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Altair HyperStudy 2019 Tutorials

HS-3015: Automated Fit from CSV Data

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HS-3015: Automated Fit from CSV Data

In this tutorial, you will learn how to:

- Create a Lookup model to link to tabulated data in an external .csv file.
- Run a DOE of type Run Matrix to import the data in the lookup .csv file.
- Build a predictive model using FAST (Fit Automatically Selected by Training).
- Examine the results from a FAST Fit.

Model Files

The files used in this tutorial can be found in `<hst.zip>/HS-3015/`. Copy the files from this directory to your working directory.

Exercise

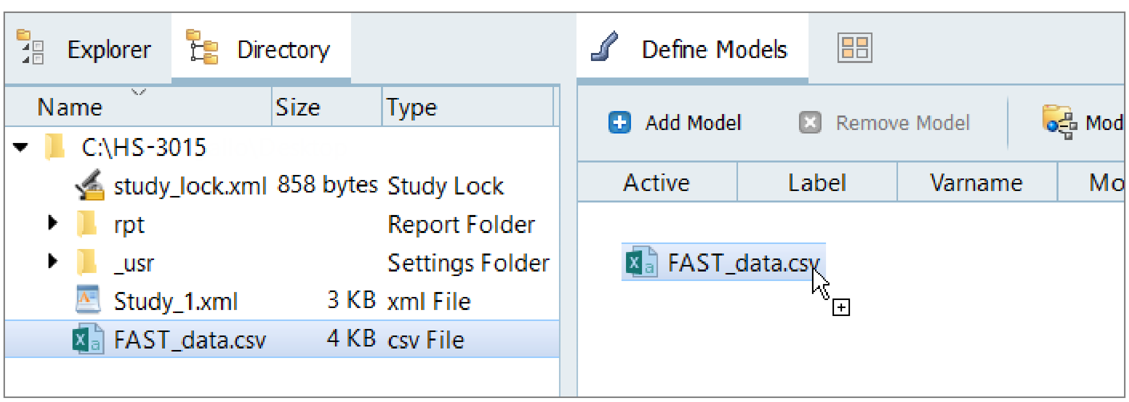
Step 1: Review the CSV Data

1. Open the `FAST_data.csv` file and review its contents.

   Notice: The `.csv` file contains two variables (x and y) and three responses.

Step 2: Perform the Study Setup

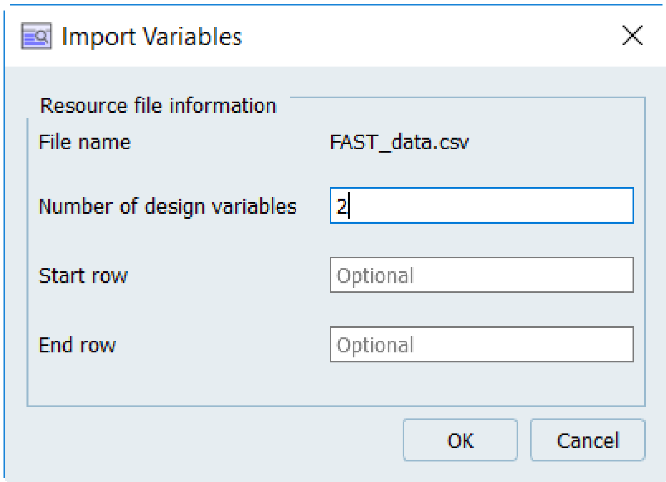
1. Start HyperStudy.
2. To start a new study, click **File** > **New** from the menu bar, or click on the toolbar.
3. In the **HyperStudy – Add** dialog, enter a study name, select a location for the study, and click **OK**.
4. Go to the **Define models** step.
5. Add a Lookup model by dragging-and-dropping the `FAST_data.csv` file from the **Directory** into the work area.



6. Click **Import Variables**.

7. In the **Import Variables** dialog, enter `2` in the Number of design variables field and click **OK**.

   The input variables are expected in the first two columns, and the remaining columns are interpreted as output responses.



8. Go to the **Define Input Variables** step.
9. Review the input variables.

   Notice: The bounds of the input variables are based on the `FAST_data.csv` file's contents. The nominal values are set to the first entry in the `.csv` file.

	Active	Label	Varname	Lower Bound	Nominal	Upper Bound
1	☑	x	var_1	-6.3960000 ...	-3.9000000 ...	6.2920000 ...
2	☑	y	var_2	-6.3960000 ...	-1.3000000 ...	6.3960000 ...

10. Go to the **Specification** step.

Step 3: Perform the Nominal Run

1. In the work area, set the **Mode** to **Nominal Run**.

	Mode	Label	Varname	Details
1	◉	Nominal Run	Nom	Run system at nominal values
2	○	System Bounds Check	Chk	Run system at nominal values, then lower and upper values
		Show more ...		

2. Click **Apply**.
3. Go to the **Evaluate** step.
4. Click **Evaluate Tasks**.

   The execution searches the `.csv` for a row of matching input variable values, and returns the corresponding output responses in the row. If no match is found, you will receive execution errors.

5. Go to the **Define Output Responses** step and review the output responses.

   Notice: One output response is named Highly Nonlinear and two are polynomials.

