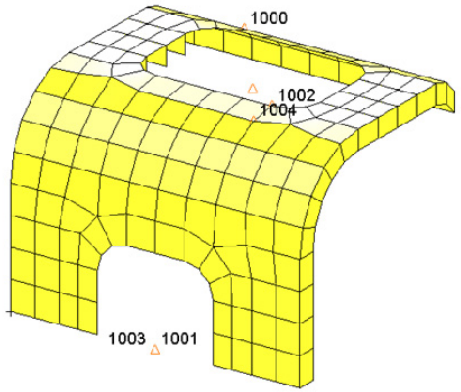
Workshop – Parameter Study, Varying the Location of Concentrated Masses

AN MSC NASTRAN MACHINE LEARNING WEB APP TUTORIAL

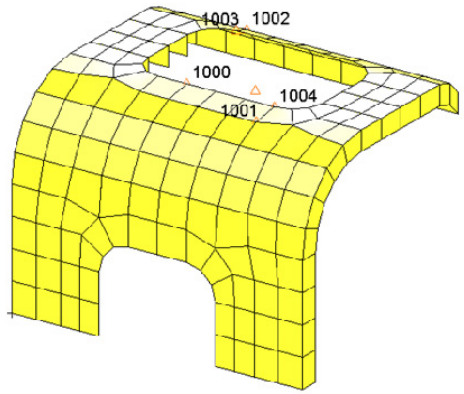
Questions? Email: christian@ the-engineering-lab.com

Goal: Configure multiple MSC Nastran runs

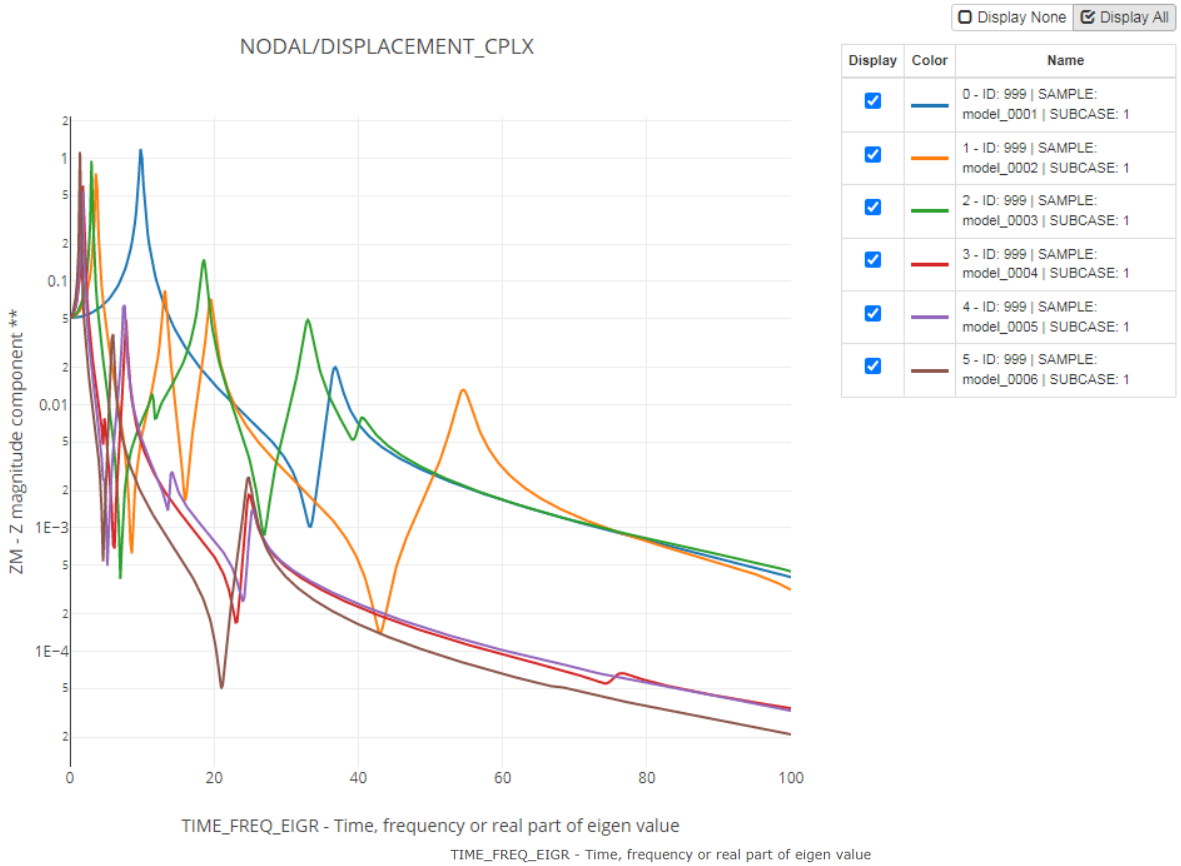
1. Vary the location of 5 concentrated masses on the bracket
2. Configure 6 MSC Nastran runs, each run with a different position for the 5 concentrated masses
3. Plot the displacement response at GRID 999 for all MSC Nastran runs



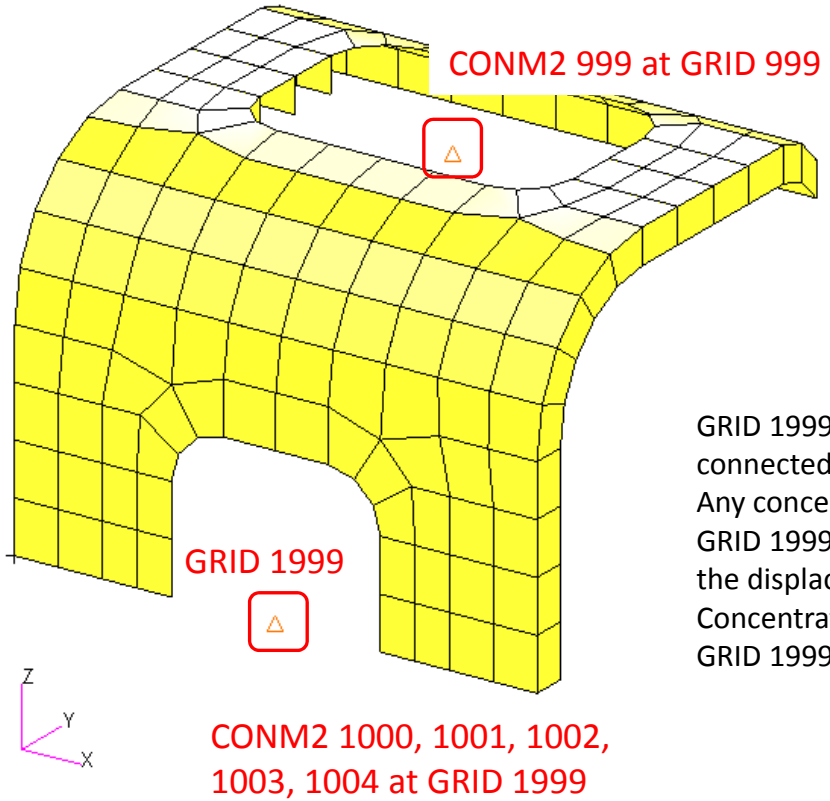
Sample 4 - 3 active CONM2



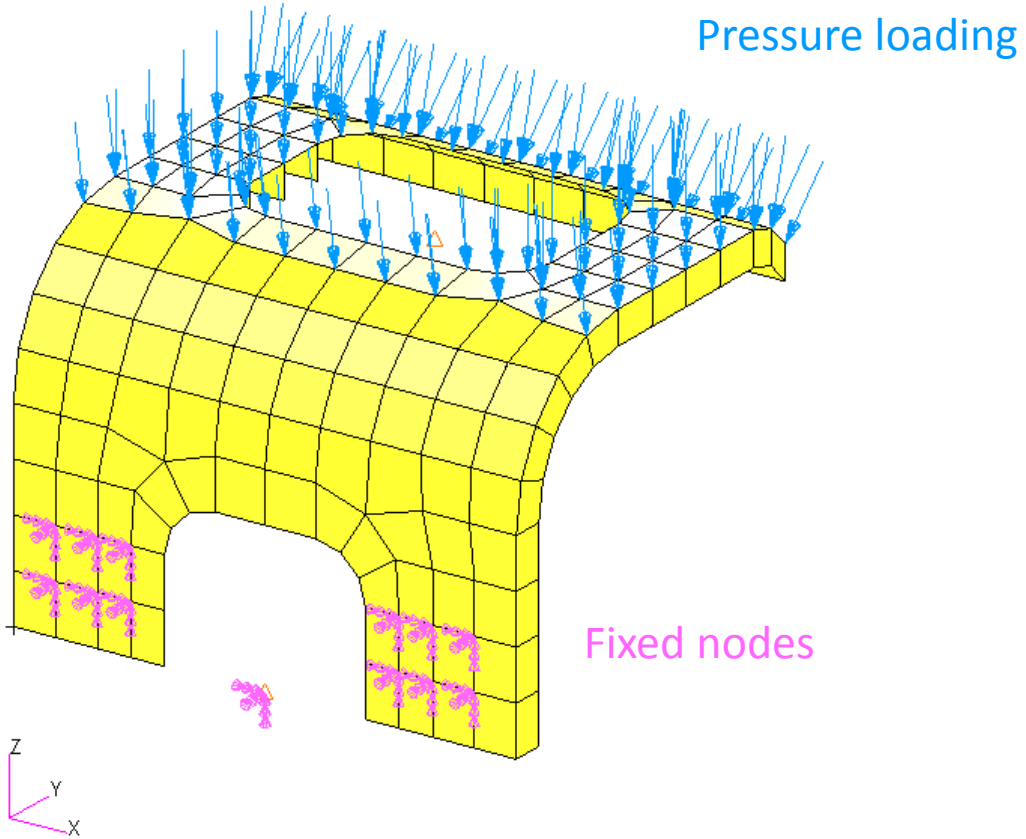
Sample 6 - 5 active CONM2



Details of the Structural Model



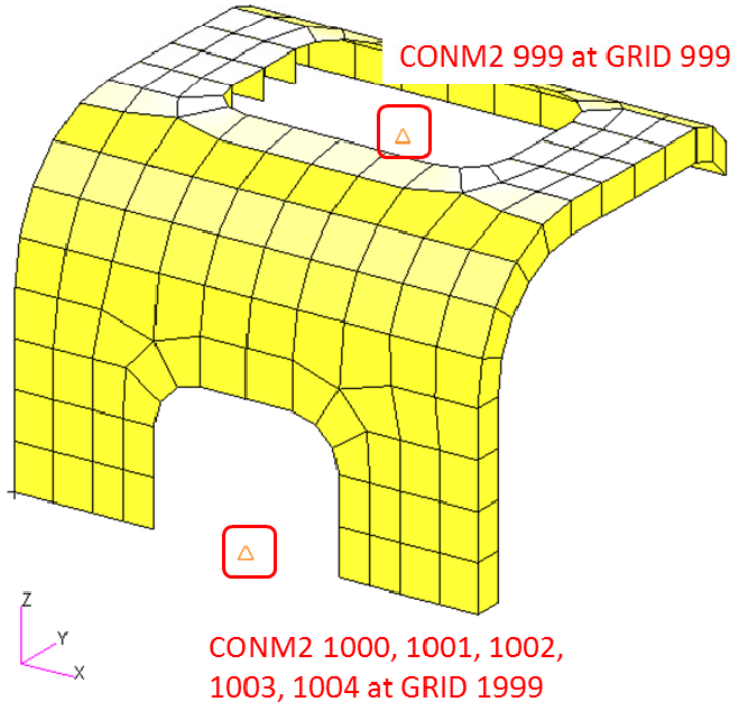
GRID 1999 is fixed and not connected to the bracket. Any concentrated mass at GRID 1999 has no effect on the displacement response. Concentrated masses at GRID 1999 are *inactive*.



Problem Statement

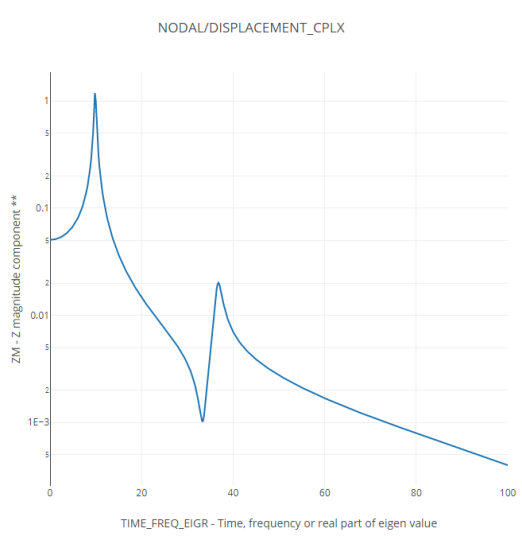
Design Variables

- x1: The grid point identification number (field G) of CONM2 1000
- x2: The grid point identification number (field G) of CONM2 1001
- x3: The grid point identification number (field G) of CONM2 1002
- x4: The grid point identification number (field G) of CONM2 1003
- x5: The grid point identification number (field G) of CONM2 1004



Monitored Responses

r1: Displacement, z component, at GRID 999 for all forcing frequencies



Samples

1. 6 MSC Nastran runs are configured
   - Each value for the parameters corresponds to a different GRID identification number
2. Consider sample 1
   - Parameters, x1, x2, x3, x4, x5 are all set to 19999, i.e. the 5 concentrated masses are placed at GRID 19999. Sample 1 has 5 inactive concentrated masses.
3. Consider sample 2
   - Parameter x1 is set to 95, i.e. CONM2 1000 is placed at GRID 95
   - All other CONM2s are left at GRID 19999, which correspond to parameters x2, x3, x4 and x5. Sample 2 has 1 active concentrated mass and 4 inactive concentrated masses.

