Workshop – Parameter Study, Varying the Position of Extra Supports
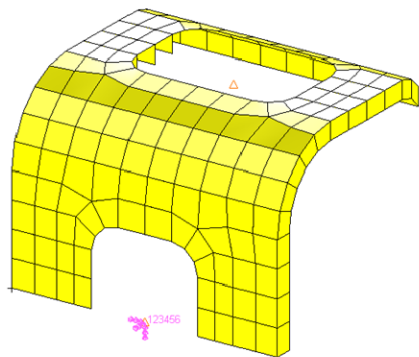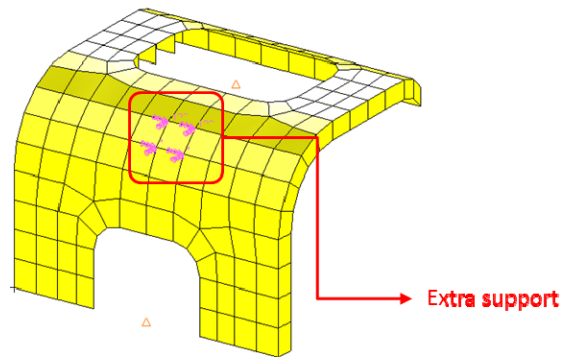
AN MSC NASTRAN MACHINE LEARNING WEB APP TUTORIAL

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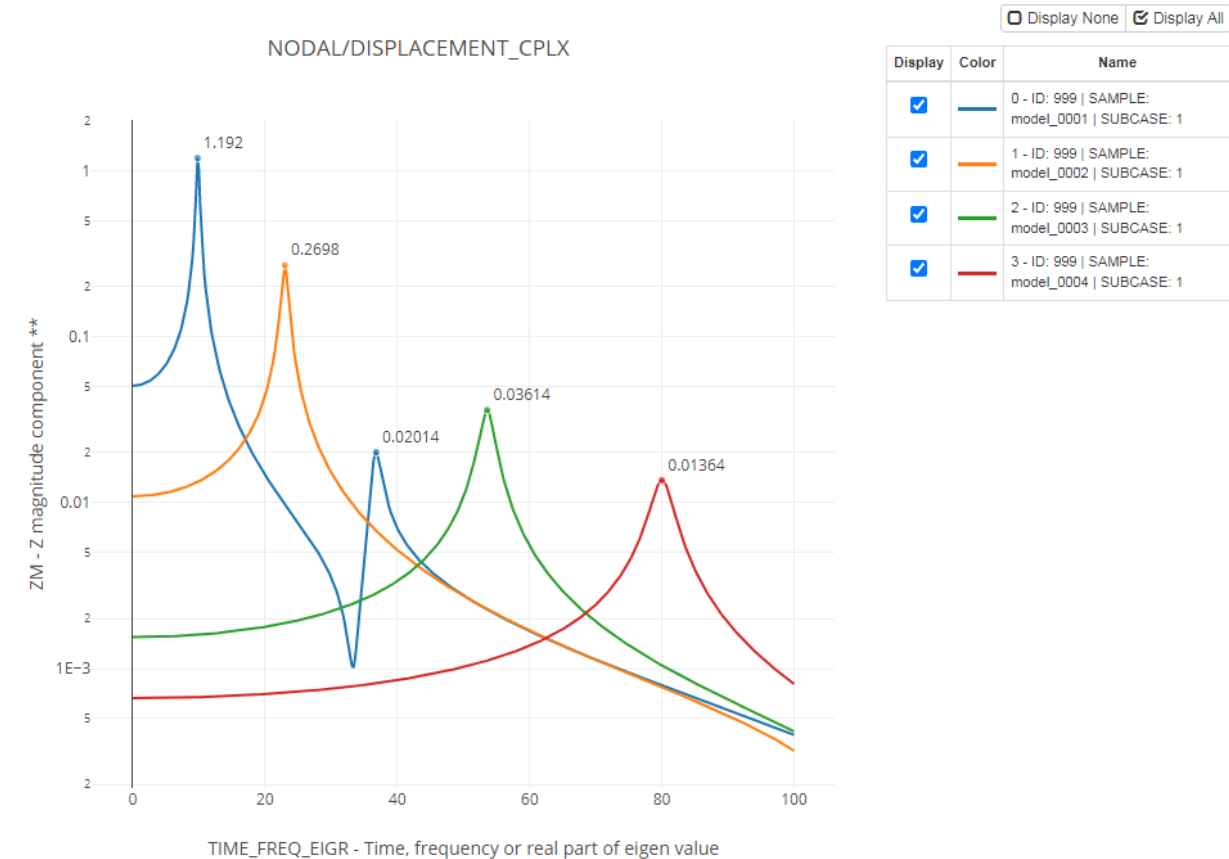# Goal: Configure multiple MSC Nastran runs

1. Vary the location of an extra support

2. Configure 4 MSC Nastran runs, each run with a different position of the extra support

3. Plot the displacement response at GRID 999 for all MSC Nastran runs
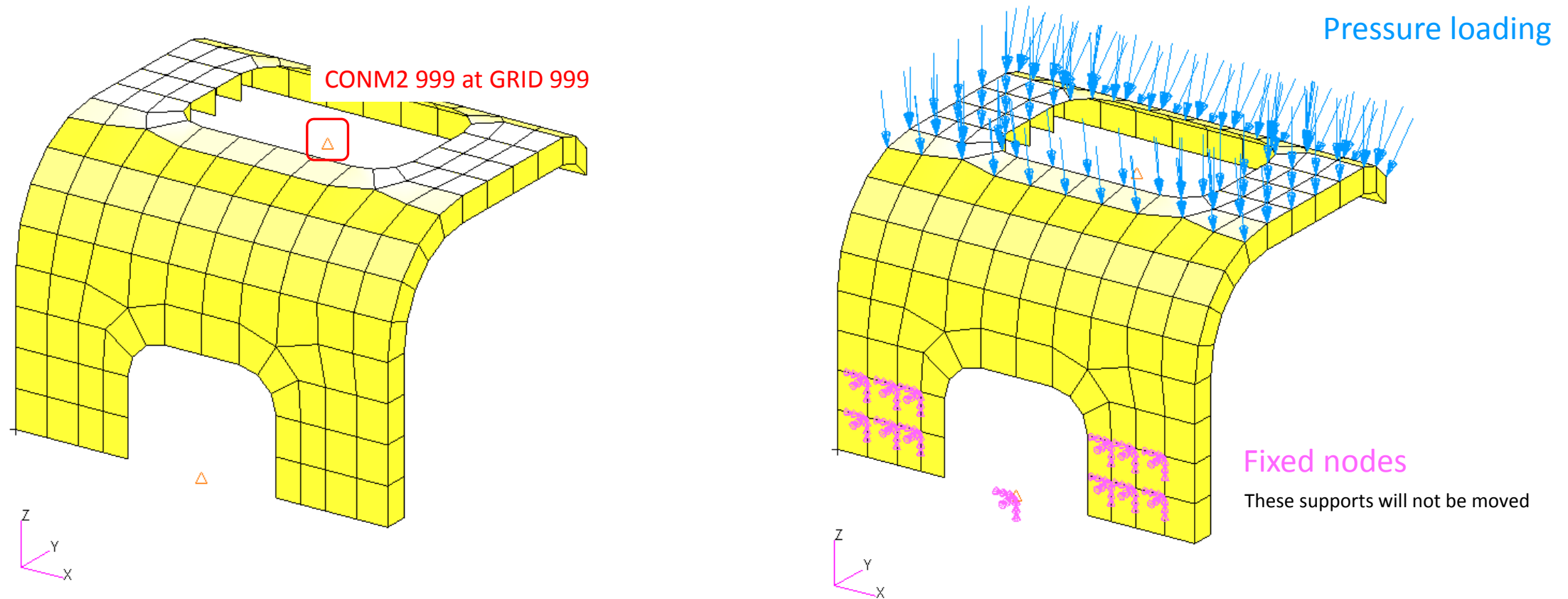

Sample 1 – The extra support Is not utilized

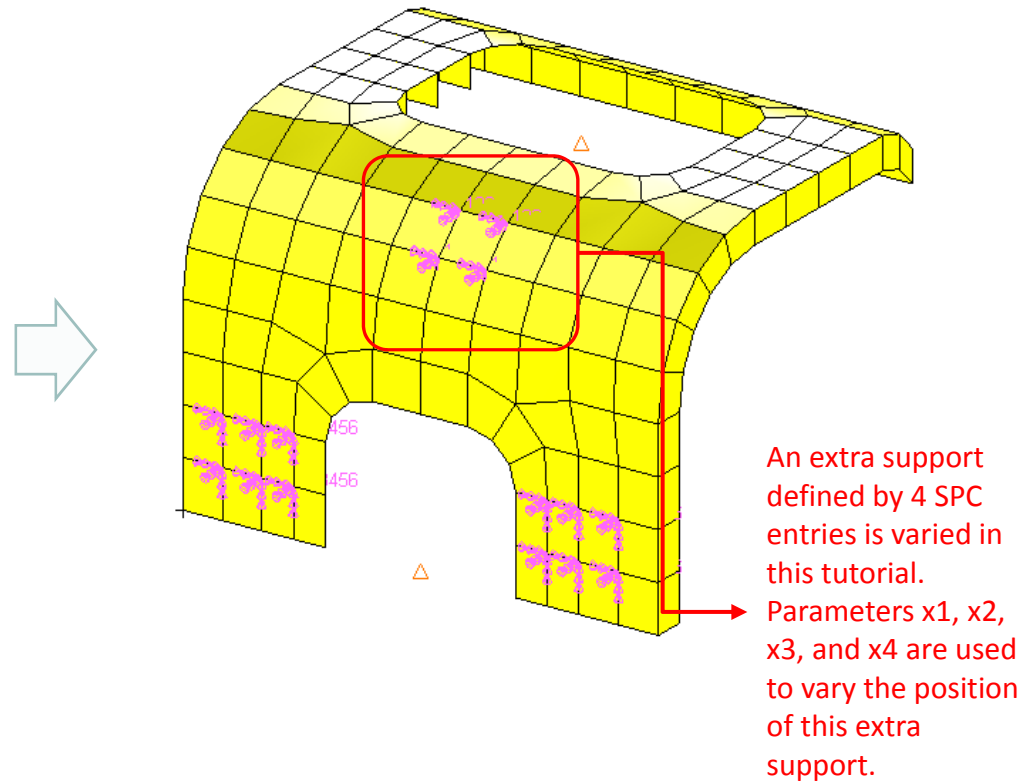Sample 2 – The extra support Is placed at GRIDs 72, 73, 61, 62

Extra support

NODAL/DISPLACEMENT_CPLX

Display	Color	Name
☑	—	0 - ID: 999 | SAMPLE: model_0001 | SUBCASE: 1
☑	—	1 - ID: 999 | SAMPLE: model_0002 | SUBCASE: 1
☑	—	2 - ID: 999 | SAMPLE: model_0003 | SUBCASE: 1
☑	—	3 - ID: 999 | SAMPLE: model_0004 | SUBCASE: 1