	Active	Label	Varname	Expression	Value
1	☑	Highly Nonlinear	r_1	ds_1[0] ...	0.1839766
2	☑	Poly 1	r_2	ds_2[0] ...	-3.7200259
3	☑	Poly 2	r_3	ds_3[0] ...	17.751969

Step 4: Run a Run Matrix DOE

1. In the Explorer, right-click and select **Add** from the context menu.
2. In the **Add – HyperStudy** dialog, select **DOE** and click **OK**.
3. Go to the **Specifications** step.
4. In the work area, set the **Mode** to **Run Matrix**.
5. From the Settings tab, Matrix File field, navigate to your working directory and select the `FAST_data.csv` file.

Edit Matrix

	Value
Matrix File	C:/HS-3015/FAST_data.csv
Use Inclusion Matrix	☐

6. Click **Apply**.

   The DOE matrix populates with the input variable values from the `FAST_data.csv` file.
7. Go to the **Evaluate** step.
8. Click **Evaluate Tasks**.

Step 5: Create a FAST Fit

1. In the Explorer, right-click and select **Add** from the context menu.
2. In the **Add – HyperStudy** dialog, select **Fit** and click **OK**.
3. Go to the **Select Matrices** step.
4. Click **Add Matrix**.
5. In the work area, Matrix Source column, select **DOE 1 (doe_1)**.
6. Click **Import Matrix**.
7. Go to the **Specifications** step.

8. Verify that the Fit Type assigned to each output response is FAST – Fit Automatically Selected by Training.

	Label	Fit Type	Fit Specifics
1	Highly Nonlinear	FAST - Fit Automatically Selected by Training	LSR / MLSM / RBF
2	Poly 1	FAST - Fit Automatically Selected by Training	LSR / MLSM / RBF
3	Poly 2	FAST - Fit Automatically Selected by Training	LSR / MLSM / RBF

Note: By default, FAST automatically selects the best Fit type from all available Fits. You can manually select the Fit types FAST can choose by highlighting one or more responses in the work area and selecting Fits from the Settings tab.

	Label	Fit Type	Fit Specifics
1	Highly Nonlinear	FAST - Fit Automati...	LSR / MLSM / RBF
2	Poly 1	FAST - Fit Automati...	LSR / MLSM / RBF
3	Poly 2	FAST - Fit Automati...	LSR / MLSM / RBF

Fit Type: FAST - Fit Automatically Selected by Training

	Value
Least Squares Regression	☑
Stepwise Regression Terms	full quadratic
Moving Least Squares	☑
Radial Basis Function	☑

9. Click **Apply**.
10. Go to the **Evaluate** step.
11. Click **Evaluate Tasks**.

Note: The choices for the best available Fit vary for each output response, which can cause these loops to be time consuming compared to when you select a single specific Fit. The steps for each output response are mutually exclusive, therefore you can use the Multi-Execution option to accelerate this process.

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

Step 6: Post-Process the FAST Fit

1. Click the **Diagnostics** tab.

Notice: The Highly Nonlinear response uses RBF, while the other responses use LSR. In each case, FAST selected the specifics to have the highest x-validation R-square value. The R-Square can be interpreted as the % of the data's variance that can be explained by the model.

	Label	Fit Type	Fit Specifics	X R-Square
1	Highly Nonlinear	RBF	linear - Multiquadric - 1.0000000	0.7834235
2	Poly 1	LSR	Custom	0.9827936
3	Poly 2	LSR	Custom	0.9896159

2. Click the **Regression Terms** sub-tab.

3. Compare Poly1 and Poly2 by selecting them individually in the work area.

   Poly1 and Poly2 are using stepwise regression, which means that the coefficients of the regression are reduced to a minimal set that sufficiently models the data. Poly1 uses only x, whereas Poly2 uses x and y^2.

	Label	Fit Type	Fit Specifics	R-Square
1	Highly Nonlinear	RBF	linear - Multiquadric - 1.0000000	0.7834235
2	Poly 1	LSR	Custom	0.9827936
3	Poly 2	LSR	Custom	0.9896159

Detailed Diagnostics | Regression Terms | Regression Equation | ANOVA

	Terms	Lower	Values	Upper	Standard Error	t-value	p-value	Percent Contribution
1	intercept	4.7688291	5.0092822	5.2497352	0.1211676	41.341778	7.84e-64	0.0000000
2	var_1^1	2.4265380	2.4907266	2.5549153	0.0323455	77.003716	1.79e-89	100.00000

Poly1

	Label	Fit Type	Fit Specifics	R-Square
1	Highly Nonlinear	RBF	linear - Multiquadric - 1.0000000	0.7834235
2	Poly 1	LSR	Custom	0.9827936
3	Poly 2	LSR	Custom	0.9896159

Detailed Diagnostics | Regression Terms | Regression Equation | ANOVA

	Terms	Lower	Values	Upper	Standard Error	t-value	p-value	Percent Contribution
1	intercept	2.7874169	3.9265521	5.0656872	0.5739516	6.8412594	7.07e-10	0.0000000
2	var_1^1	-2.1141265	-1.9100455	-1.7059645	0.1028259	-18.575526	1.03e-33	16.167057
3	var_2^2	3.0100833	3.0718762	3.1336692	0.0311343	98.665356	4.22e-99	83.832943

Poly2

4. If required, copy the data from the Fit Type and Fit Specifics columns in the Diagnostics table and paste it into the Fit Type and Fit Specifics columns in the Specification step.

   This step explicitly sets the Fit specifications to the results determined from FAST; if the Fit must be re-run, this step can save time because FAST does not need to search for the best settings.

5. Click the **Trade-Off** Tab to plot all the functions and see the predicted versus the known data points.

   Note: In each case, the Fit model follows the data closely regardless of the sinusoidal functions in the Highly Nonlinear response to the simple planar data of the polynomial responses.