			Parameters				
	Sample Number	Status	x1	x2	x3	x4	x5
✖	1	✔	19999	19999	19999	19999	19999
✖	2	✔	95	19999	19999	19999	19999
✖	3	✔	85	19999	19999	19999	82
✖	4	✔	185	19999	95	19999	85
✖	5	✔	195	95	19999	92	85
✖	6	✔	92	85	185	195	95

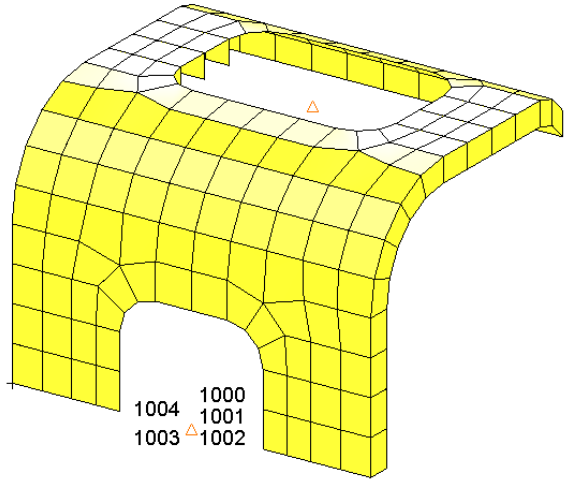
1

5 | 10 | 20 | 30 | 40 | 50

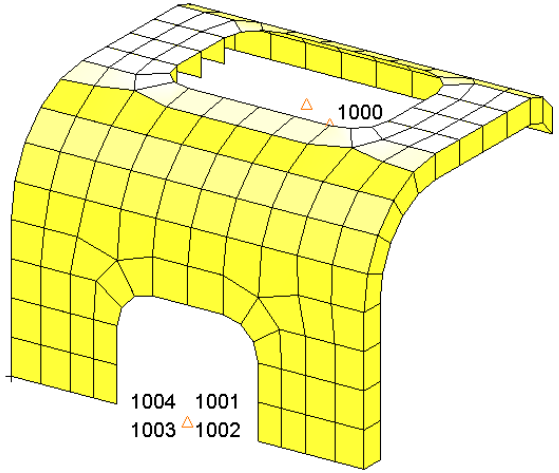
Samples

1. The position of concentrated mass for all 6 samples are displayed
2. Sample 1 is the only sample where all 5 concentrated masses (CONM2 1000, 1001, 1002, 1003, 1004) are placed at the fixed GRID 1999. The 5 concentrated masses are inactive for sample 1. MSC Nastran will run each sample.

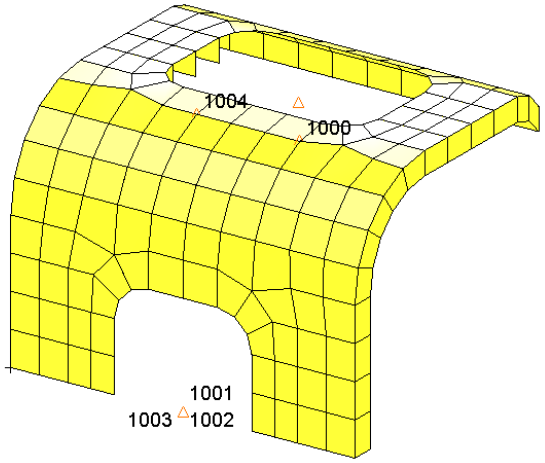
Concentrated Mass (CONM2)



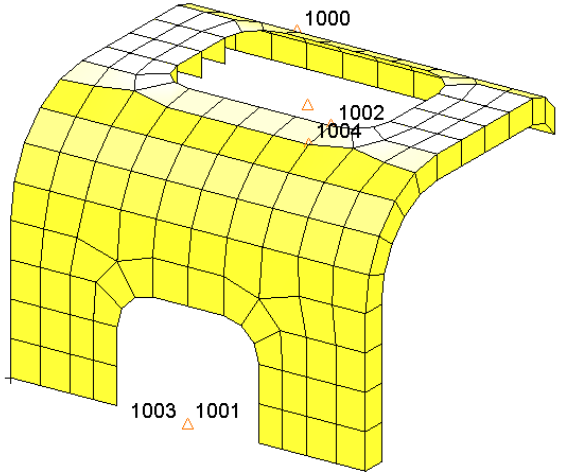
Sample 1 - 0 active CONM2



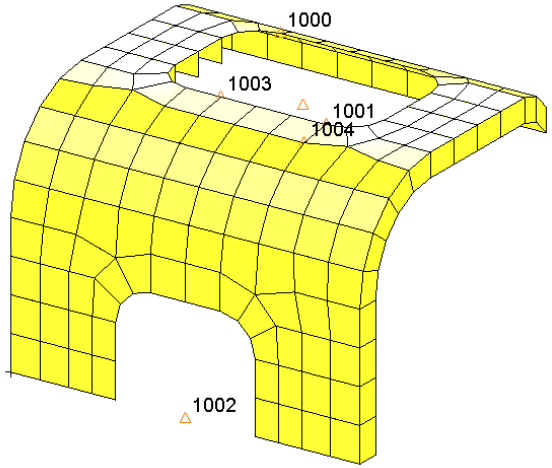
Sample 2 - 1 active CONM2



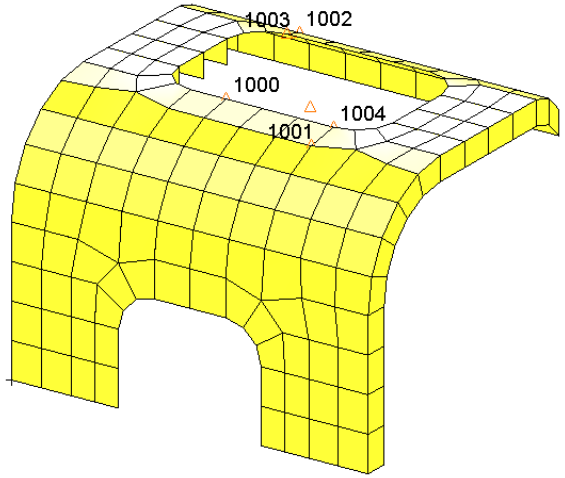
Sample 3 - 2 active CONM2



Sample 4 - 3 active CONM2



Sample 5 - 4 active CONM2

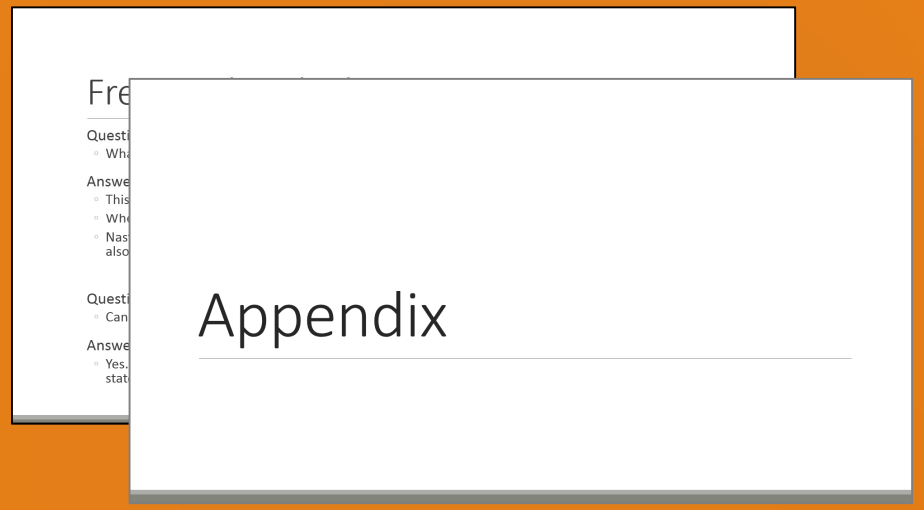


Sample 6 - 5 active CONM2

More Information Available in the Appendix

The Appendix includes information regarding the following:

- Response Configuration
  - Monitor the maximum or minimum response, whichever has the greatest absolute value: Yes, No or blank
- How to import and edit files



Contact me

- Nastran SOL 200 training
- Nastran SOL 200 questions
- Structural or mechanical optimization questions
- Access to the SOL 200 Web App

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Tutorial

Tutorial Overview

1. Start with a .bdf or .dat file
2. Use the Machine Learning web app to:
    1. Configure the problem statement
    2. Configure multiple batch runs
3. Use the HDF5 Explorer to:
    1. Create response vs. frequency plots

Special Topics Covered

Automatic Response Extraction – Often responses are manually or automatically extracted from the F06 file. This becomes challenging when extracting responses from multiple F06 files. This tutorial highlights the web app's ability to automatically extract responses from multiple H5 files with minimal user effort.

XY Plots – This tutorial focuses on the displacement response generated by a frequency response analysis. XY plots must be created. The HDF5 Explorer is used to automatically generate the XY plots.

SOL 200 Web App Capabilities

The Post-processor Web App and HDF5 Explorer are free to MSC Nastran users.

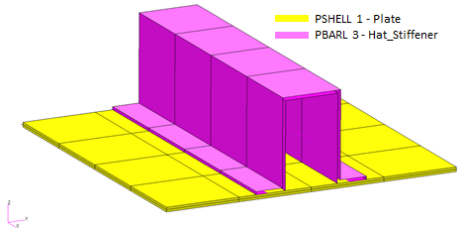
Compatibility

- Google Chrome, Mozilla Firefox or Microsoft Edge
- Windows and Red Hat Linux
- Installable on a company laptop, workstation or server. All data remains within your company.

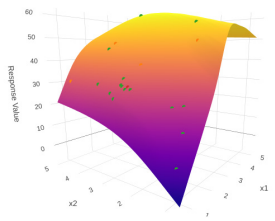
Benefits

- REAL TIME error detection. 200+ error validations.
- REALT TIME creation of bulk data entries.
- Web browser accessible
- Free Post-processor web apps
- +80 tutorials

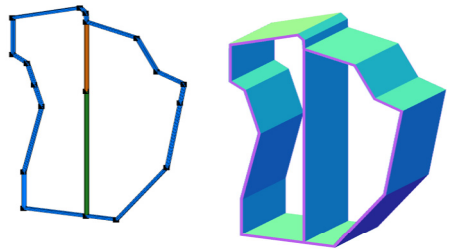
Web Apps



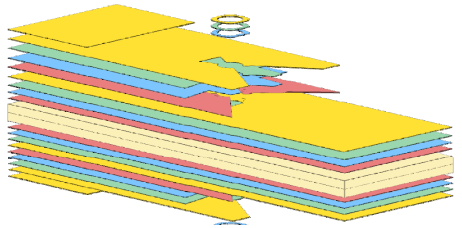
Web Apps for MSC Nastran SOL 200
Pre/post for MSC Nastran SOL 200. Support for size, topology, topometry, topography, multi-model optimization.



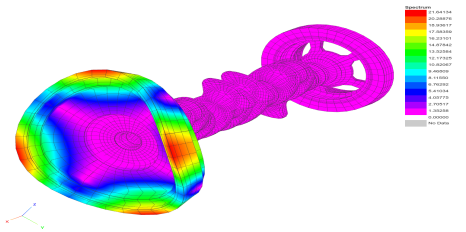
Machine Learning Web App
Bayesian Optimization for nonlinear response optimization (SOL 400)



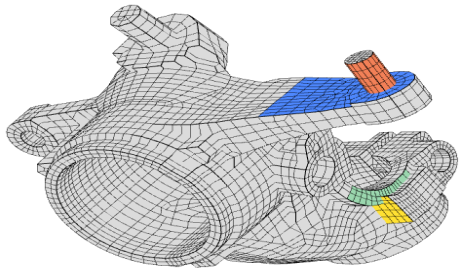
PBMSECT Web App
Generate PBMSECT and PBRSECT entries graphically



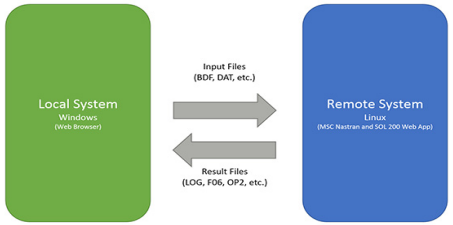
Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries



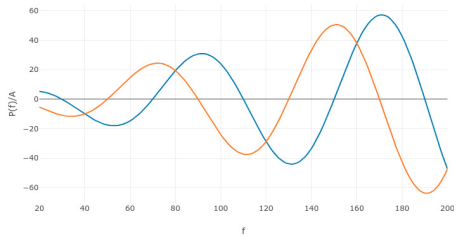
Post-processor Web App
View MSC Nastran results in a web browser on Windows and Linux



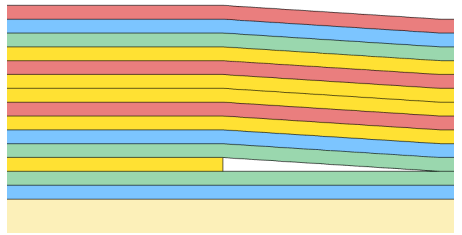
Shape Optimization Web App
Use a web application to configure and perform shape optimization.



Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network



Dynamic Loads Web App
Generate RLOAD1, RLOAD2 and DLOAD entries graphically



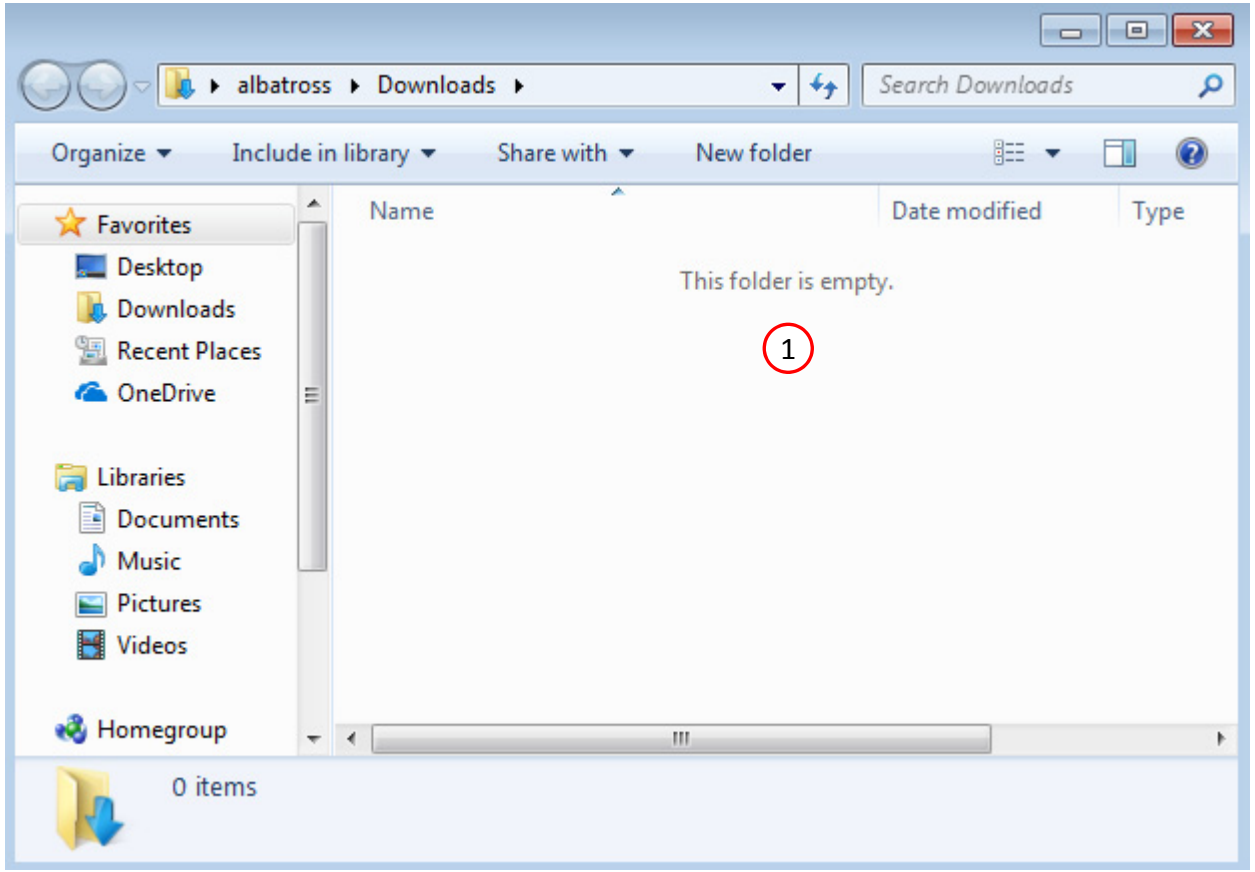
Stacking Sequence Web App
Optimize the stacking sequence of composite laminate plies

HDF5 Explorer Web App
Create graphs (XY plots) using data from the H5 file

Before Starting

1. Ensure the Downloads directory is empty in order to prevent confusion with other files

- Throughout this workshop, you will be working with multiple file types and directories such as:
  - .bdf/.dat
  - nastran_working_directory
  - .f06, .log, .pch, .h5, etc.
- To minimize confusion with files and folders, it is encouraged to start with a clean directory.



Go to the User's Guide

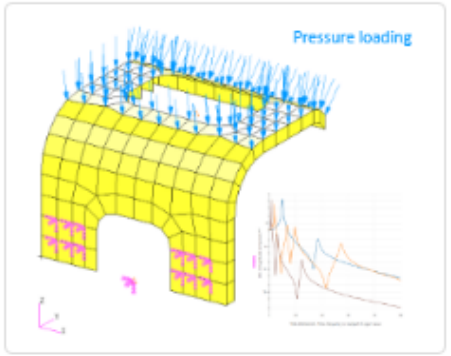
1. Click on the indicated link

- The necessary BDF files for this tutorial are available in the Tutorials section of the User's Guide.

Obtain Starting Files

1. Find the indicated example
2. Click Link
3. The starting file has been downloaded

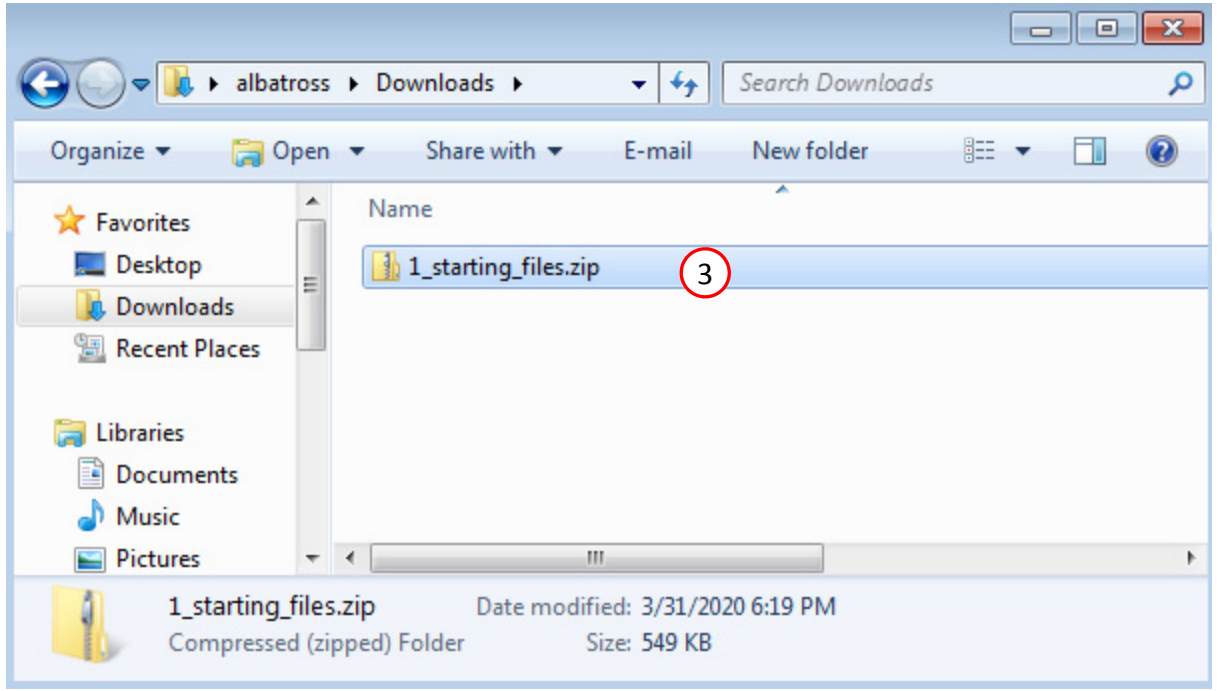
- When starting the procedure, all the necessary BDF, or DAT, files must be collected and uploaded together. Relevant INCLUDE files must also be collected and uploaded.



Parameter Study, Varying the Location of Concentrated Masses (1)

A frequency response analysis is performed on a bracket. The goal in this tutorial is to vary the position of 5 concentrated masses on the bracket and determine the displacement vs. frequency plots for each different configuration of concentrated masses. In total, six MSC Nastran runs are configured, each with a different configuration of the concentrated masses.

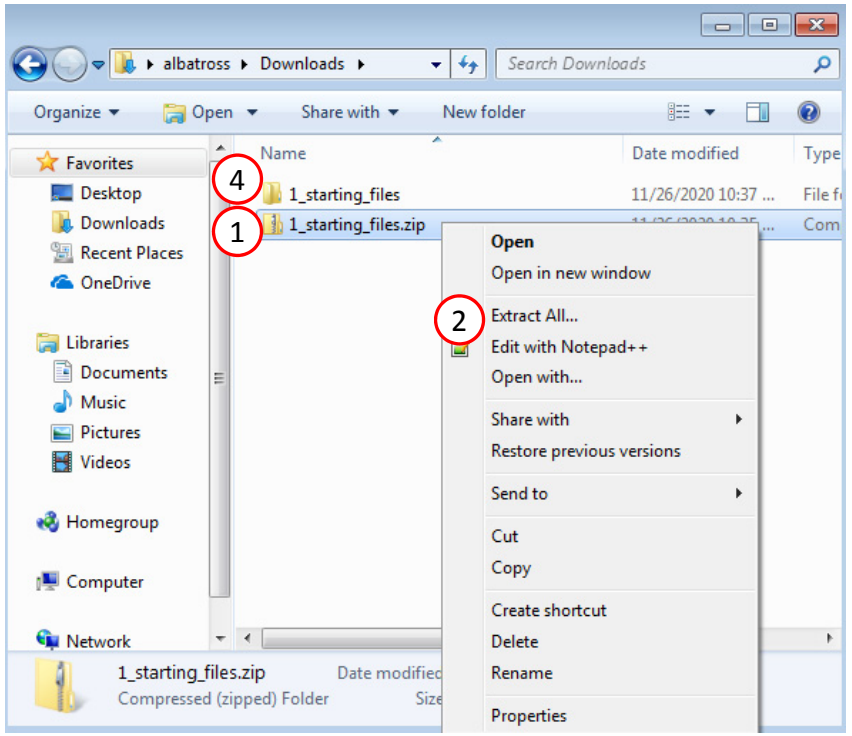
Starting Files: Link
Solution BDF Files: Link (2)

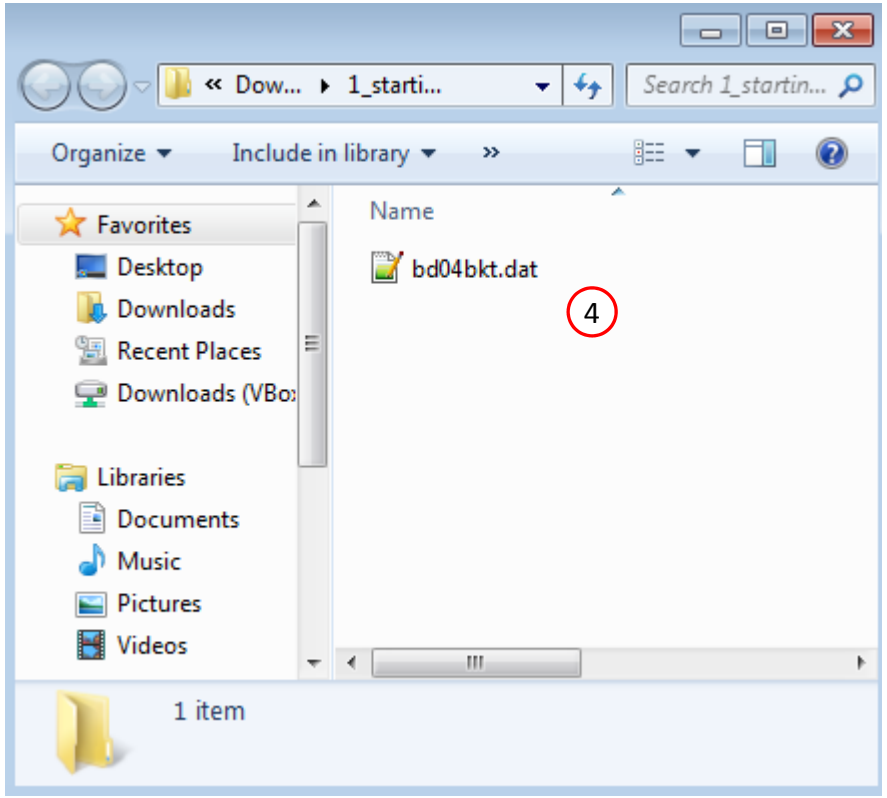


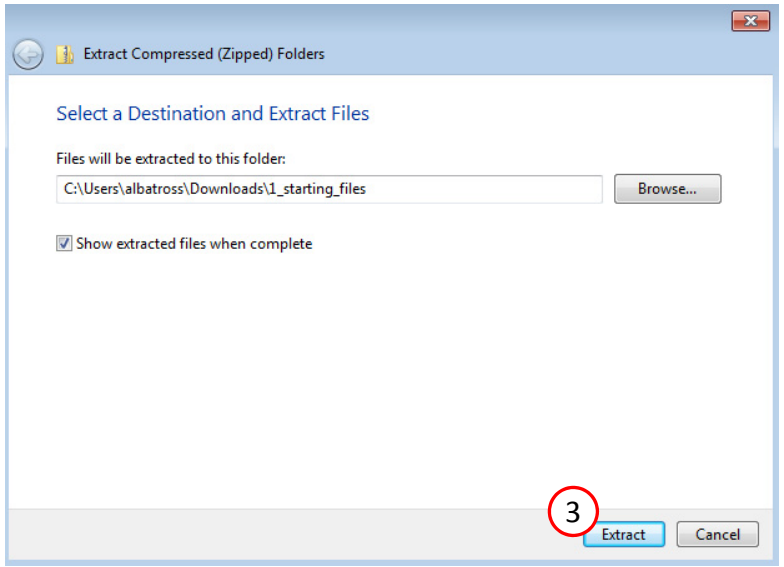
Obtain Starting Files

1. Right click on the zip file
2. Select Extract All…
3. Click Extract
4. The starting files are now available in a folder

- The starting files for this tutorial are contained in a ZIP file and must be extracted as shown.