☐ Display None   ☑ Display All

Details of the Structural Model

CONM2 999 at GRID 999

Pressure loading

Fixed nodes

These supports will not be moved
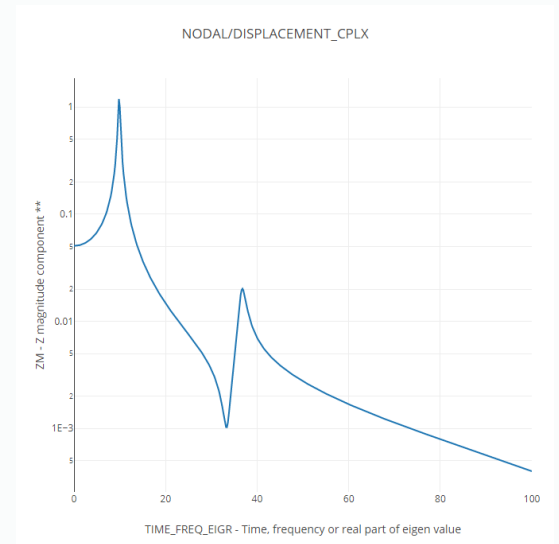
Problem Statement

Design Variables

- x1: The grid point identification number (field G1) of the 1st SPC 1 1999
- x2: The grid point identification number (field G1) of the 2nd SPC 1 1999
- x3: The grid point identification number (field G1) of the 3rd SPC 1 1999
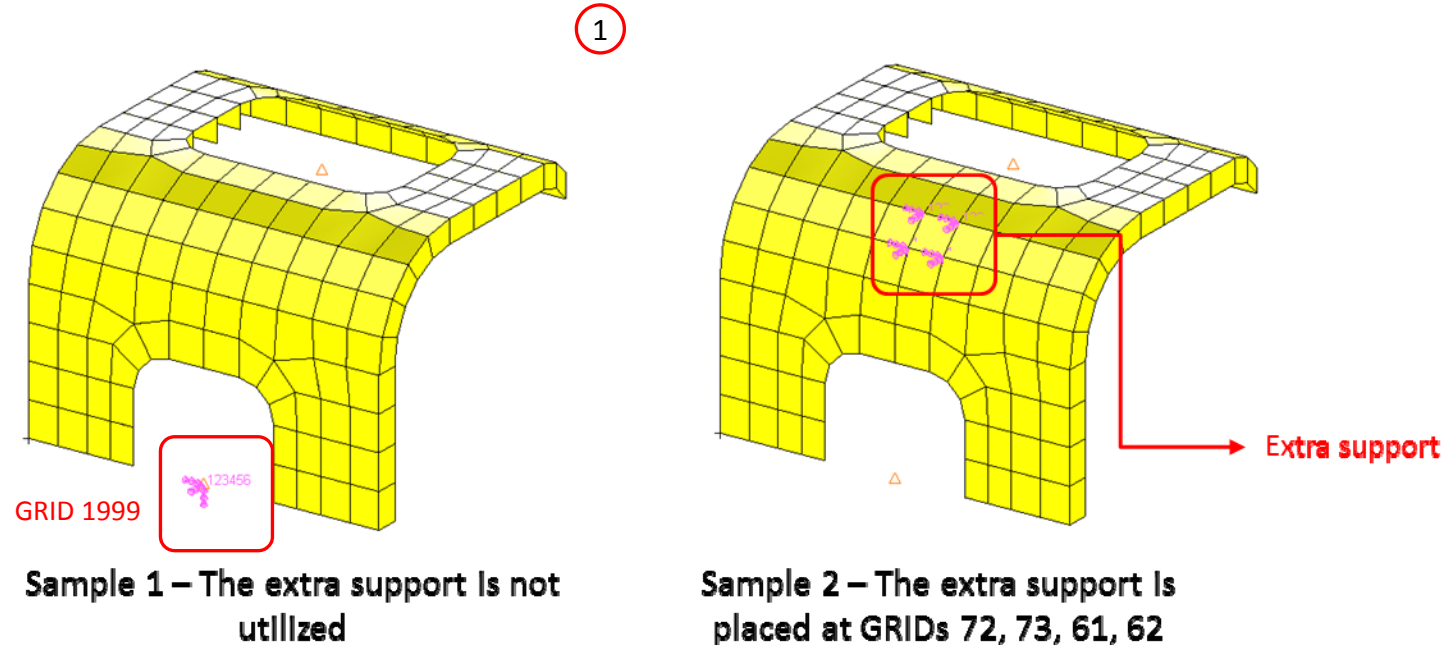- x4: The grid point identification number (field G1) of the 4th SPC 1 1999

An extra support defined by 4 SPC entries is varied in this tutorial. Parameters x1, x2, x3, and x4 are used to vary the position of this extra support.

Monitored Responses

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

Samples

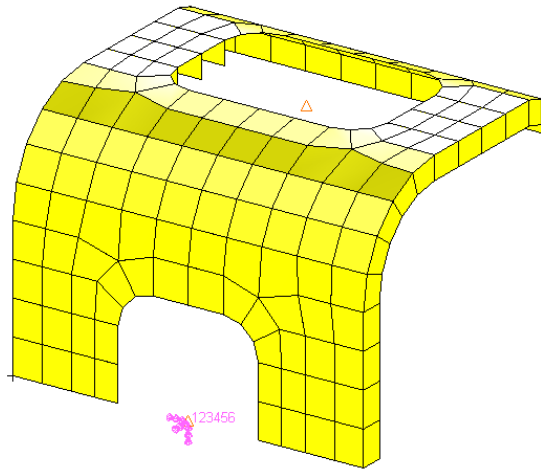|	Sample Number	Status	Parameters			
			x1	x2	x3	x4
✖	1	✔	19999	19999	19999	19999
✖	2	✔	72	73	61	62
✖	3	✔	163	105	162	99
✖	4	✔	206	236	108	168

①

1. 4 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 are all set to 19999, i.e. the 4 SPC entries are placed at GRID 19999. GRID 19999 is a GRID that has no effect on the final results of the analysis

3. Consider sample 2
   - Parameter x1 is set to 72, i.e. SPC 2 is placed at GRID 72
   - Parameter x2 is set to 73, i.e. the next SPC 2 is placed at GRID 73
   - Parameter x3 is set to 61, i.e. the next SPC 2 is placed at GRID 61
   - Parameter x4 is set to 62, i.e. the next SPC 2 is placed at GRID 62

GRID 1999

Sample 1 – The extra support is not utilized

Extra support

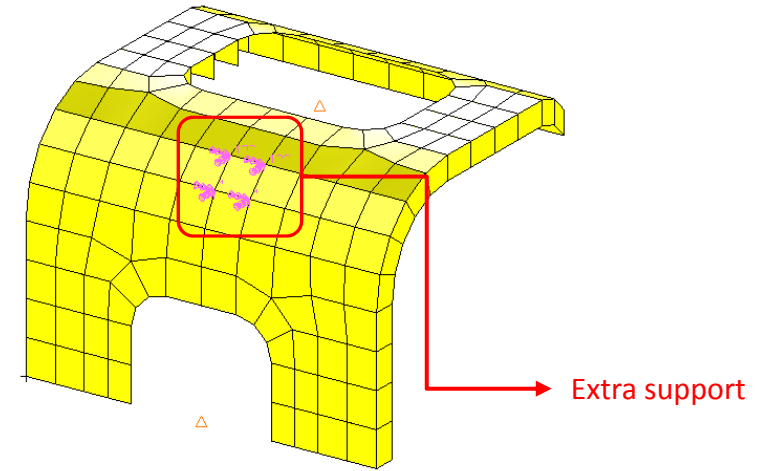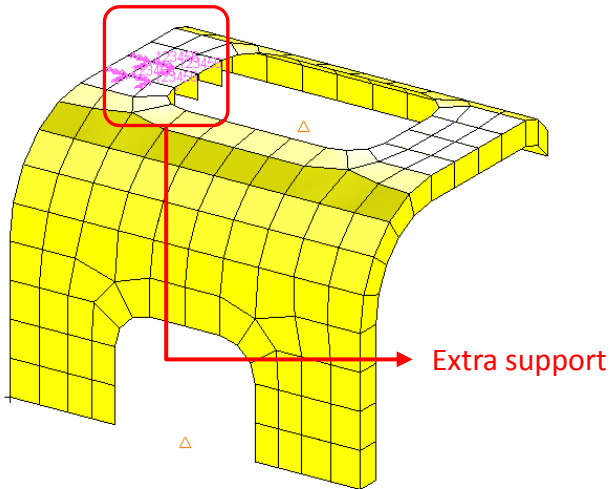**Sample 2 – The extra support is placed at GRIDs 72, 73, 61, 62**

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.
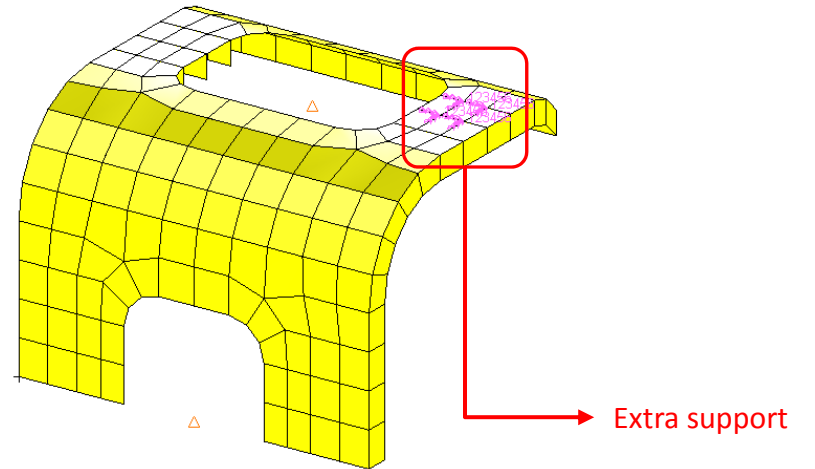

Sample 1 – The extra support is not utilized

Extra support

Sample 2 – The extra support is placed at GRIDs 72, 73, 61, 62

Extra support

Sample 3 - The extra support is placed at GRIDs 163, 105, 162, 99

Extra support

Sample 4 - The extra support is placed at GRIDs 206, 236, 108, 168

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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

Appendix
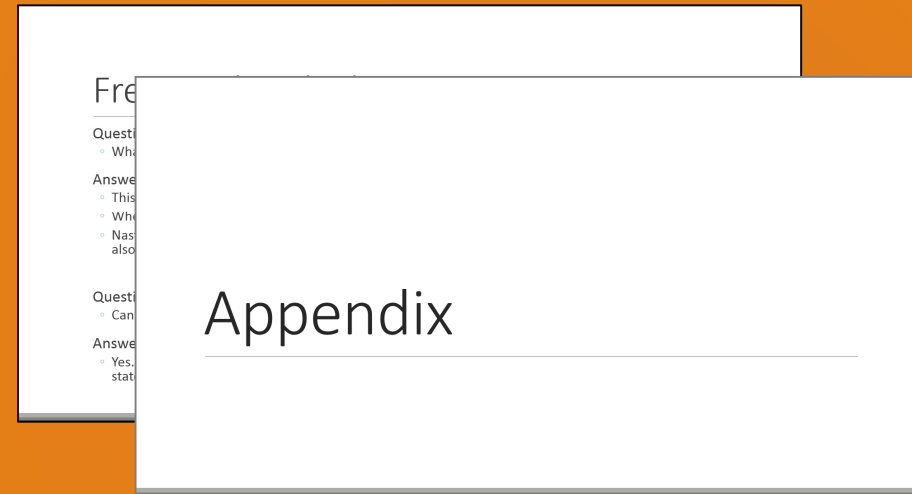
Contact me

- Nastran SOL 200 training

- Nastran SOL 200 questions

- Structural or mechanical optimization questions

- Access to the SOL 200 Web App

christian@ the-engineering-lab.com

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Tutorial

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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

