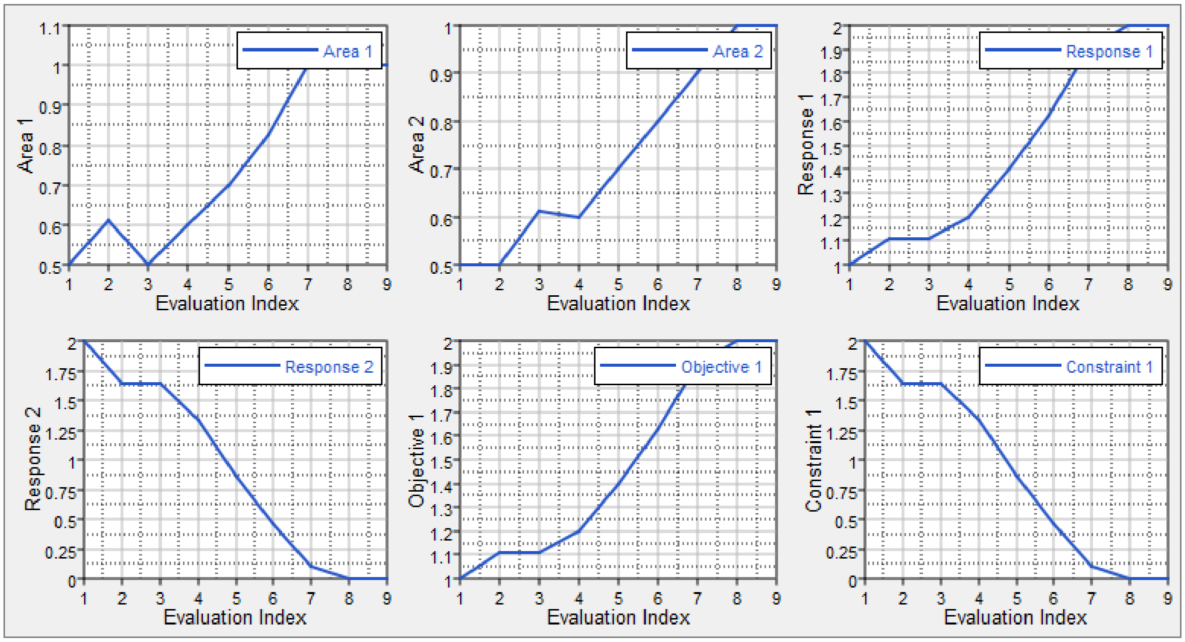
16. Click ***Apply***.
17. Go to the **Evaluate** step.
18. Click ***Evaluate Tasks***.
19. Optional. Click the different tabs in the **Evaluate** step to monitor the progress of the Optimization.
20. After the optimization has finished, review the optimization history first.
21. With many of the algorithms (SQP, GA, …), each iteration requires many evaluations.
    - **Evaluation** (plots or tables) show all runs performed during the optimization.
    - **Iteration** (plots or tables) show the optimization iterations.

    The **Iteration History** tab uses color coding to indicate which design are feasible, optimal, and violated.

    - White background/black font indicates the design is feasible.
    - White background/red font indicates the design is violated.
    - White background/orange font indicates the design is acceptable, but at least one constraint is near violated.
    - Green background/white font indicates the design is optimal.
    - Green background/orange font indicates the design is optimal, but at least one constraint is near violated.

	Area 1	Area 2	Response 1	Response 2	Objective 1	Constraint 1	Iteration Index	Evaluation Reference	Iterati
1	0.5000000	0.5000000	1.0000000	2.0000000	1.0000000	2.0000000	1	1	1
2	0.6100000	0.5000000	1.1100000	1.6393400	1.1100000	1.6393400	2	2	2
3	0.5000000	0.6100000	1.1100000	1.6393400	1.1100000	1.6393400	3	3	3
4	0.5999999	0.5999999	1.2000000	1.3333300	1.2000000	1.3333300	4	4	4
5	0.6999999	0.6999997	1.4000000	0.8571440	1.4000000	0.8571440	5	5	5
6	0.8254987	0.7999997	1.6255000	0.4613890	1.6255000	0.4613890	6	6	6
7	1.0023912	0.9003989	1.9027900	0.1082330	1.9027900	0.1082330	7	7	7
8	1.0000883	0.9999133	2.0000000	-1.57e-06	2.0000000	-1.57e-06	8	8	8
9	0.9999097	1.0000903	2.0000000	5.26e-08	2.0000000	5.26e-08	9	9	9

22. The **Evaluation Plot** tab displays charts for all of the entities in the optimization (input variables, output responses, objective functions, constraints) against the iteration.
    - Select entities to plot using the **Channel** selector in the left pane.
    - Plot multiple entities in separate windows by clicking .



23. Go to the **Post-Processing** step.

Step 2: Post-Processing of an Optimization Study

In the **Post-Processing** step of an Optimization approach, you can access additional tools to review the results. Use the **Integrity**, **Distribution**, and **Scatter** tabs to compare and analyze designs.

1. Click the **Integrity** tab to analyze statistics of the optimization study.

	Label	Varname	Category	Variance	Std. Dev.	Avg. Dev.	CoV.	Skewness	Kurtosis	RMS
1	Area 1	m_1_DVAR1	Variable	0.0454980	0.2133026	0.1851714	0.2849148	0.1943044	-1.8966867	0.7751940
2	Area 2	m_1_DVAR2	Variable	0.0396945	0.1992349	0.1694324	0.2712565	0.2457702	-1.6251689	0.7581281
3	Response 1	m_1_r_1	Response	0.1662041	0.4076814	0.3546037	0.2748766	0.2679505	-1.9156419	1.5321394
4	Response 2	m_1_r_2	Response	0.6164650	0.7851528	0.6753825	0.8790364	0.0937966	-1.8610013	1.1600733
5	Objective 1	obj_1	Objective	0.1662041	0.4076814	0.3546037	0.2748766	0.2679505	-1.9156419	1.5321394
6	Constraint 1	c_1	Constraint	0.6164650	0.7851528	0.6753825	0.8790364	0.0937966	-1.8610013	1.1600733