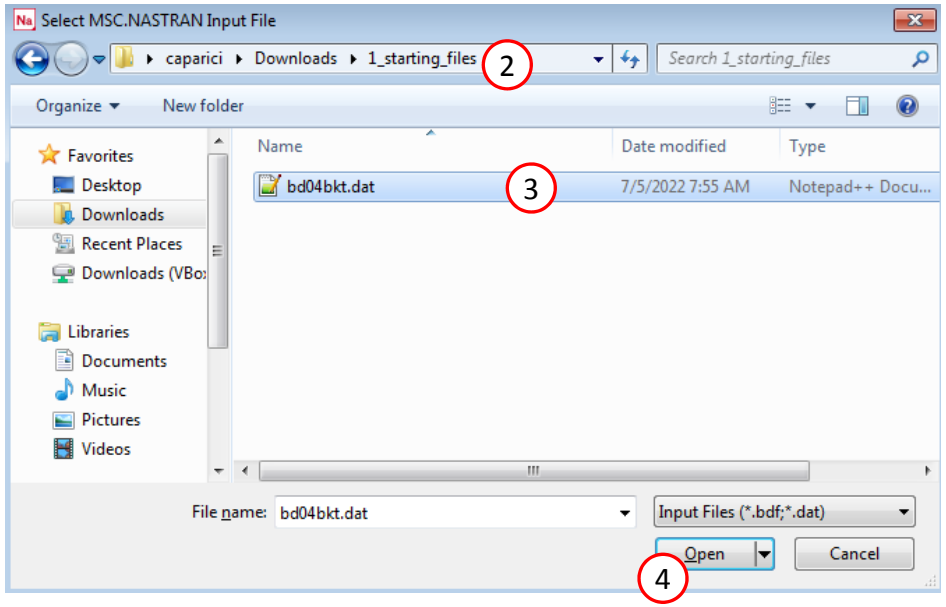


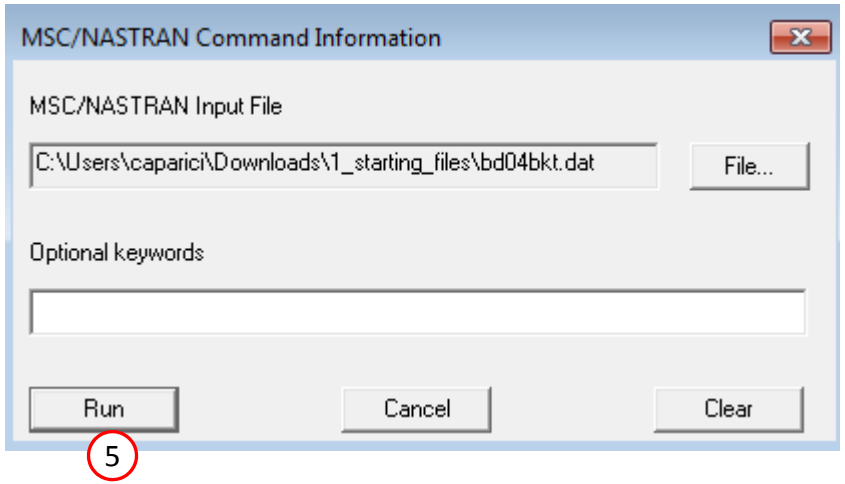


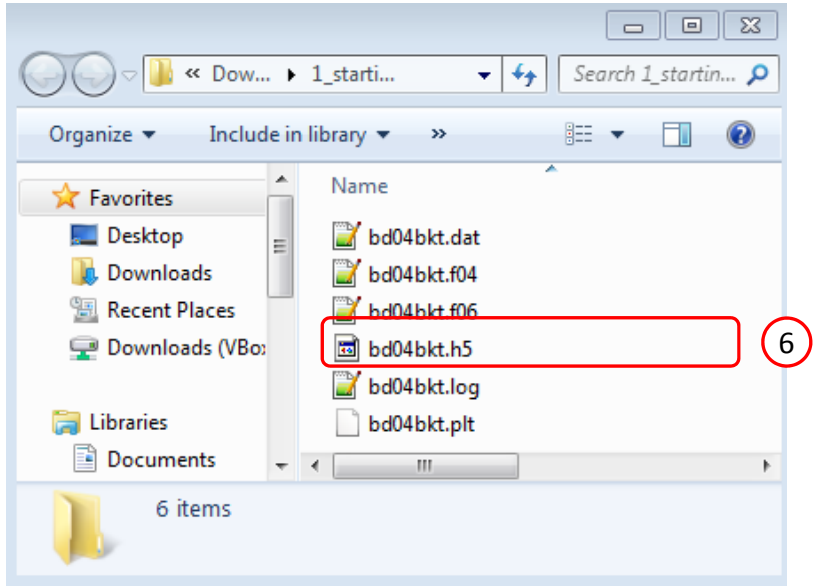
Create the Starting H5 File

A starting H5 file must be created. This H5 file will be used to configure the responses later on.

1. Double click the MSC Nastran desktop shortcut
2. Navigate to the directory named 1_starting_files
3. Select the indicated file
4. Click Open
5. Click Run
6. The starting H5 file is created







Use the same MSC Nastran version throughout this exercise

The following applies if you have multiple versions of MSC Nastran installed.

To ensure compatibility, use the same MSC Nastran version throughout this exercise.
For example, scenario 1 is OK but scenario 2 is NOT OK.

- Scenario 1 - OK
  - MSC Nastran 2021 is used to create the starting H5 file.
  - MSC Nastran 2021 is used for each run during Machine Learning or Parameter study.
- Scenario 2 – NOT OK
  - MSC Nastran 2018.2 is used to create the starting H5 file.
  - MSC Nastran 2021 is used for each run during Machine Learning or Parameter study.

Using the same MSC Nastran version is critical for consistent response extraction from the H5 file. A response configured for Nastran version X may not match in Nastran version Y, which leads to unsuccessful response extraction from the H5 files. The goal is to make sure all H5 files generated are from the same MSC Nastran version.

Open the Correct Page

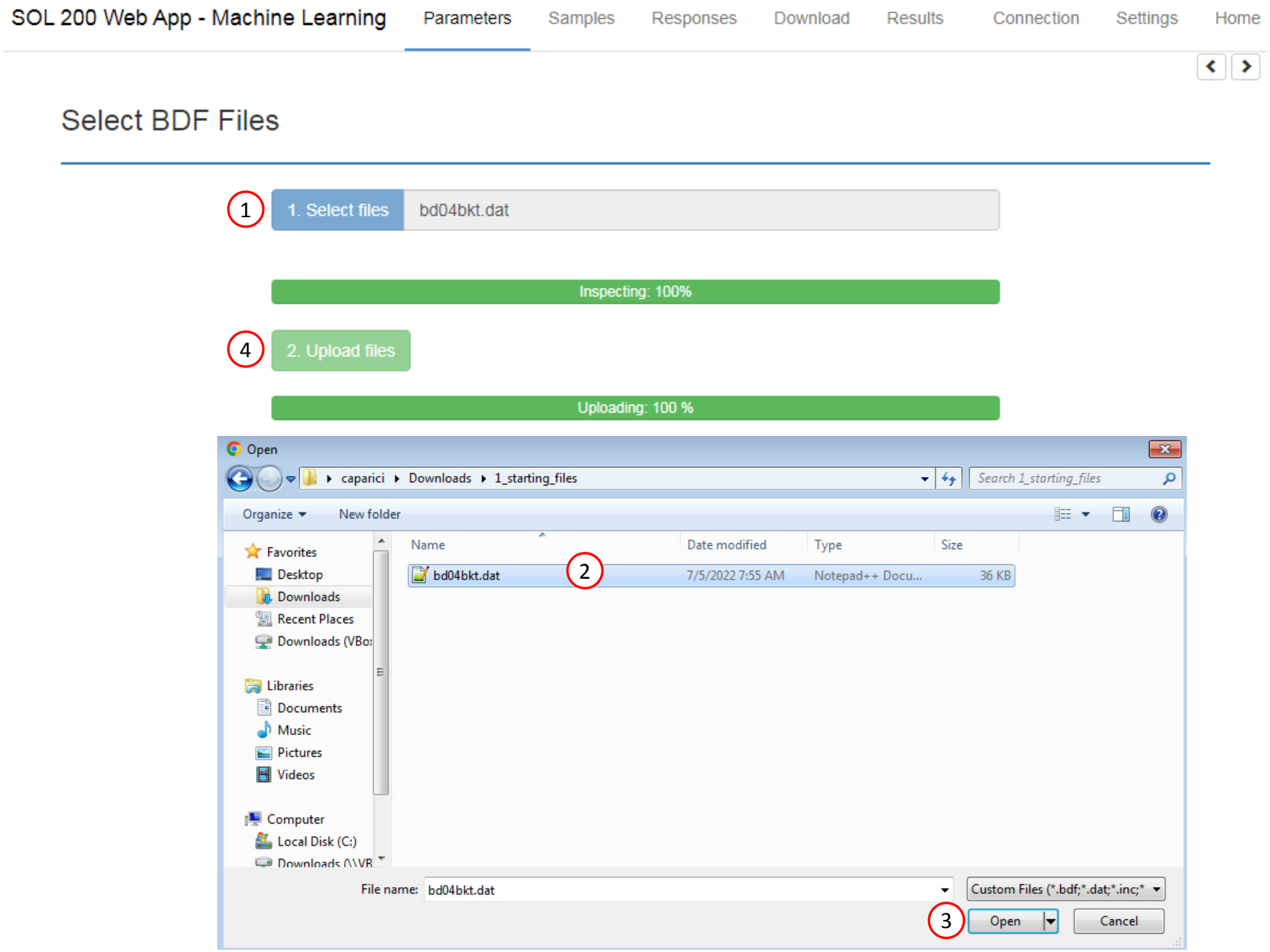
1. Click on the indicated link

- MSC Nastran can perform many optimization types. The SOL 200 Web App includes dedicated web apps for the following:
  - Optimization for SOL 200 (Size, Topology, Topometry, Topography, Local Optimization, Sensitivity Analysis and Global Optimization)
  - Multi Model Optimization
  - Machine Learning
- The web app also features the HDF5 Explorer, a web application to extract results from the H5 file type.

Select BDF Files

1. Click Select files
2. Select the indicated files
3. Click Open
4. Click Upload files

- When starting the procedure, all the necessary BDF, or DAT, files must be collected and uploaded together. Relevant INCLUDE files must also be collected and uploaded.



Parameters

1. Set the following fields as parameters
   - x1: The grid point identification number (field G) of CONM2 1000
   - x2: The grid point identification number (field G) of CONM2 1001
   - x3: The grid point identification number (field G) of CONM2 1002
   - x4: The grid point identification number (field G) of CONM2 1003
   - x5: The grid point identification number (field G) of CONM2 1004
2. A parameter has been created for the selected fields

- Bulk data entries will always be displayed in the small field format.
- Only fields that have real or integer data entries may be selected as parameters. If the field is blank or contains only characters, the field may not be selected.

Select Parameters

```
$__1___||__2___||__3___||__4___||__5___

CONM2   999     999             .0906
+       .35             .56
CONM2   1000    %x1%            1.0
CONM2   1001    %x2%            1.0
CONM2   1002    %x3%            1.0
CONM2   1003    %x4%            1.0
CONM2   1004    %x5%            1.0
EIGRL   777     -0.1    1000.
FREQ1   5       0.0     0.2     500
MAT1    1       3.+7    1.153+7
MDLPRM  HDF5    2
PLOAD4  1       171     -3.
PLOAD4  1       172     -3.
PLOAD4  1       160     -3.
PLOAD4  1       161     -3.
```

1

Configure Parameters

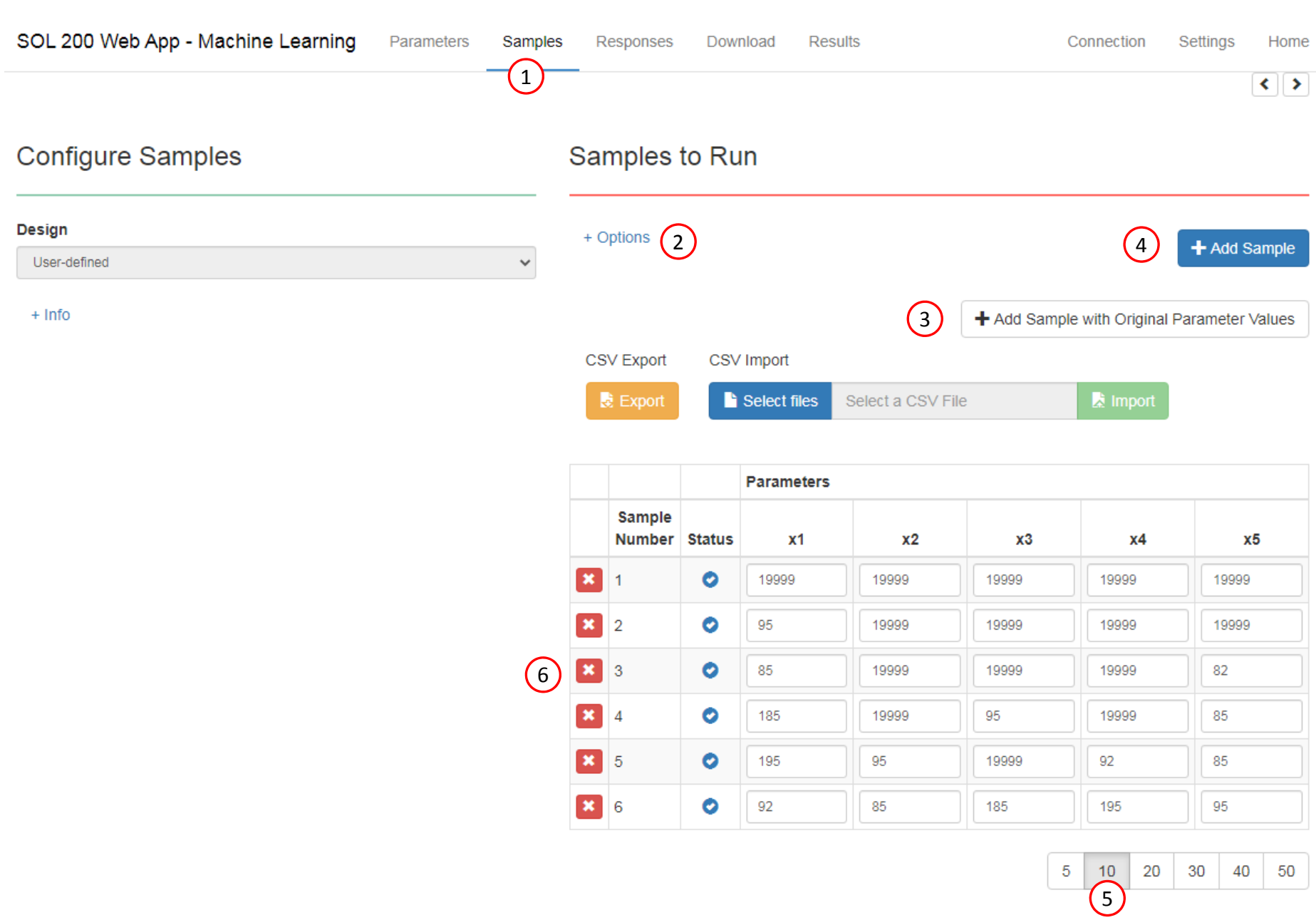
2

Delete	Parameter	Status	Input Type	Low	High	Comments
✖	x1	✔	integer	Low	High	Field 3 of CONM2 10
✖	x2	✔	integer	Low	High	Field 3 of CONM2 10
✖	x3	✔	integer	Low	High	Field 3 of CONM2 10
✖	x4	✔	integer	Low	High	Field 3 of CONM2 10
✖	x5	✔	integer	Low	High	Field 3 of CONM2 10

Samples

1. Click Samples
2. Click + Options
3. Click Add Sample with Original Parameter Values
4. Click Add Sample 5 times
5. Click 10 on the pagination bar to display at most 10 rows on the table
6. 6 samples have been created

- Each sample is a new configuration of the FE model. MSC Nastran will be run for each sample.