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.
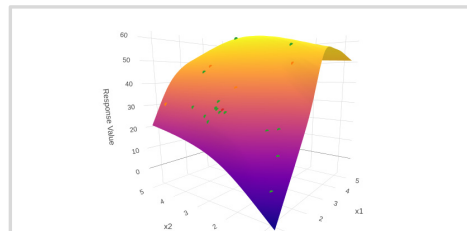
Benefits

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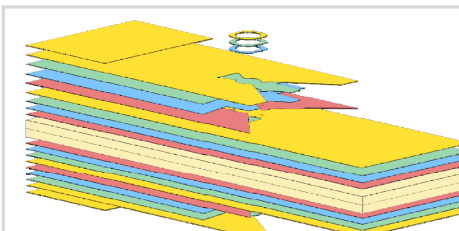- Free Post-processor web apps
- +80 tutorials
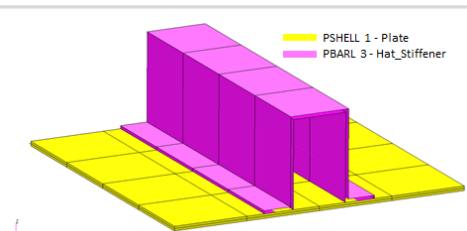
Web Apps

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
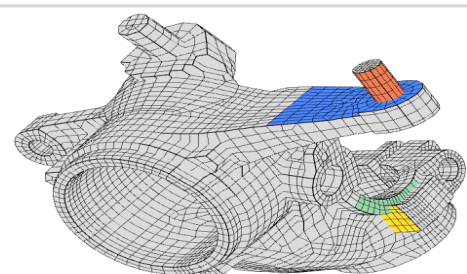Bayesian Optimization for nonlinear response optimization (SOL 400)
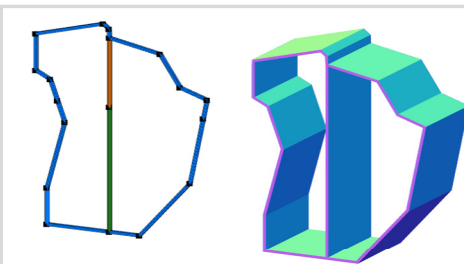
PBMSECT Web App
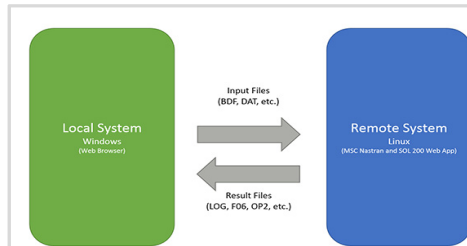Generate PBMSECT and PBRSECT entries graphically

Ply Shape Optimization Web App
Optimize composite ply drop-off locations, and generate new PCOMPG entries
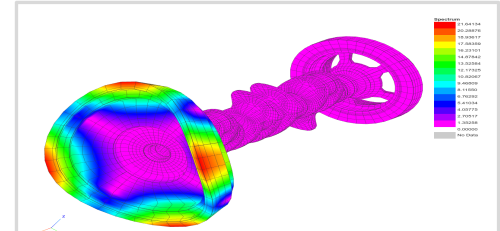
Post-processor Web App
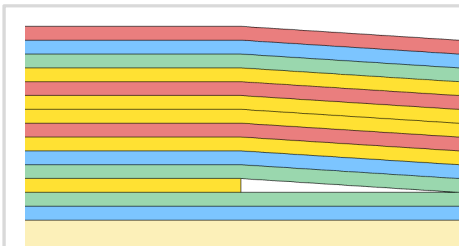View MSC Nastran results in a web browser on Windows and Linux

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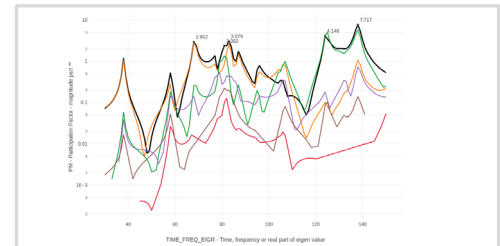Use a web application to configure and perform shape optimization.

Remote Execution Web App
Run MSC Nastran jobs on remote Linux or Windows systems available on the local network
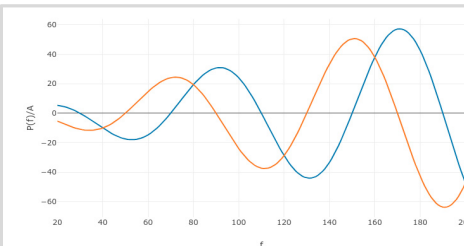
Dynamic Loads Web App
Generate RLOAD1, RLOAD2 and DLOAD entries graphically

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.
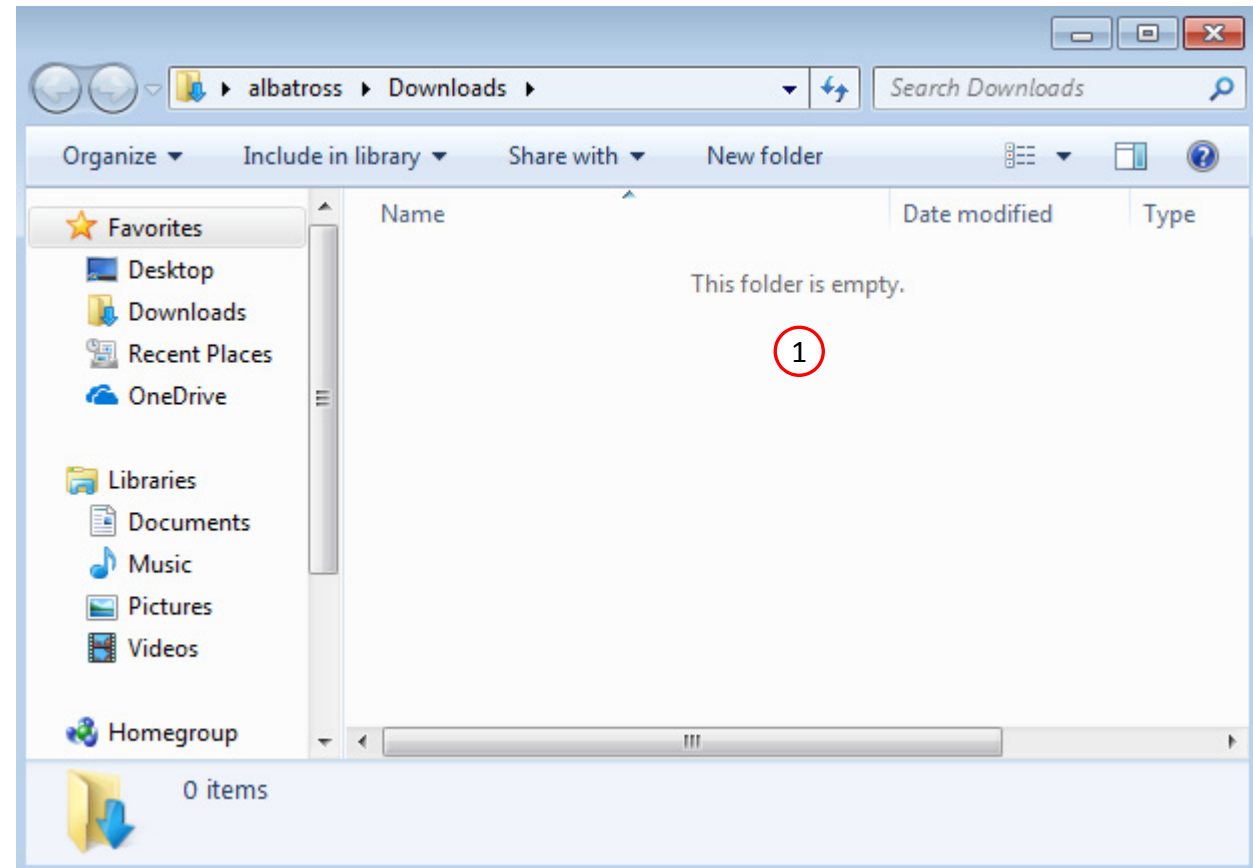
Go to the User's Guide

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.
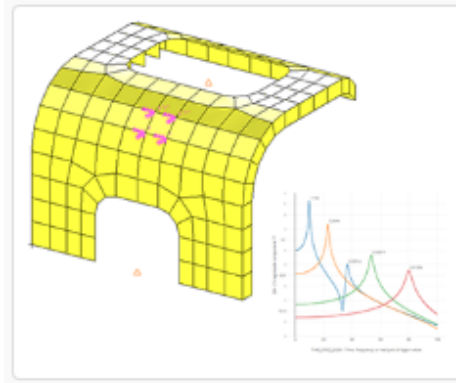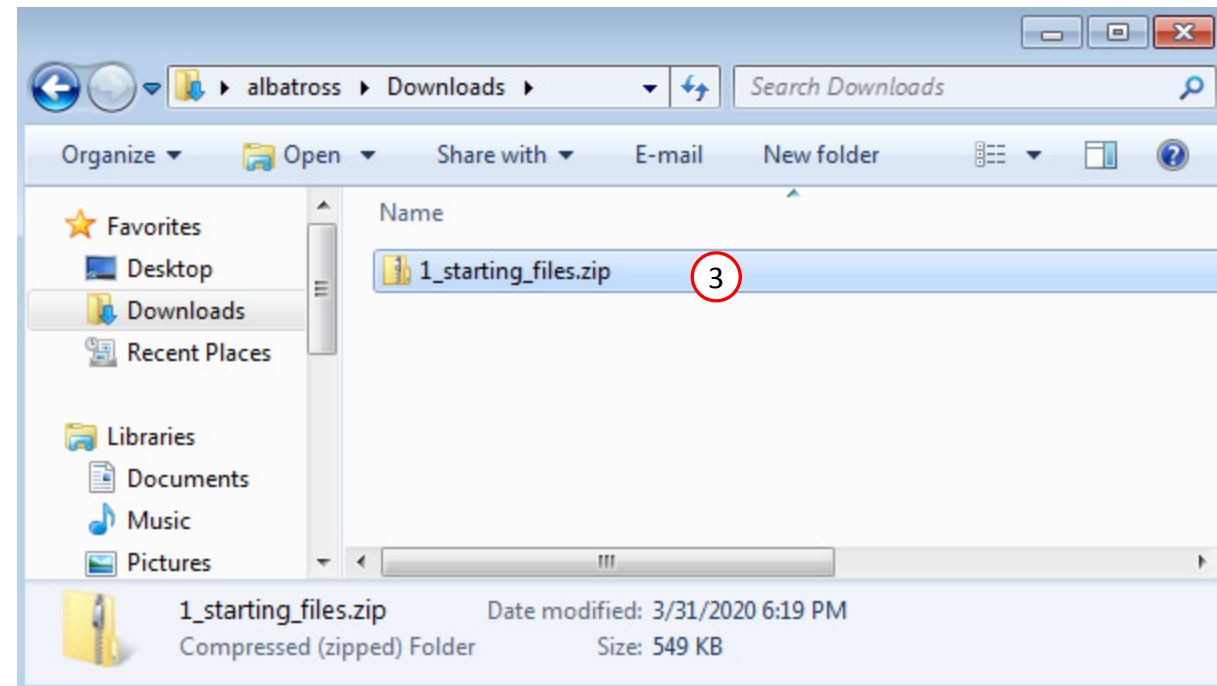
Parameter Study, Varying the Position of Extra Supports (1)

The location of supports on a structural or mechanical system greatly influences its stiffness. This tutorial discusses one method to vary the location of supports and view displacement vs. frequency plots.
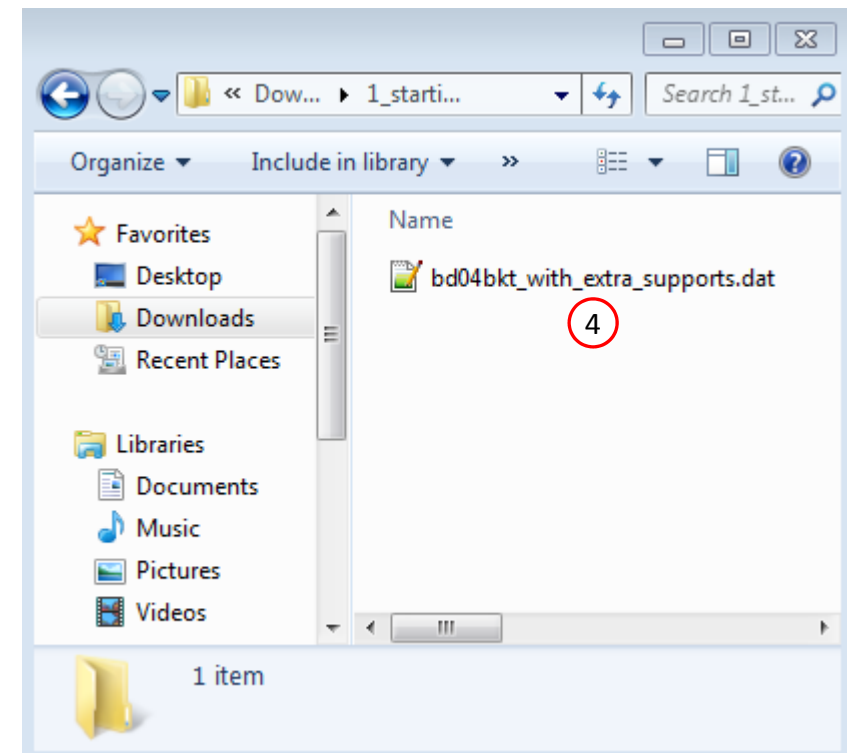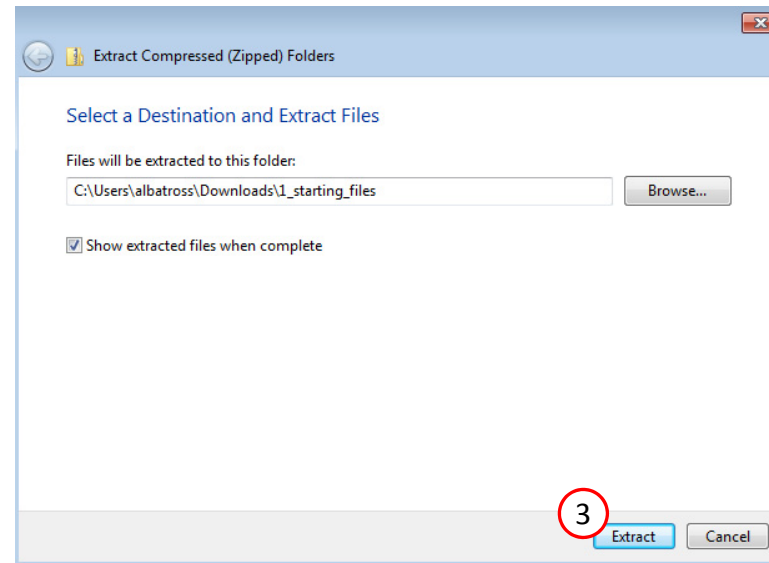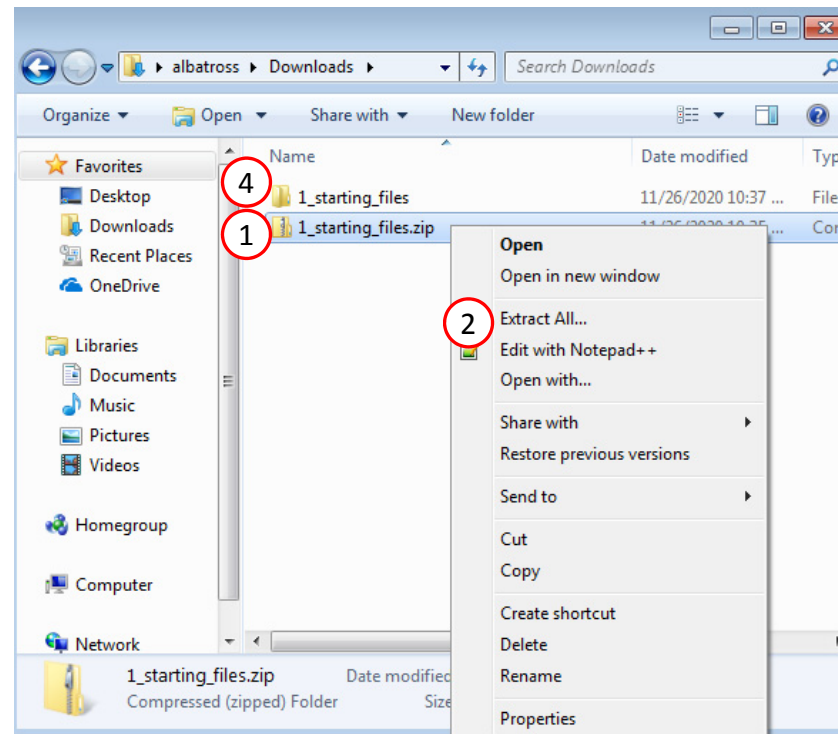
Starting Files: Link (2)
Solution BDF Files: Link

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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.

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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

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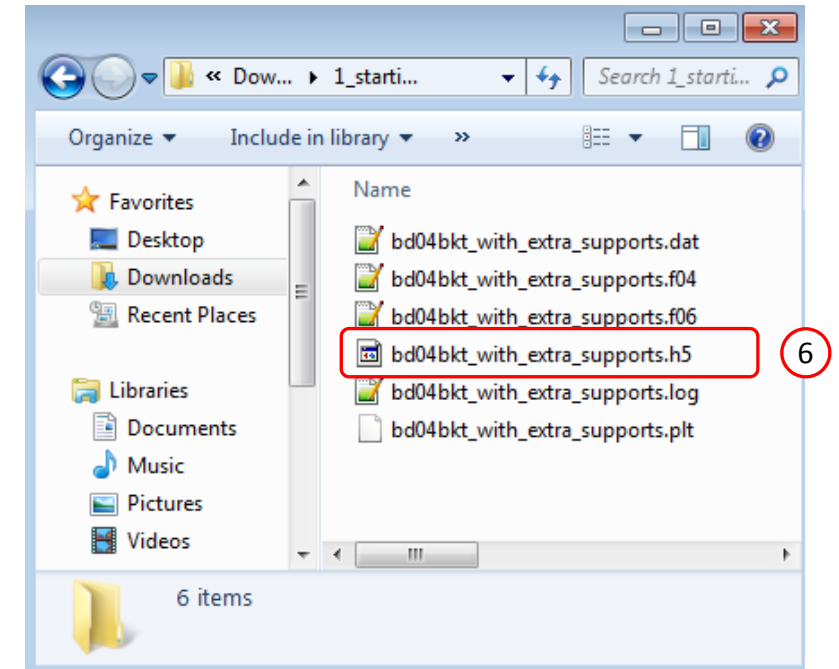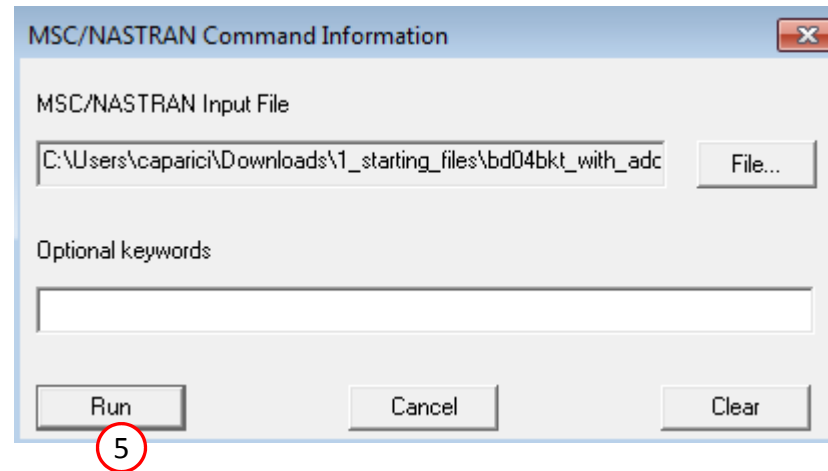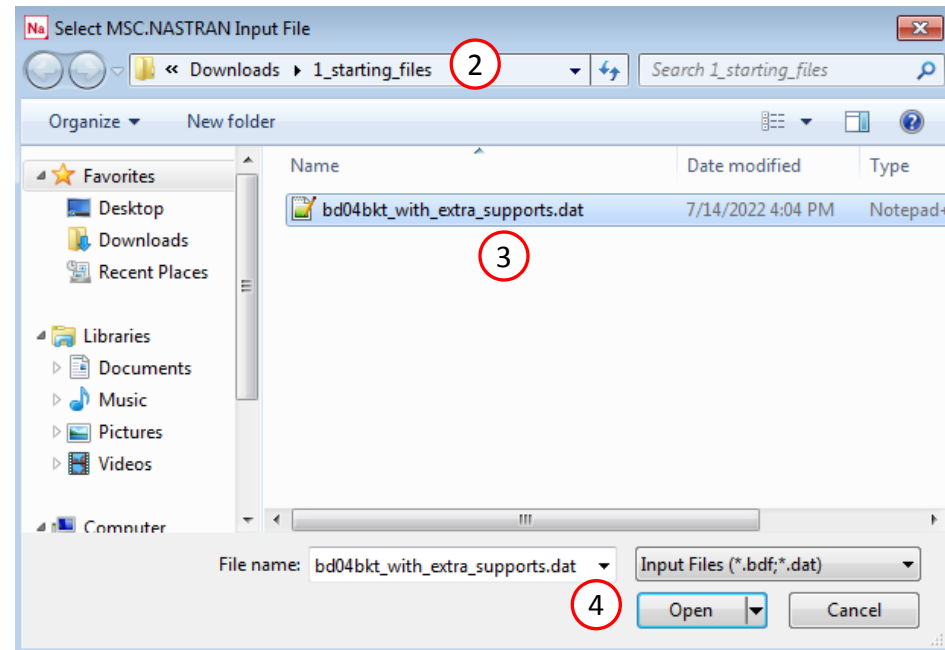
Use the same MSC Nastran version throughout this exercise

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

To ensure compatibility, <u>use the same MSC Nastran version throughout this exercise</u>. 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.