Samples

1. Update the values to match the table shown

			Parameters				
	Sample Number	Status	x1	x2	x3	x4	x5
✖	1	✔	19999	19999	19999	19999	19999
✖	2	✔	95	19999	19999	19999	19999
✖	3	✔	85	19999	19999	19999	82
✖	4	✔	185	19999	95	19999	85
✖	5	✔	195	95	19999	92	85
✖	6	✔	92	85	185	195	95

1

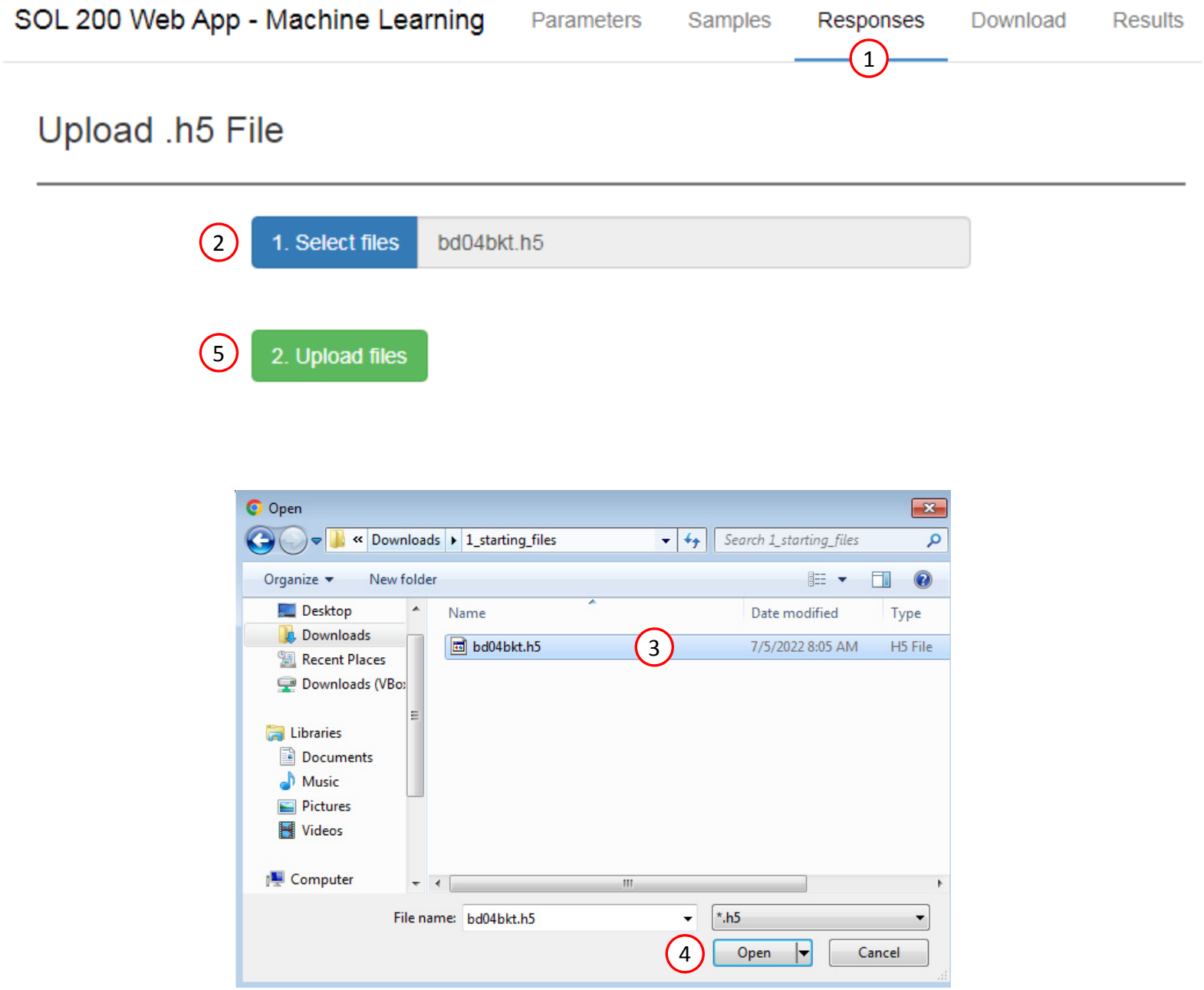
5 | 10 | 20 | 30 | 40 | 50

- Parameters x1, x2, …, x6 correspond to the GRID position of each concentrated mass (CONM2). GRID 19999 is fixed in all 3 directions of translation and rotation. GRID 19999 is not connected to the bracket. Any concentrated mass at GRID 19999 is not contributing to the response of the bracket. Concentrated masses are GRID 19999 are deemed inactive.

Responses

1. Click Responses
2. Click Select files
3. Select the indicated file
4. Click Open
5. Click Upload files

- On this page, the H5 file is uploaded to the web app.

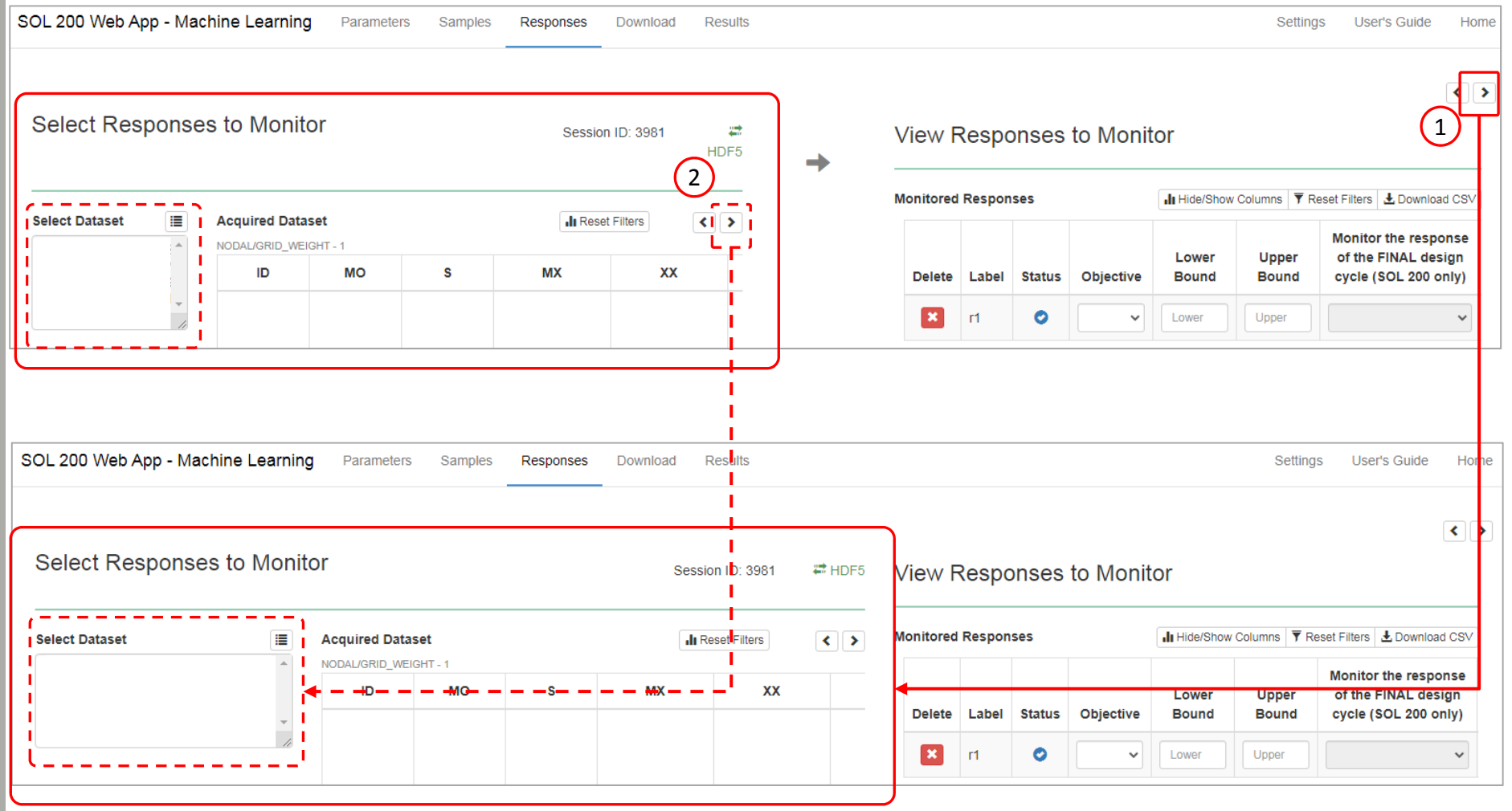


Adjust the Column Width

1. Optional - Use at your liking the buttons at the top right hand corner to adjust the width of the left and right columns

2. Optional – Use the indicated buttons to adjust the width of the column Select Dataset

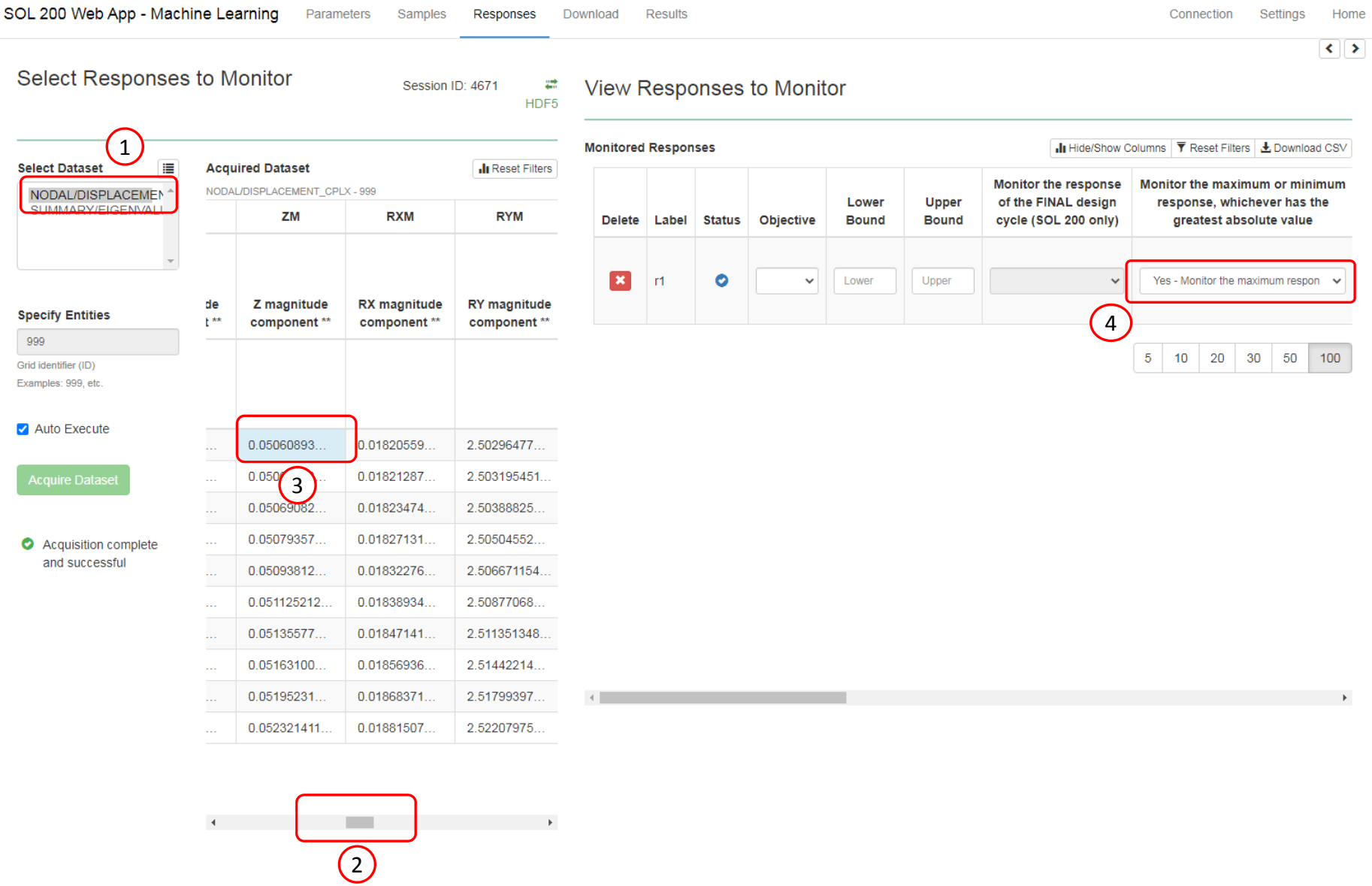
- IMPORTANT! This image is not meant to match exactly what you see in your view. The text in this image is expected to be different from your view. The purpose of this page and image is to demonstrate how to increase the width of the indicated sections.