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SOL 200 Web App

Select a web app to begin

Optimization for SOL 200   Multi Model Optimization   Machine Learning | Parameter Study   HDF5 Explorer   Viewer
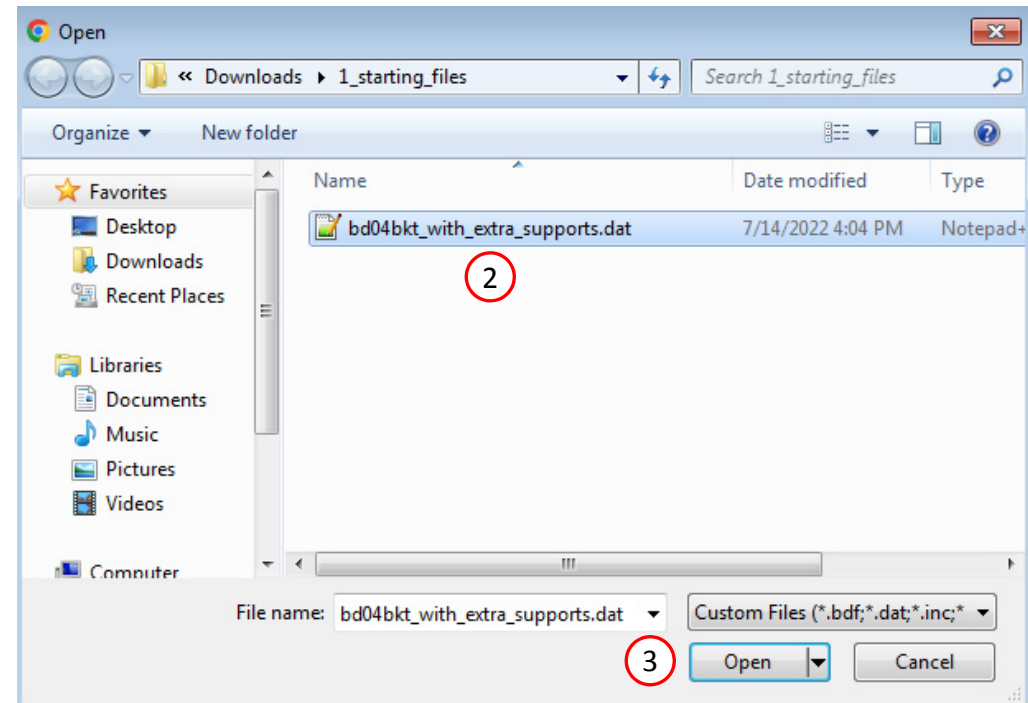
Tutorials and User's Guide

Full list of web apps

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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. Use the vertical scroll bar to find the SPC 1 1999 entries

2. Set the following fields as parameters
   - x1: The grid point identification number (field G1) of the 1st SPC 1 1999
   - x2: The grid point identification number (field G1) of the 2nd SPC 1 1999
   - x3: The grid point identification number (field G1) of the 3rd SPC 1 1999
   - x4: The grid point identification number (field G1) of the 4th SPC 1 1999

3. Parameters have 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

```
PLOAD4  1        135      -3.
PLOAD4  1        181      -3.
PLOAD4  1        183      -3.
PLOAD4  1        185      -3.
PLOAD4  1        159      -3.
PLOAD4  1        158      -3.
PLOAD4  1        157      -3.
```

```
SPC     1        22       123456  0.0
SPC     1        23       123456  0.0
SPC     2        %x1%     123456  0.0
SPC     2        %x2%     123456  0.0
SPC     2        %x3%     123456  0.0
SPC     2        %x4%     123456  0.0
SPCADD  10       1        2
TABDMP1 4        CRIT
```

Configure Parameters

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

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

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20

Samples

1. Click Samples

2. Click + Options

3. Click Add Sample with Original Parameter Values

4. Click Add Sample 3 times

5. 4 samples have been created

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

Configure Samples

Design

User-defined

+ Info

Samples to Run

+ Options

+ Add Sample

+ Add Sample with Original Parameter Values

CSV Export   CSV Import

Export   **Select files**   Select a CSV File   **Import**

	Sample Number	Status	Parameters x1	x2	x3	x4
✖	1	●	19999	19999	19999	19999
✖	2	●	72	73	61	62
✖	3	●	163	105	162	99
✖	4	●	206	236	108	168

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Samples

1. Update the values to match the table shown

- 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.

| | Sample Number | Status | Parameters | | | |
			x1	x2	x3	x4
✖	1	✔	19999	19999	19999	19999
✖	2	✔	72	73	61	62
✖	3	✔	163	105	162	99
✖	4	✔	206	236	108	168

①

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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.
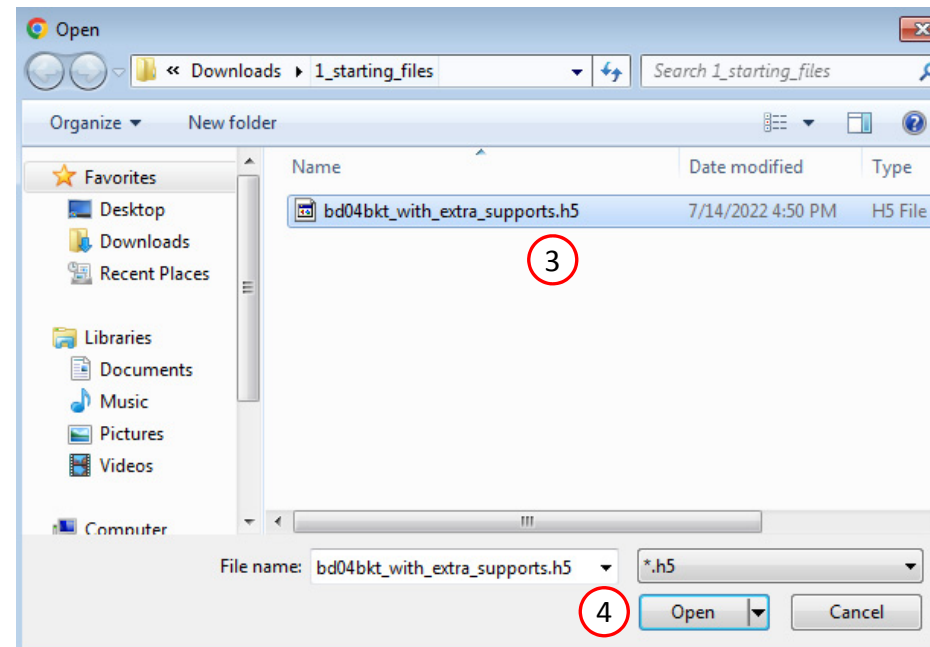
Adjust the Column Width

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

SOL 200 Web App - Machine Learning Parameters Samples Responses Download Results Connection Settings Home

①

Download

⬇ Download BDF Files

②

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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.

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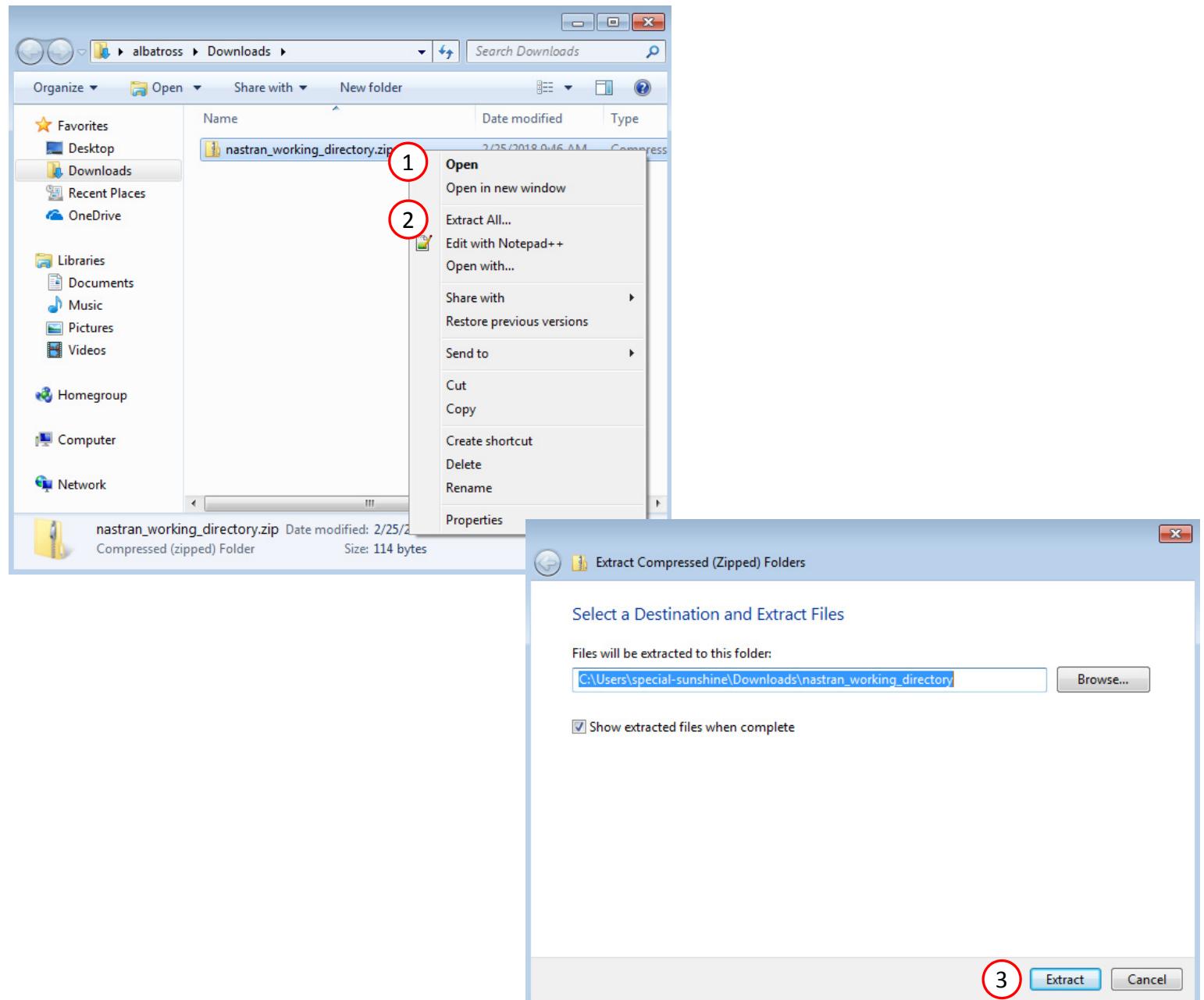
Start MSC Nastran

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
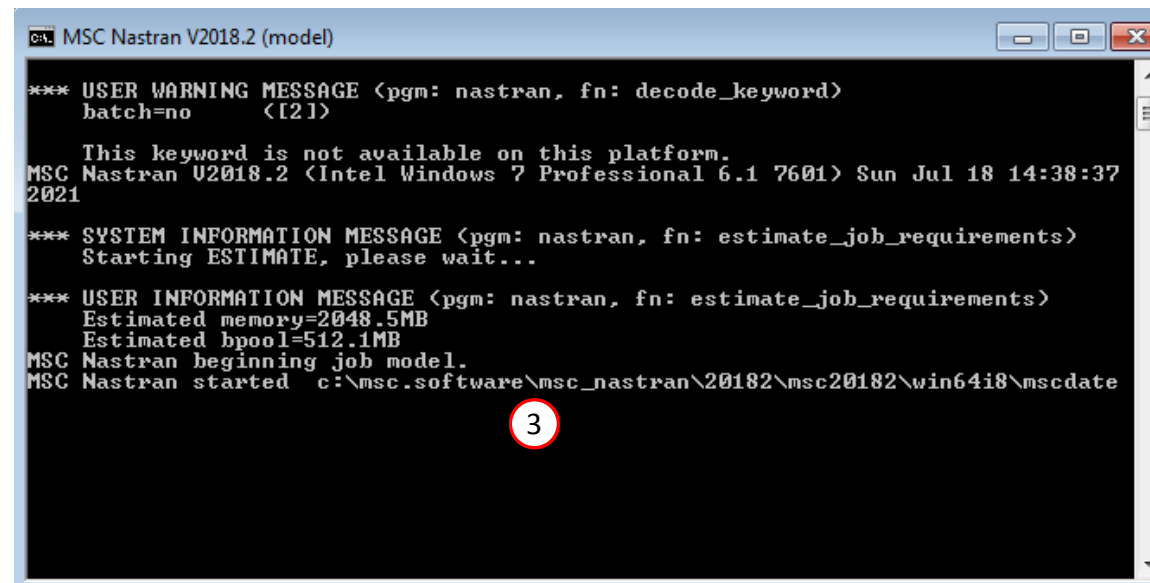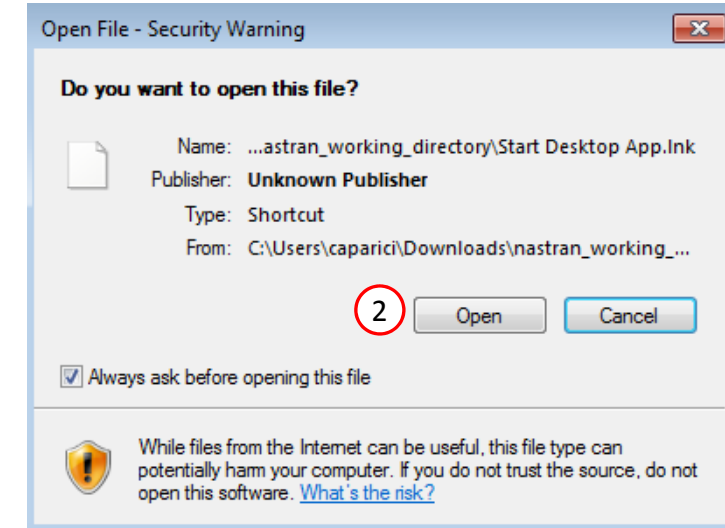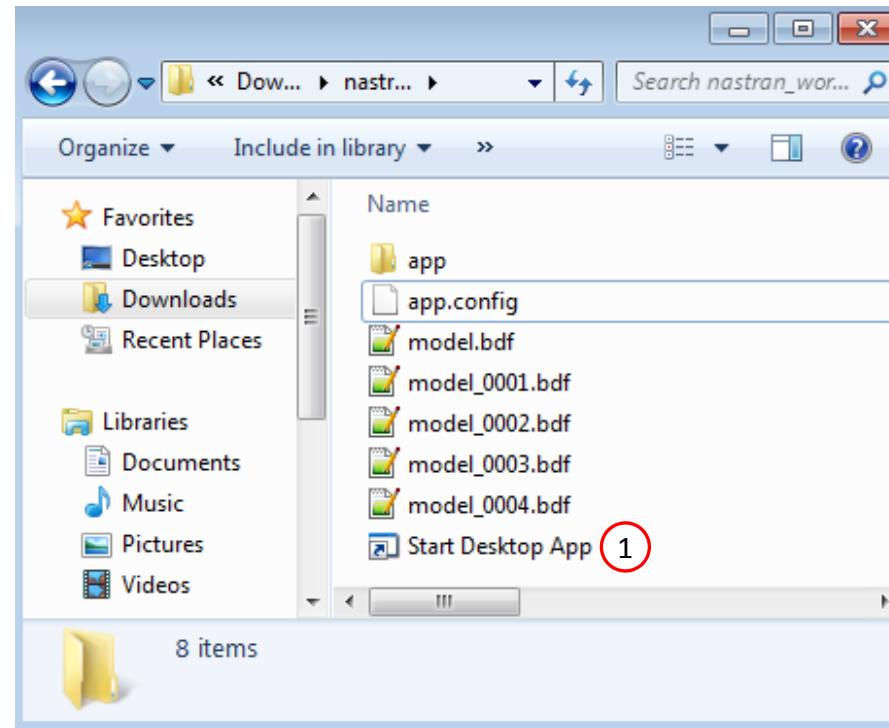
Status

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

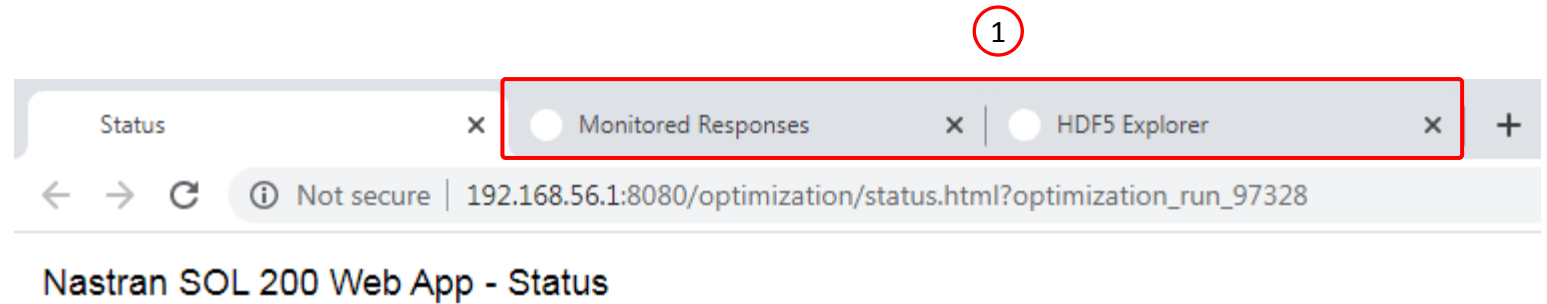## SOL 200 Web App - Status

⇄ Python   ☁ MSC Nastran

Status

Name	Status of Job	Design Cycle	RUN TERMINATED DUE TO
model.bdf	Running	None	

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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
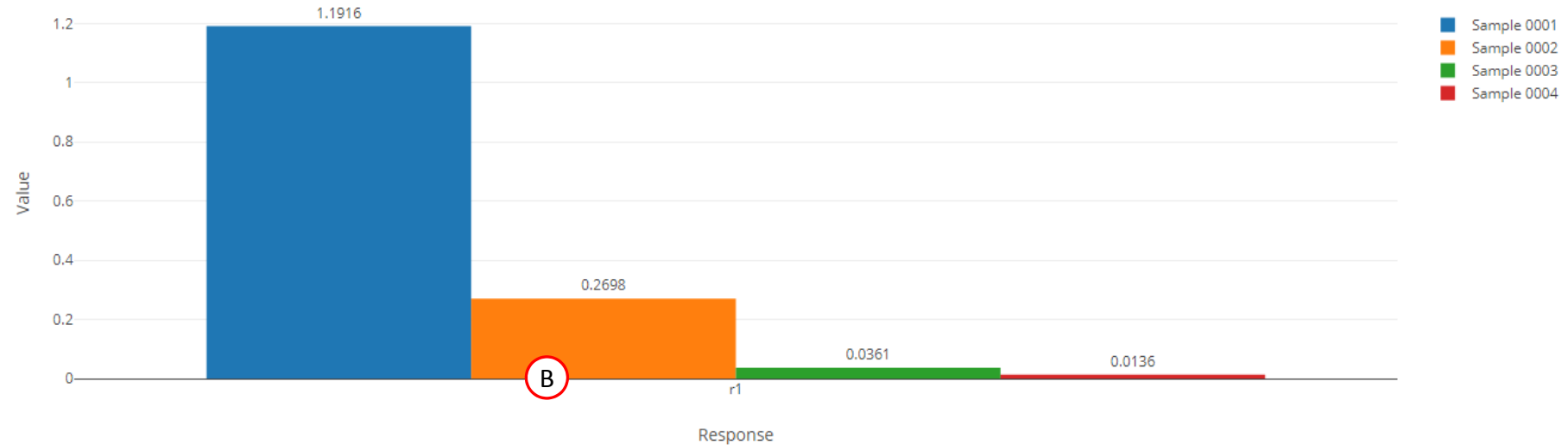
2. A description of each web app is given in the table.

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.	

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Review Results

1. The Monitored Responses web app is opened

2. Select response r1 in the Label column

3. The r1 response corresponds to the maximum displacement at GRID 999 across all forcing frequencies. Since 4 batch runs have been performed, there are 4 responses that have been recorded.

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.

Review Results

1. A new window is opened

2. Select all 4 H5 files

3. Click Continue

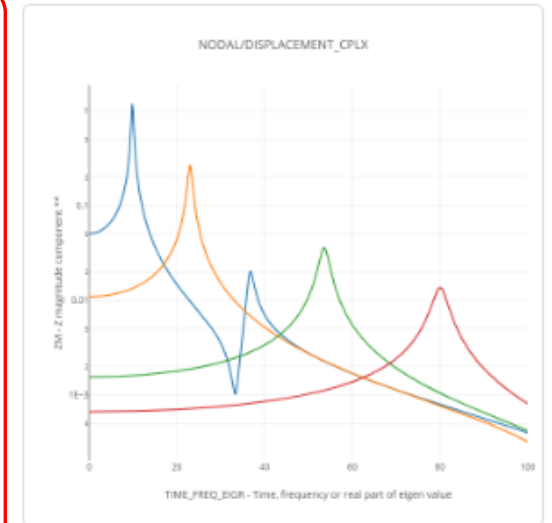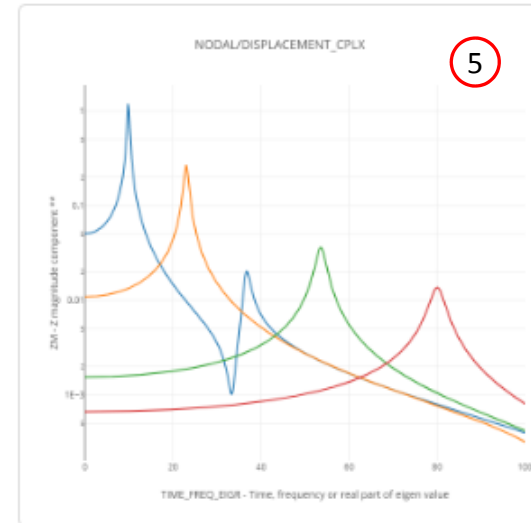4. The HDF5 Explorer is automatically opened.