Select Responses

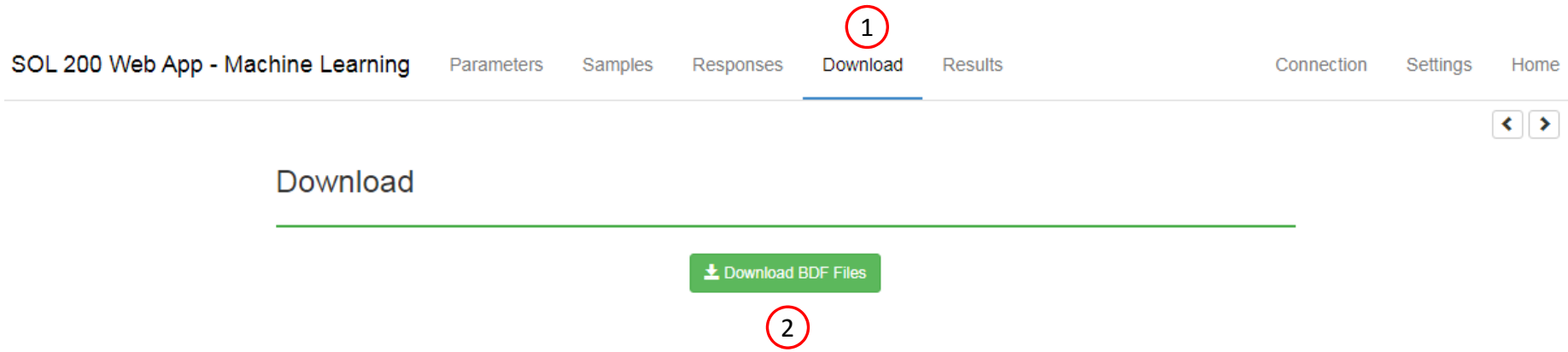
1. Select the following dataset: NODAL/DISPLACEMENT_CPLX
2. Use the horizontal scroll bar to find the column ZM
3. Select the indicated cell, a new response r1 is created
4. Ensure Yes is set for column *Monitor the maximum or minimum response, whichever has the greatest absolute value*

- Refer to the Appendix for an explanation on the use of the following:
  - *Monitor the maximum or minimum response, whichever has the greatest absolute value*



Download

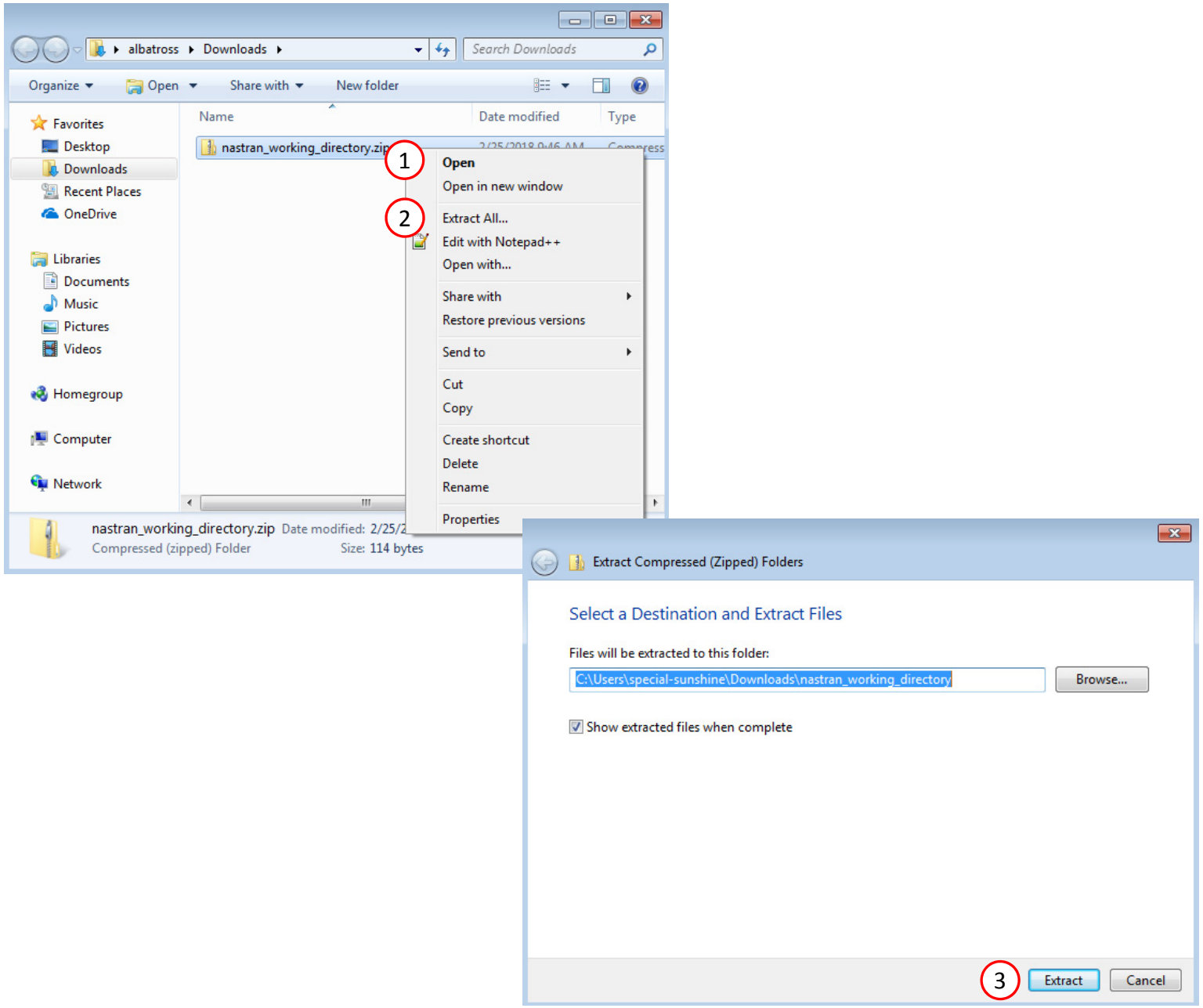
1. Click Download
2. Click Download BDF Files



Start MSC Nastran

1. A new .zip file has been downloaded
2. Right click on the file
3. Click Extract All
4. Click Extract on the following window

- Always extract the contents of the ZIP file to a new, empty folder.



Start MSC Nastran

1. Inside of the new folder, double click on Start Desktop App
2. Click Open, Run or Allow Access on any subsequent windows
3. MSC Nastran will now start

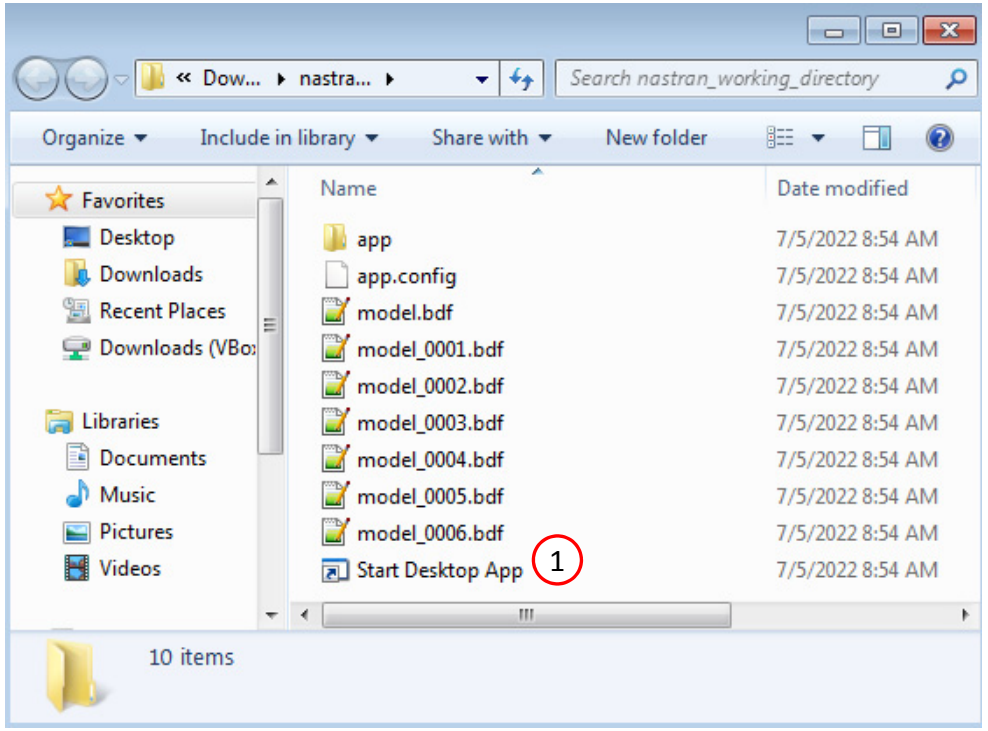
- One can run the Nastran job on a remote machine as follows:
  1) Copy the BDF files and the INCLUDE files to a remote machine. 2) Run the MSC Nastran job on the remote machine. 3) After completion, copy the BDF, F06, LOG, H5 files to the local machine. 4) Click "Start MSC Nastran" to display the results.

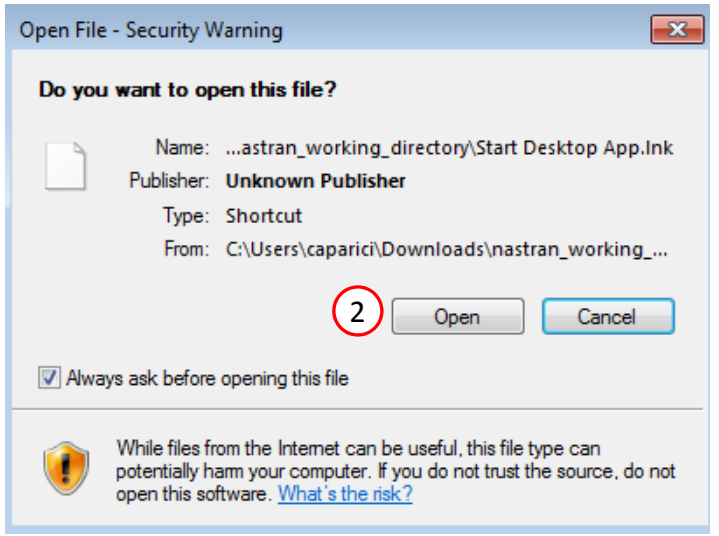
Using Linux?

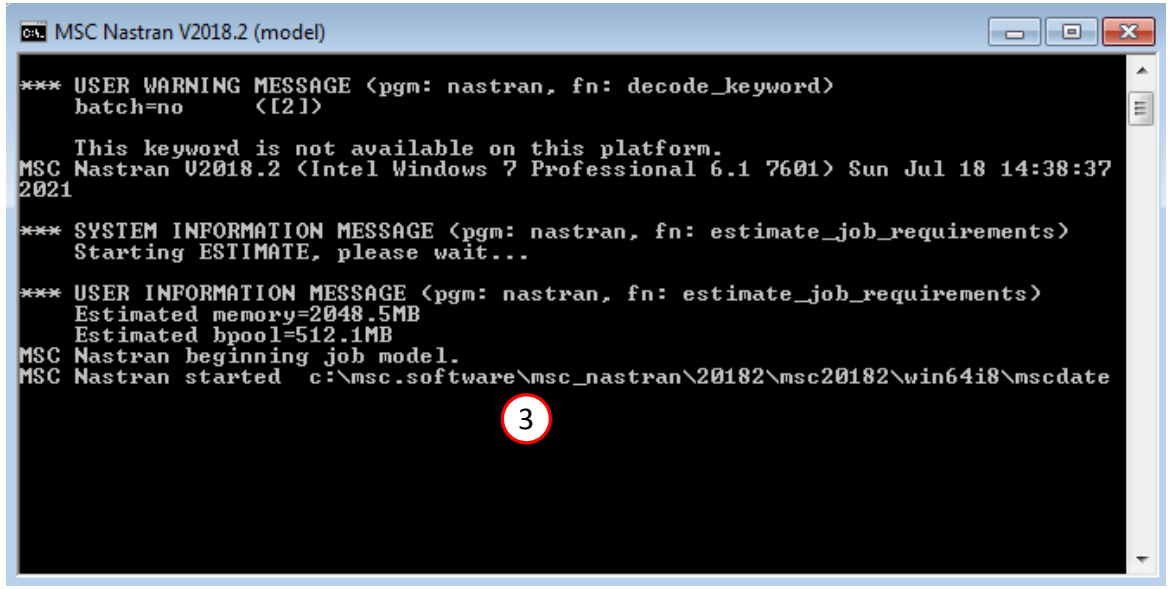
Follow these instructions:
1) Open Terminal
2) Navigate to the nastran_working_directory
cd ./nastran_working_directory
3) Use this command to start the process
./Start_MSC_Nastran.sh

In some instances, execute permission must be granted to the directory. Use this command. This command assumes you are one folder level up.

sudo chmod -R u+x ./nastran_working_directory

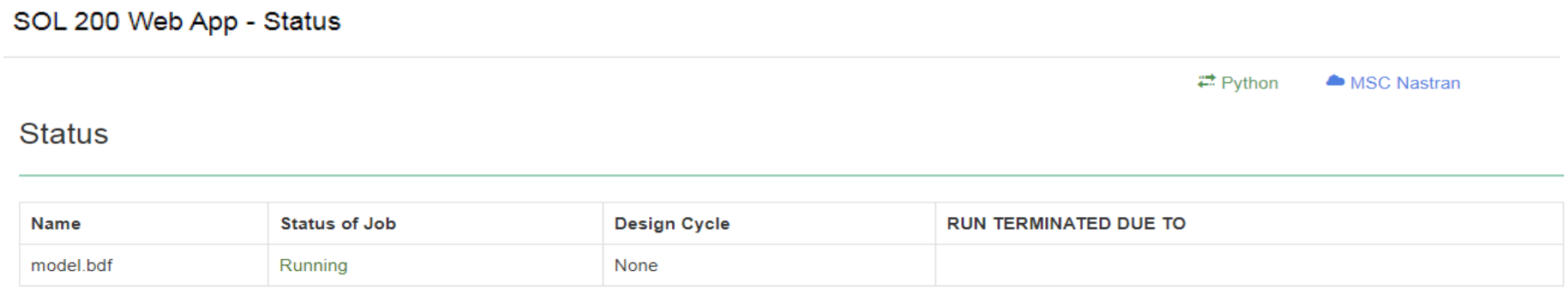






Status

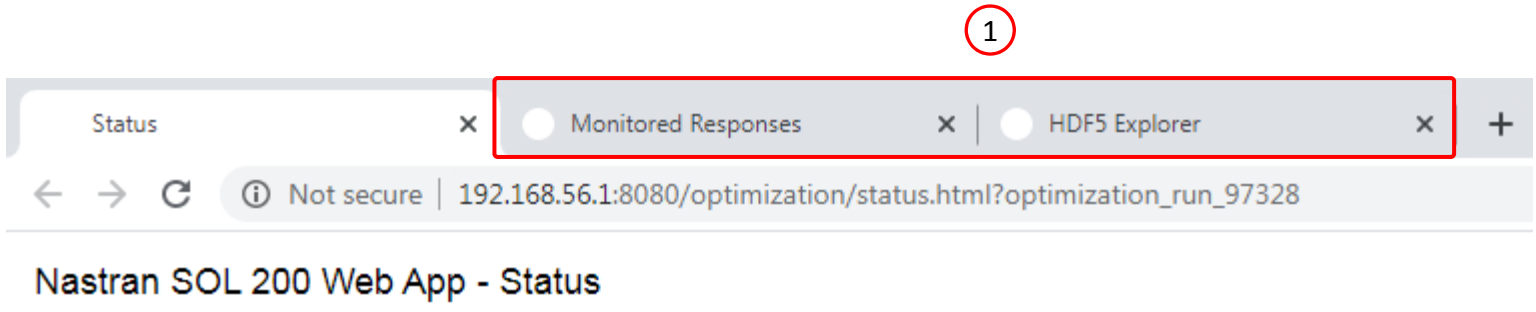
- While MSC Nastran is running, a status page will show the current state of MSC Nastran



Results

After each MSC Nastran analysis is complete, multiple web apps are automatically opened to display the results.