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.
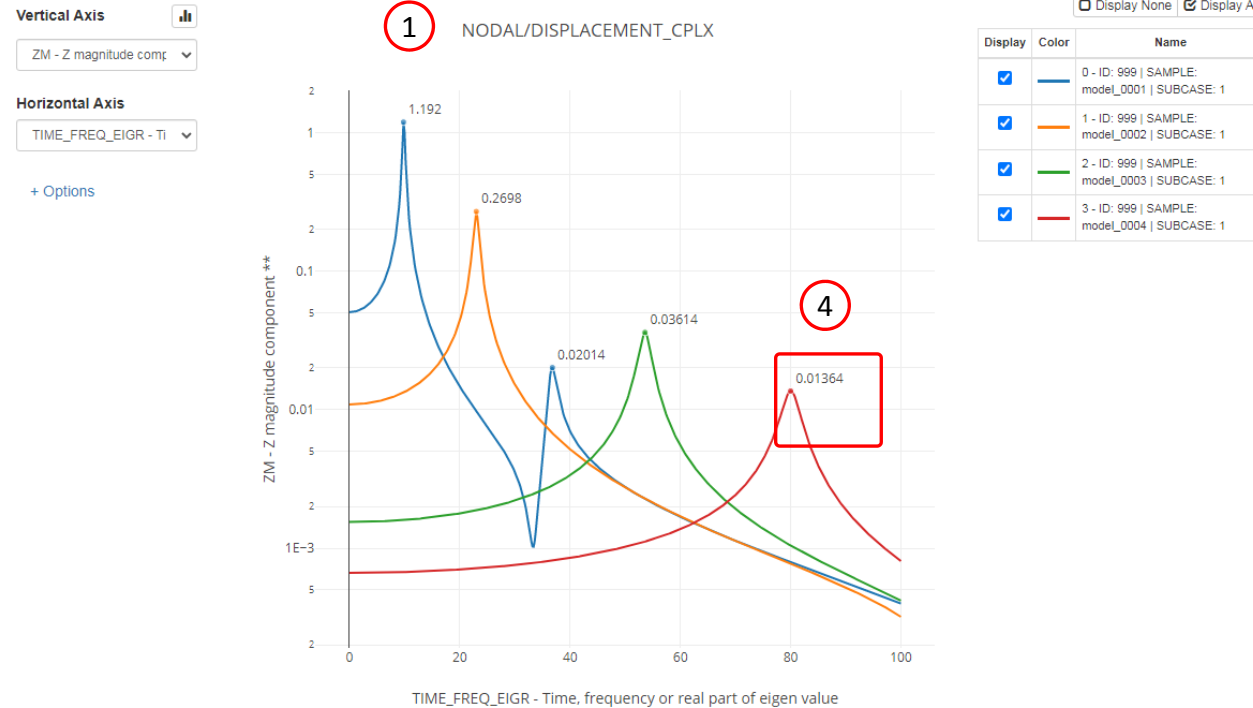

SOL 200 Web App Alert

Multiple HDF5(.h5) files have been found.

1) Select a file

2) Select similar files
   OK - model.h5, model_0000.h5, model_0001.h5
   OK - nk098.h5
   NOT OK - nk098.h5, model_0000.h5, model_0001.h5

3) Click Continue to start the HDF5 Explorer or click Skip to ignore this step

model_0001.h5
model_0002.h5
model_0003.h5
model_0004.h5

Continue   Skip
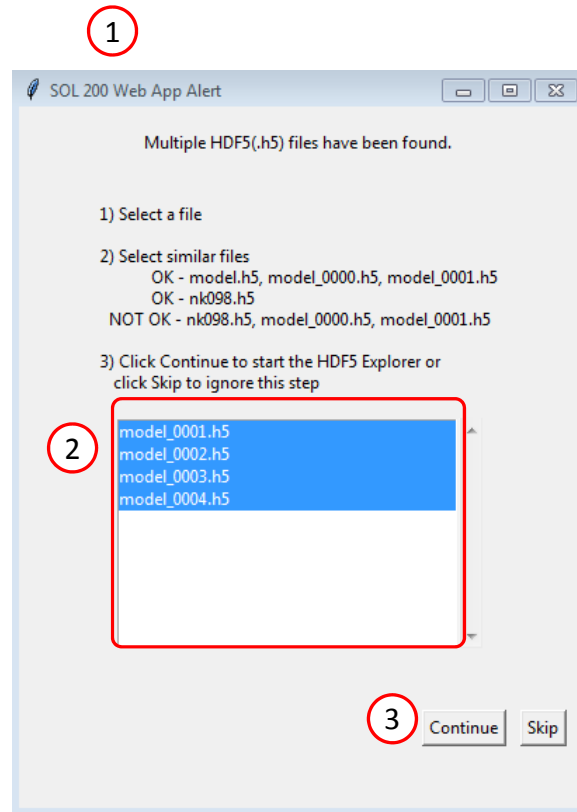
Plots Browser

NODAL/DISPLACEMENT_CPLX

Plot #: 1 - ID: 999 | SAMPLE: model_0001, model_0002, model_0003, ... | SUBCASE: 1 | ZM vs. TIME_FREQ_EIGR

Plot #: 2 - ID: 999 | SAMPLE: model_0001, model_0002, model_0003, ... | SUBCASE: 1 | ZM vs. TIME_FREQ_EIGR

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Review Results

1. A Displacement vs Frequency plot is displayed

2. Click + View Filters and Plotted Values

3. Mark the checkboxes listed in the column Show Max Peaks

4. The maximum value of each plot is now labeled

Review Results

1. The r1 response corresponds to the maximum displacement at GRID 999 across all forcing frequencies.

2. The max value labels on the ZM vs. Frequency are identical to the r1 responses displayed in the Monitored Responses bar chart

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End of Tutorial

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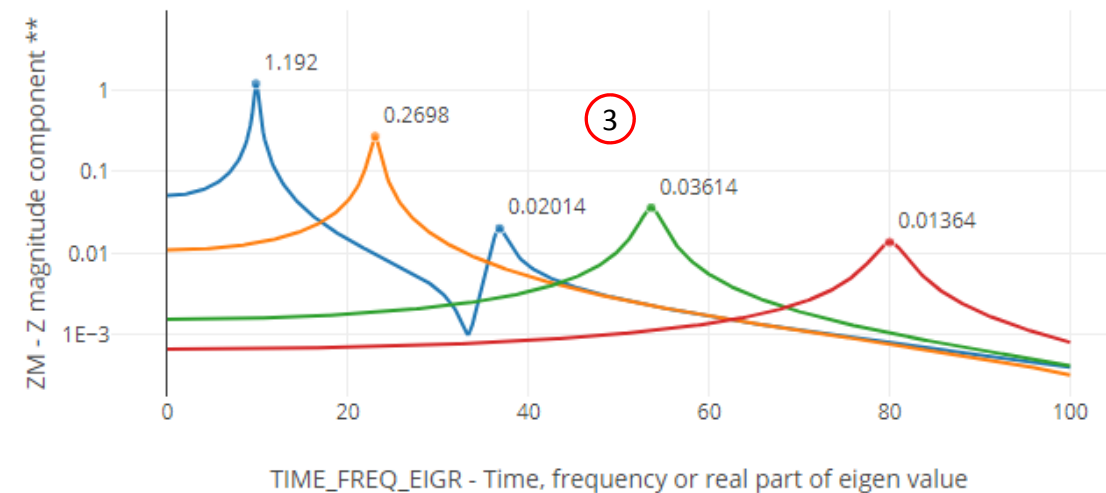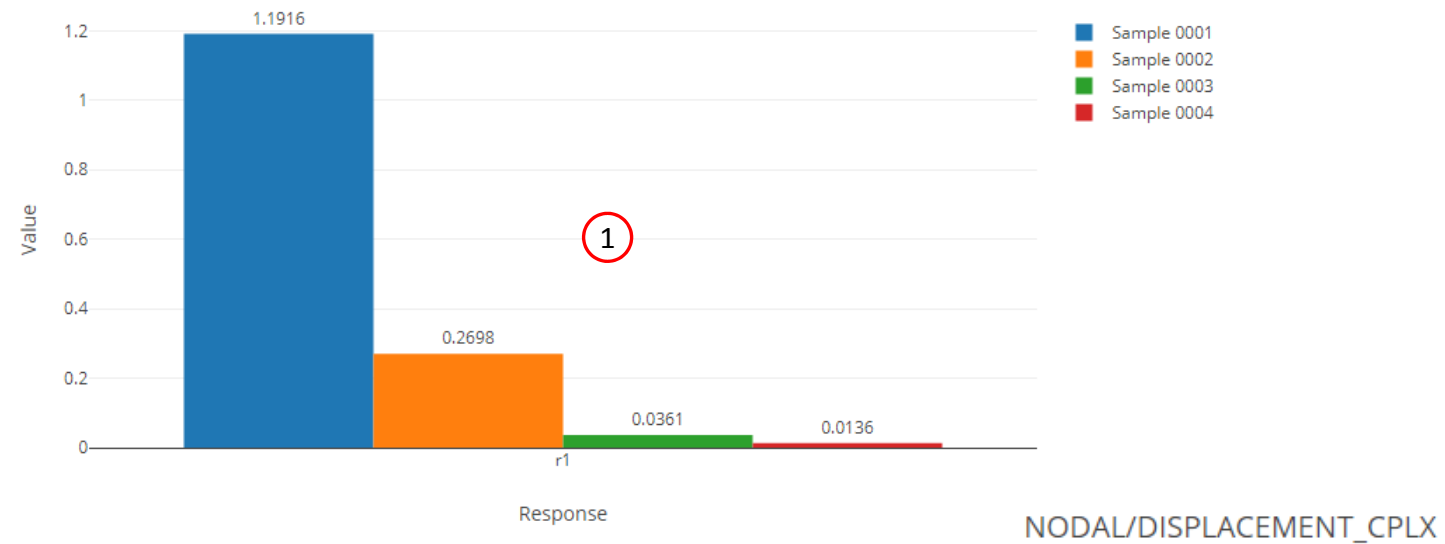
Appendix

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?

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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.
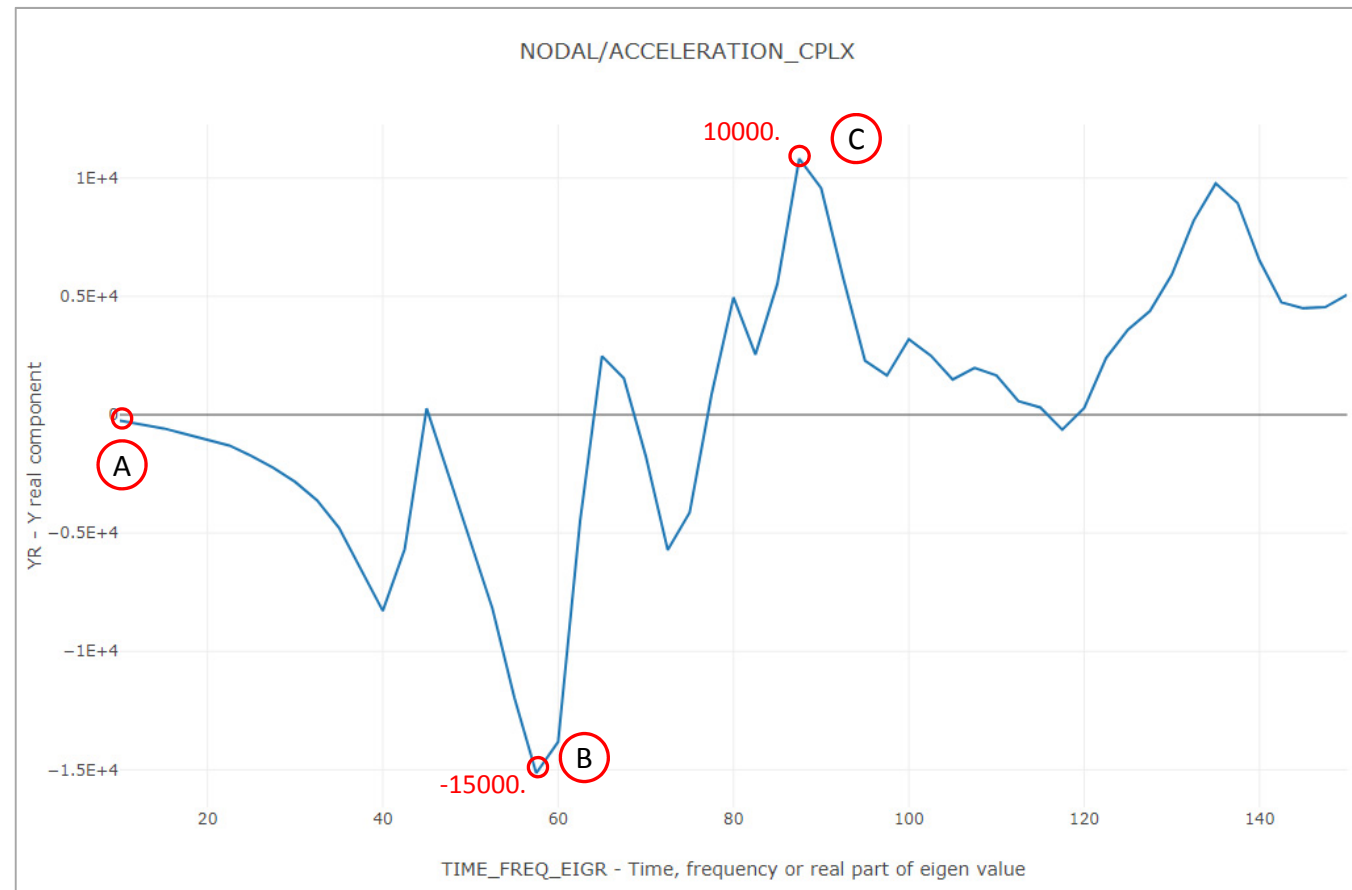

View Responses to Monitor

Monitored Responses

Delete	Label	Status	Objective	Lower Bound	Upper Bound	Monitor the response of the FINAL design cycle (SOL 200 only)	Monitor the maximum or minimum response, whichever has the greatest absolute value		Current Value	ID	SUBCASE	STEP	ANALYSI
✖	r99	●	⌄	Lower	Upper	⌄	Yes - Monitor the maximum respon ⌄		1443.476297324485	1001	12	0	5

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

Yes - Monitor the maximum respon ⌄

NODAL/ACCELERATION_CPLX

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How to import and edit previous files

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How to import and edit previous files

The parameters, samples and responses are contained in the following files
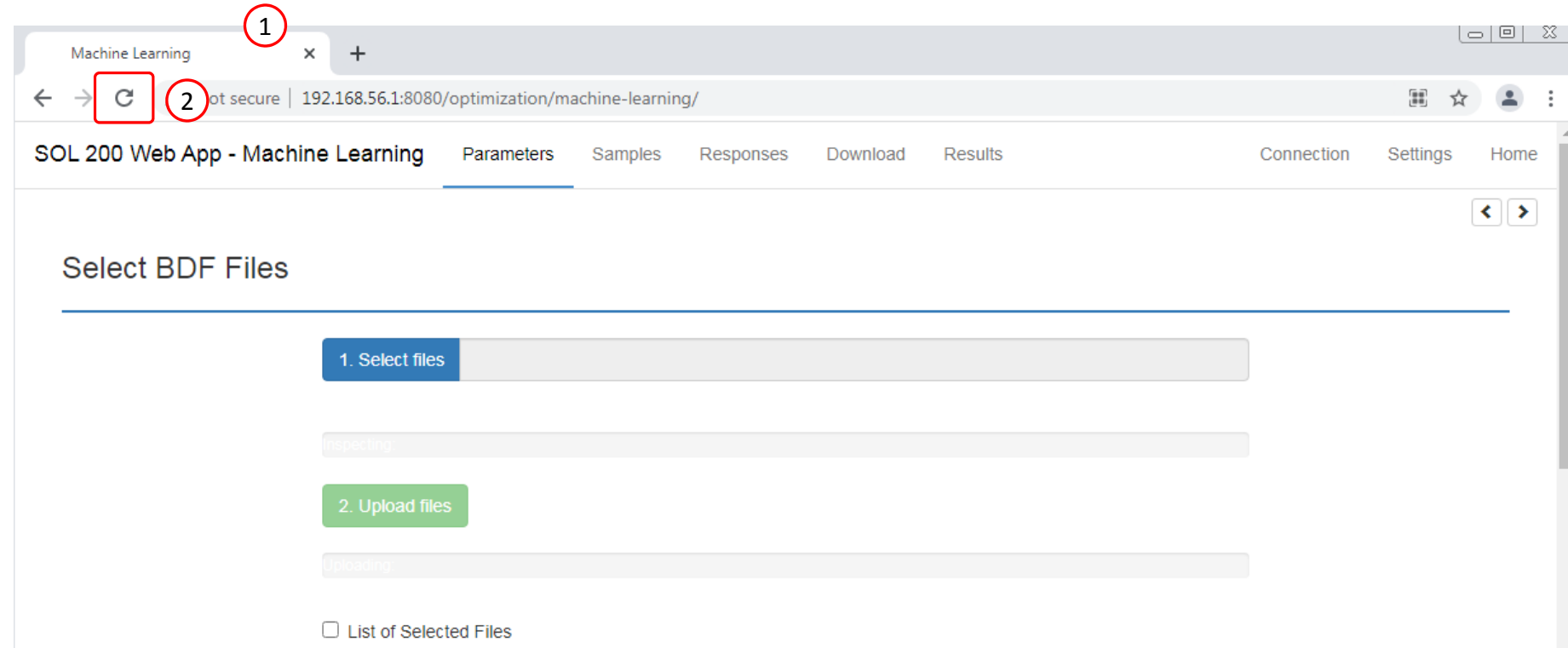- app.config
- BDF files

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

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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.
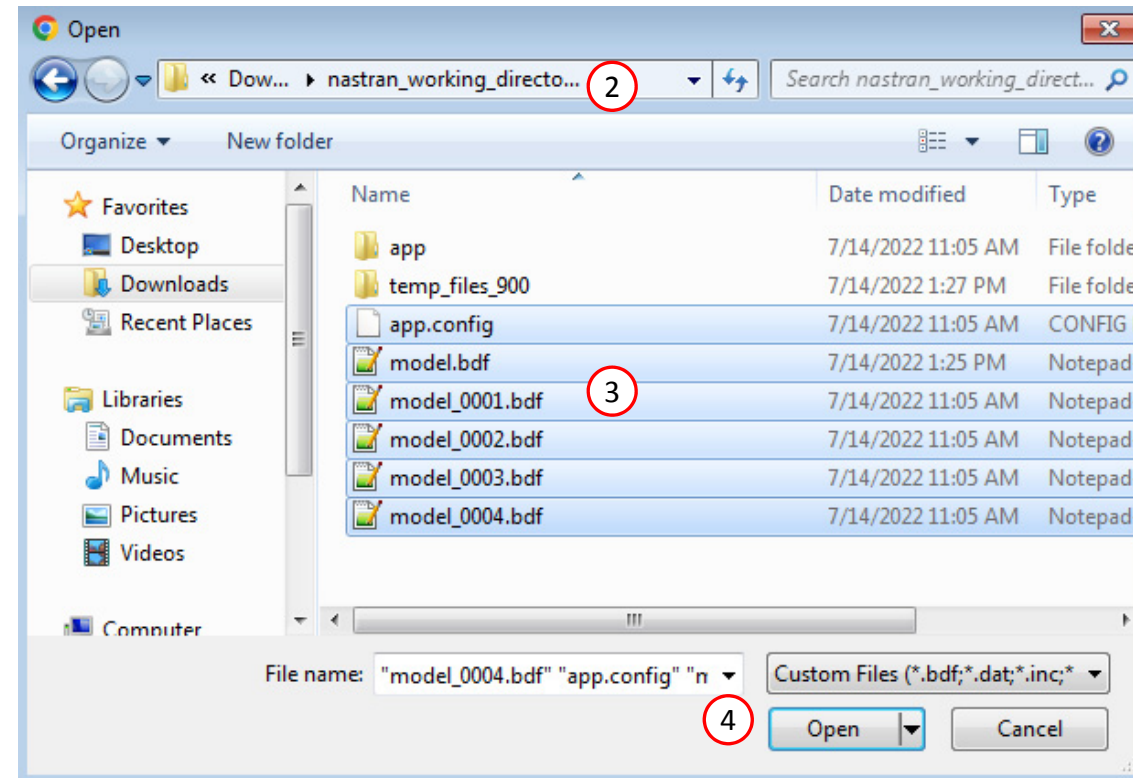
4. Click Open

5. Click Upload files

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

Select BDF Files

(1) | 1. Select files | 2 files selected |

Inspecting: 100%

(5) | 2. Upload files |

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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

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

Import

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

Select BDF Files

| 1. Select files | 2 files selected |

Inspecting: 100%

2. Upload files

Uploading: 100 %

☐ List of Selected Files

Select Parameters

```
$__1___||__2___||__3___||__4___||__5___||__6___||__7___||__8___||__9___||__10__|


CONM2   999     999             .0906                                   +
+       .35             .56                     .07
CONM2   1000    19999           1.0
CONM2   1001    19999           1.0
CONM2   1002    19999           1.0
CONM2   1003    19999           1.0
CONM2   1004    19999           1.0
EIGRL   777     -0.1    1000.
FREQ1   5       0.0     0.2     500
MAT1    1       3.+7    1.153+7         7.76-4
MDLPRM  HDF5    2
PLOAD4  1       171     -3.
PLOAD4  1       172     -3.
PLOAD4  1       160     -3.
PLOAD4  1       161     -3.
PLOAD4  1       162     2
```

Configure Parameters

Delete	Parameter	Status	Input Type	Low	High	Comments
❌	x1	✓	integer	Low	High	Field 3 of SPC
❌	x2	✓	integer	Low	High	Field 3 of SPC
❌	x3	✓	integer	Low	High	Field 3 of SPC
❌	x4	✓	integer	Low	High	Field 3 of SPC