1. Use the tabs to switch between each web app
2. A description of each web app is given in the table.



2

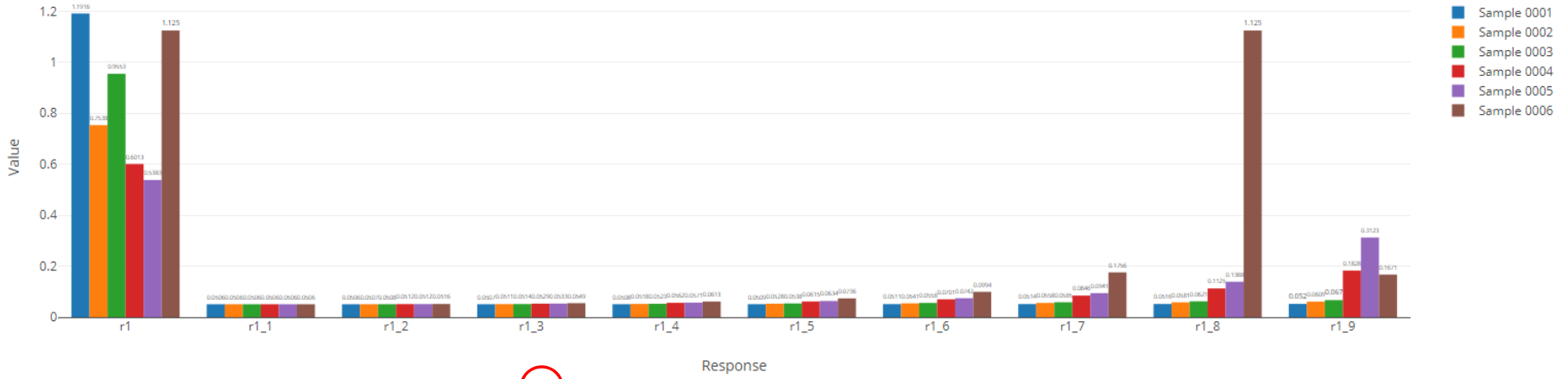
Name of Web App	Purpose	Description
Monitored Responses	• The response value from each sample can be compared.	• After each MSC Nastran analysis, the response values are extracted from the H5 file and contained in a file named app_monitored_responses.csv. The Monitored Responses web app is used to create a bar chart of the values contained in this CSV file.
HDF5 Explorer	• This web app is used to probe each H5 file and generate XY plots.	

Review Results

1. The Monitored Responses web app is opened
2. The r1 response corresponds to the maximum displacement at GRID 999 across all forcing frequencies

A. The table titled Monitored Response can be interacted with. Each column in the table contains filters. Once a filter is modified, the Bar Chart will instantly update.
B. Additional functions include the ability to highlight the MAX and MIN bars, download a CSV file and reset the filters.

SOL 200 Web App - Monitored Responses (1) Home



(B)

Monitored Responses — Display MAX and MIN | Download CSV | Reset Filters

Label	Dataset Name	Field	Field Description	Current Val
r1 r1_1 r1_2 r1_3 (A)	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	
r1	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050608935364
r1_1	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050608935364
r1_2	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050629383090
r1_3	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050690827070
r1_4	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050793570946
r1_5	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.050938124974
r1_6	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.051125212385
r1_7	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.051355778516
r1_8	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.051631002907
r1_9	NODAL/DISPLACEMENT_CPLX	ZM	Z magnitude component **	0.051952314661

« 1 2 3 4 5 6 7 … 51 » 5 10 20 30 50 100

Monitored Responses from Each Sample

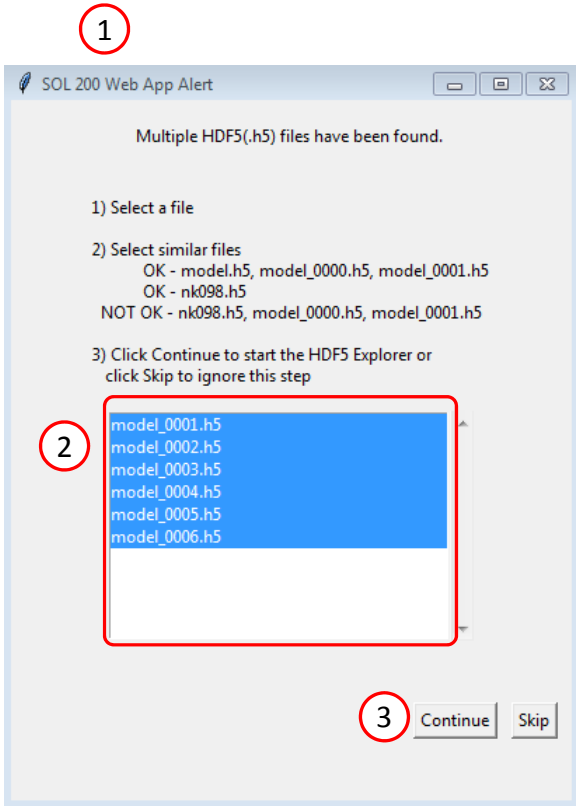
0001	0002	0003	0004	
1.1916060448515353	0.7537704266123554	0.9552510468587065	0.6012526173004038	0.538251
0.05060893536426272	0.050 (2) 4544591775	0.05060893544638503	0.050608935446096064	0.050608
0.050629383090729015	0.05073945513045424	0.050794315229207895	0.05117156823252348	0.051249
0.05069082707001812	0.051135648713305316	0.05136025379389051	0.05294026806581755	0.053279
0.05079357094684524	0.05181184014377652	0.05233747759685566	0.056188347103022576	0.057069
0.050938124974652464	0.052793376556925	0.05378197382281801	0.061498558494454895	0.063444
0.05112521238574228	0.05411911424083467	0.05578352166033682	0.07007347328429885	0.074237
0.0513557785168971	0.05584553298102757	0.05848101917086541	0.08462317270969963	0.094109
0.051631002907274196	0.0580533467085918	0.06208998527967659	0.11252435151143514	0.138818
0.051952314661253156	0.06085818552001885	0.0669537699998354	0.18277865844766644	0.312323

Review Results

1. A new window is opened
2. Select all 6 H5 files
3. Click Continue
4. The HDF5 Explorer is automatically opened.
5. Click the indicate image

The HDF5 Explorer is broken into sections.

- Acquire Dataset – Specific datasets from the H5 file can be extracted in this section.
- Plots Browser – Use this section to navigate every plot created.
- Combine Plots – This section allows you to combine multiple plots. For example, you can create Load vs. Displacement plots in this section.
- Last Plot Added – The Acquire Dataset section has a button titled “Create Plot.” This button, when clicked, creates a new plot. When the link “Last Plot Added” is clicked, the new plot is displayed.



Review Results

1. A Displacement vs Frequency plot is displayed
2. Click Display None
3. Mark any checkbox in the Display column to turn plots on and off
4. Each plot is the response at GRID 999 for each sample

End of Tutorial

Appendix

Appendix Contents

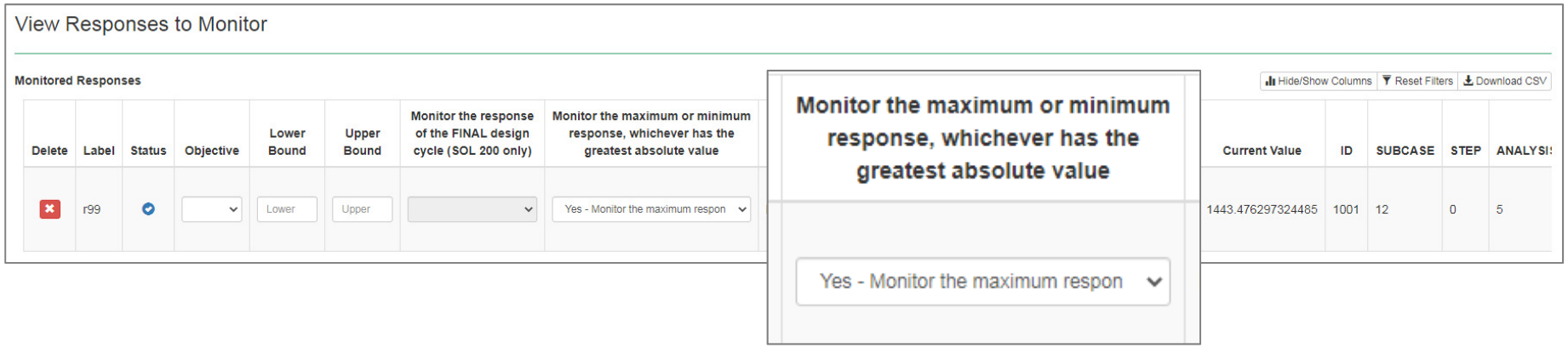
- Response Configuration
  - Monitor the maximum or minimum response, whichever has the greatest absolute value: Yes, No or blank
- How to import and edit previous files
- What is Gaussian Process Regression?

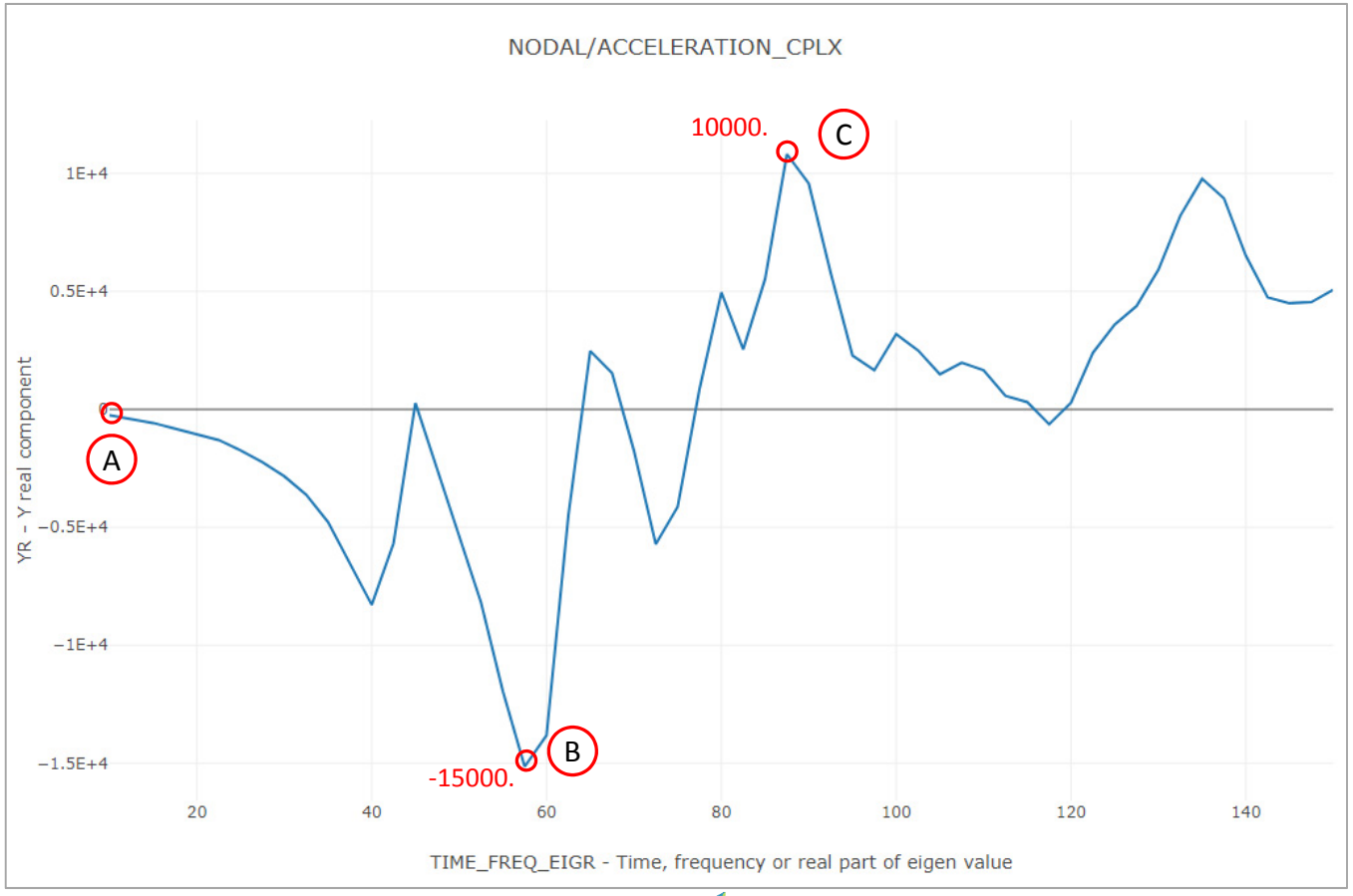
Response Configuration

During this tutorial, this option was used:

- Monitor the maximum or minimum response, whichever has the greatest absolute value : Yes

Suppose response r99 is configured for 10 seconds and corresponds to point A on the plot. When Yes is used for the option, the response furthest from the horizontal axis is monitored. In this example, points B and c are furthest from the horizontal axis. Since point B is furthest from the horizontal axis, a value of -15000.0 is monitored.





How to import and edit previous files

How to import and edit previous files

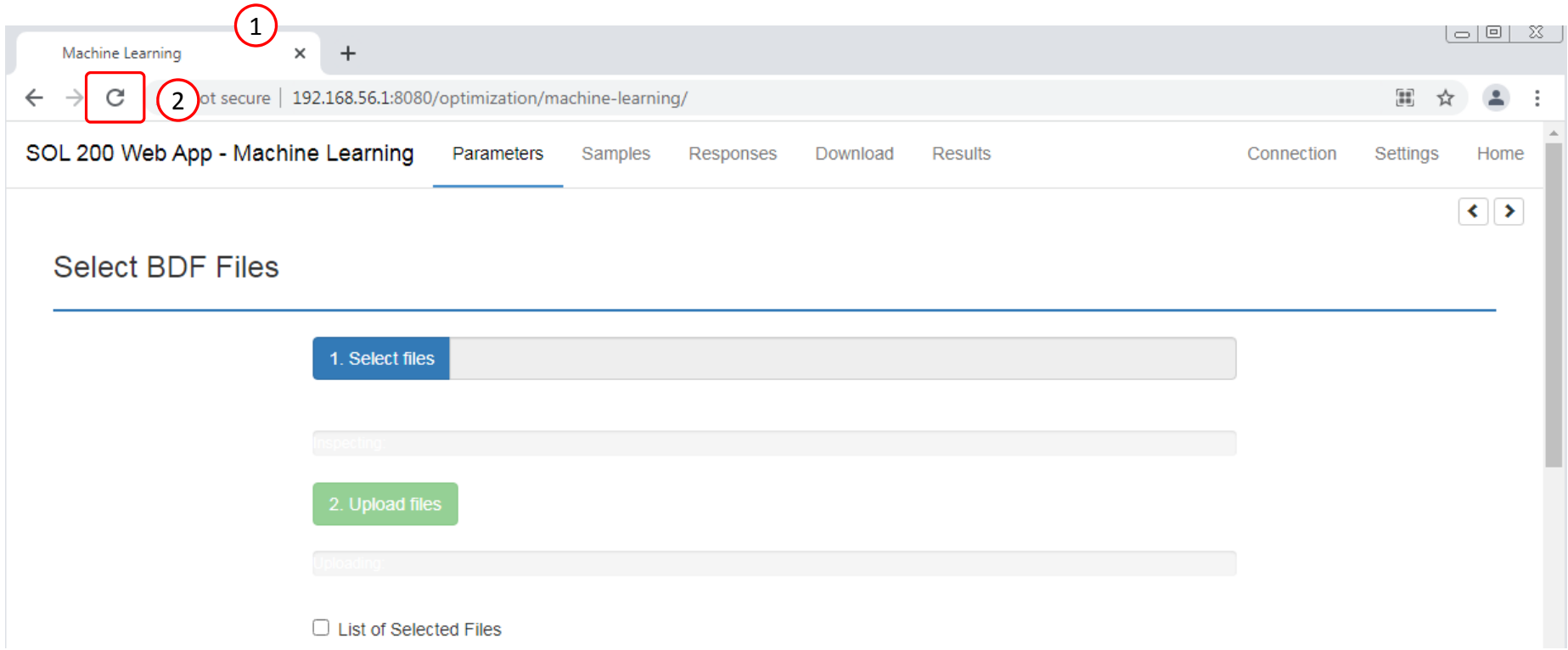
The parameters, samples and responses are contained in the following files

- app.config
- BDF files

These files may be imported back to the Machine Learning web app, and any parameters, samples and responses can be reconfigured

Import

1. Return to the window or tab that has the Machine Learning web app opened
2. Refresh the web page to start a new session

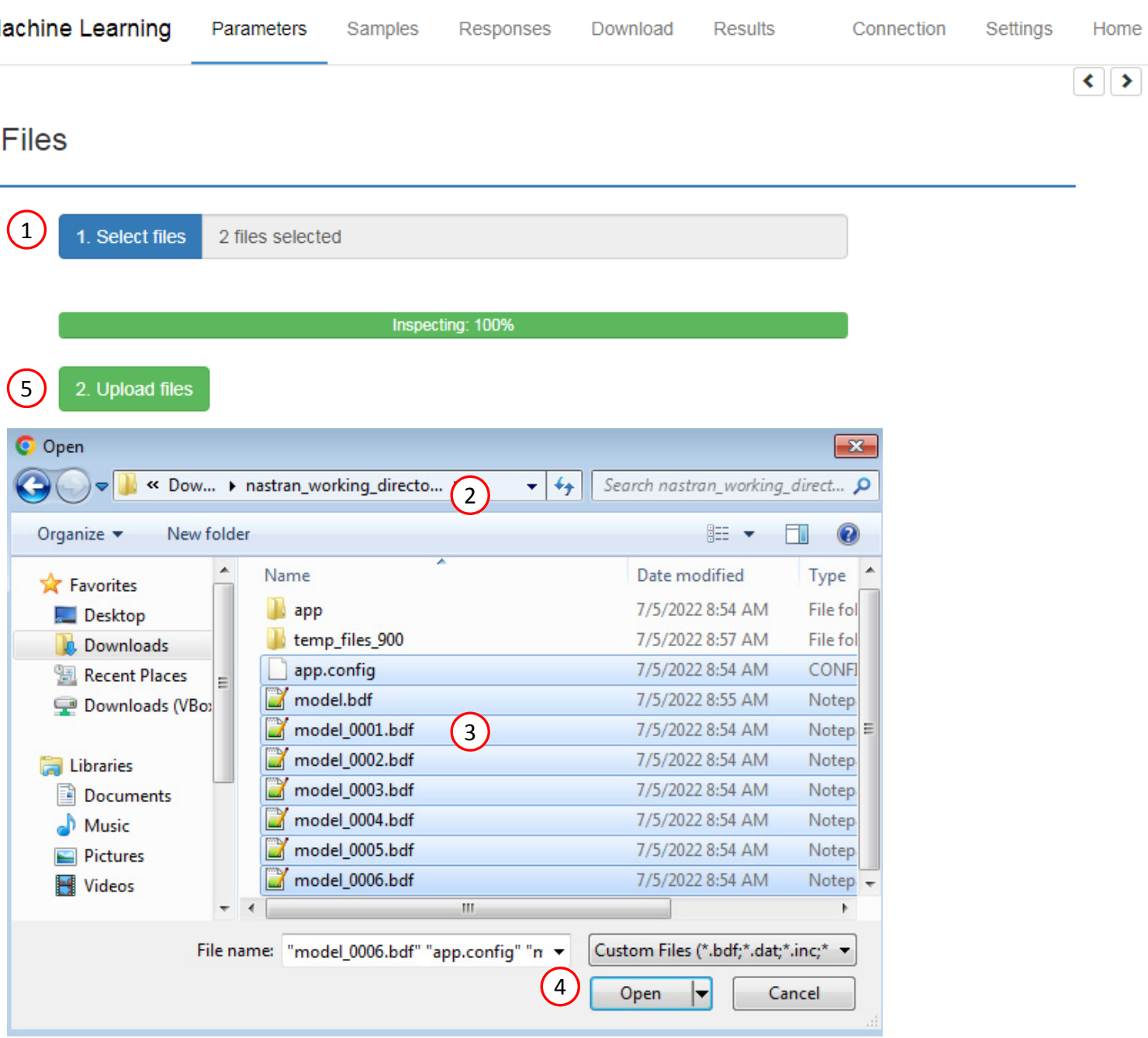


- Refreshing the page is only required when the *Select files* button is disabled.

Import

1. Click Select Files
2. Navigate to the folder named nastran_working_directory
3. Select all the BDF files AND the app.config file.
4. Click Open
5. Click Upload files

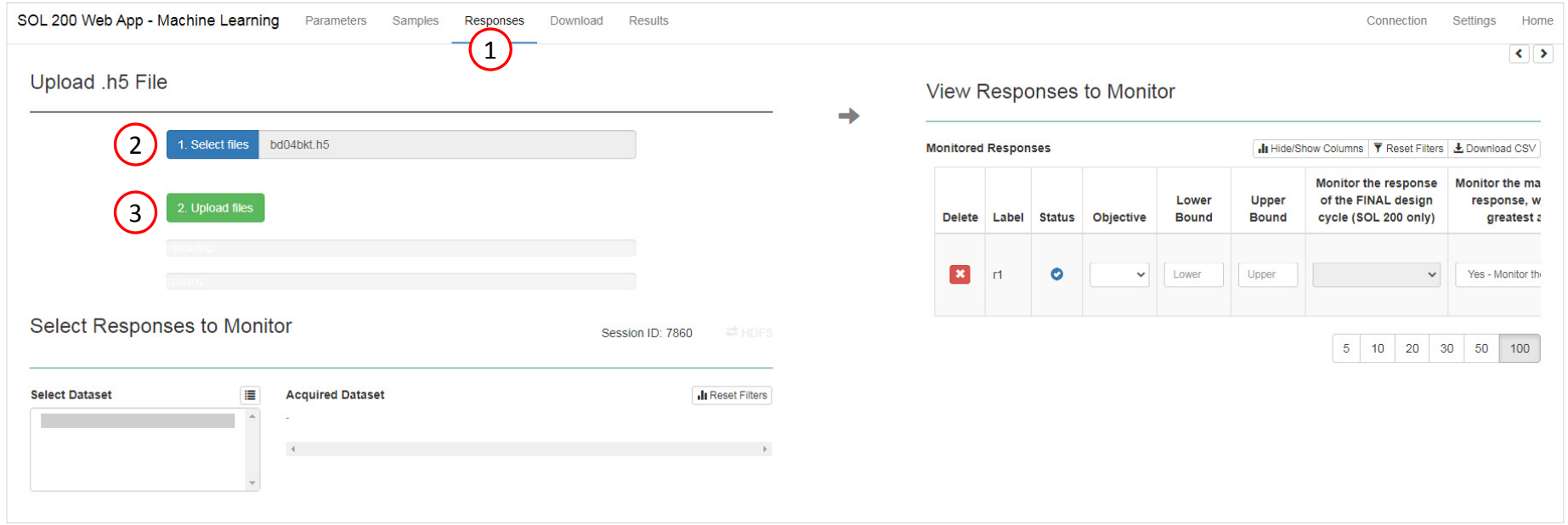
- All imports require the app.config file to be selected.

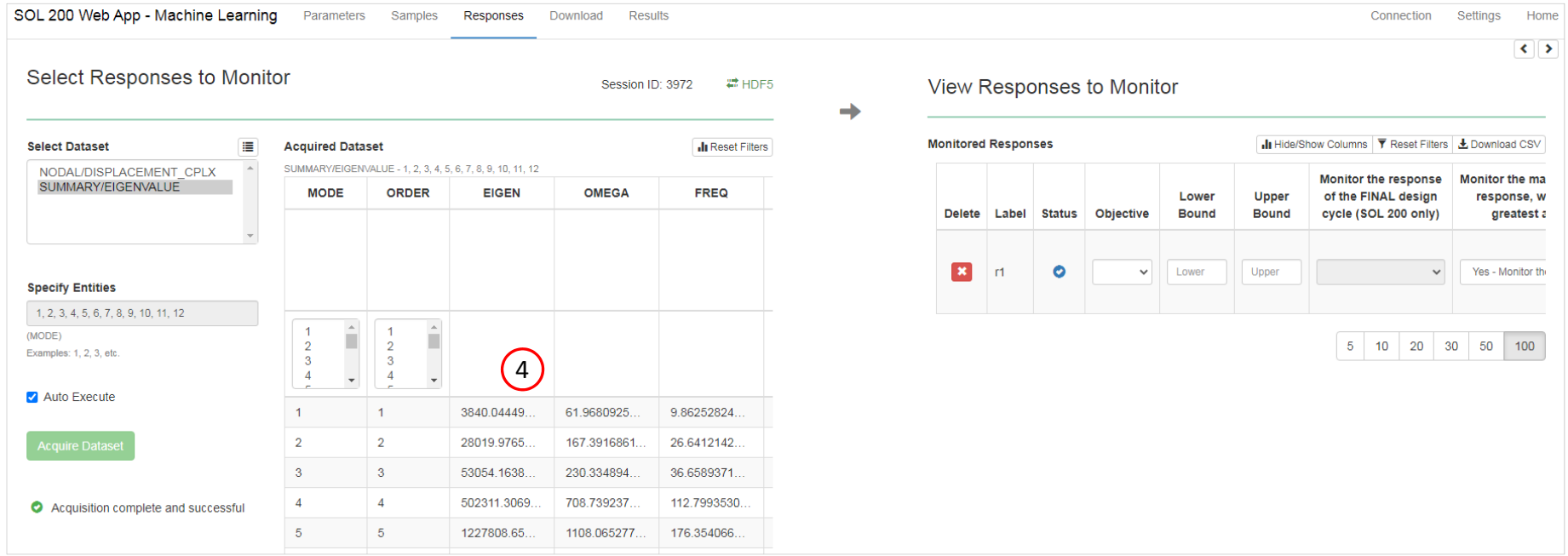


Import

For the Response section, the H5 file will need to be re-uploaded.

1. Click Responses
2. Select the H5 file
3. Click Upload
4. Data from the H5 is loaded and ready to use





Import

After import, any Parameter, Samples or Responses can be modified.