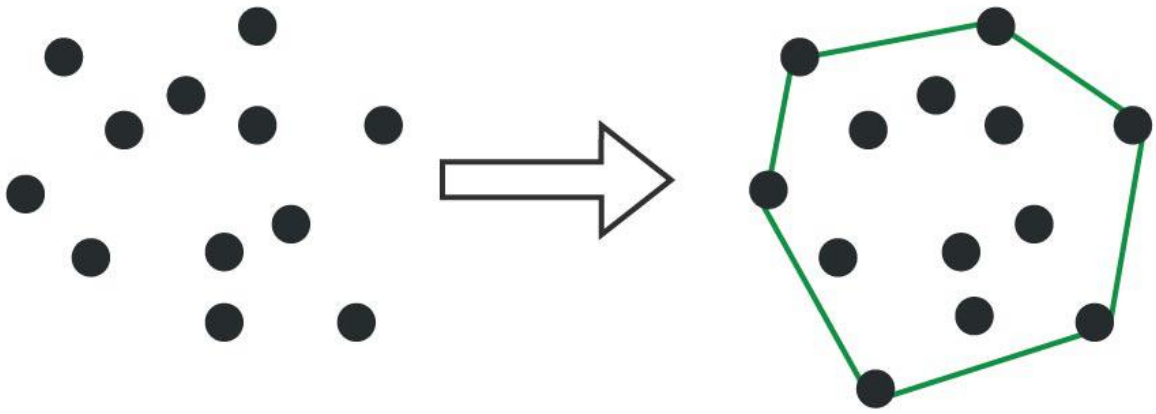
Metric Compute Volume of a Convex Hull Across Frames

Overview

The metric command **Compute Volume of a Convex Hull Across Frames** can be used to find the area or volume of the convex hull for a dataset across several frames. A convex hull is defined as the smallest convex set containing all of the points in a Euclidian space. It can be visualized in 2 dimensions as a string or rubber band around the perimeter of a set, or in 3 dimensions as shrink wrap enclosing the entire range of data points.



Convex Hull

The volume or area of the convex hull of a set can be used to describe the amount of variance in a set or to describe the geometry of the distribution of points.

Pipeline Command

The pipeline command for **Compute Volume of a Convex Hull Across Frames** can be found in the **Metric** folder in the Pipeline Workshop and is as so:

```
Metric_Compute_Volume_of_a_Convex_Hull_Across_Frames
/SIGNAL_TYPES=
! /SIGNAL_FOLDER=ORIGINAL
! /SIGNAL_NAMES=
! /RESULT_FOLDER=PROCESSED
/RESULT_NAME=
! /NUMBER_OF_DIMENSIONS=
! /COMPONENT_SEQUENCE=
! /REQUIRE_ALL_SIGNALS=TRUE
! /START_FRAME=
! /END_FRAME=
```

```
! /EVENT_SEQUENCE=
! /EXCLUDE_EVENTS=
;
```

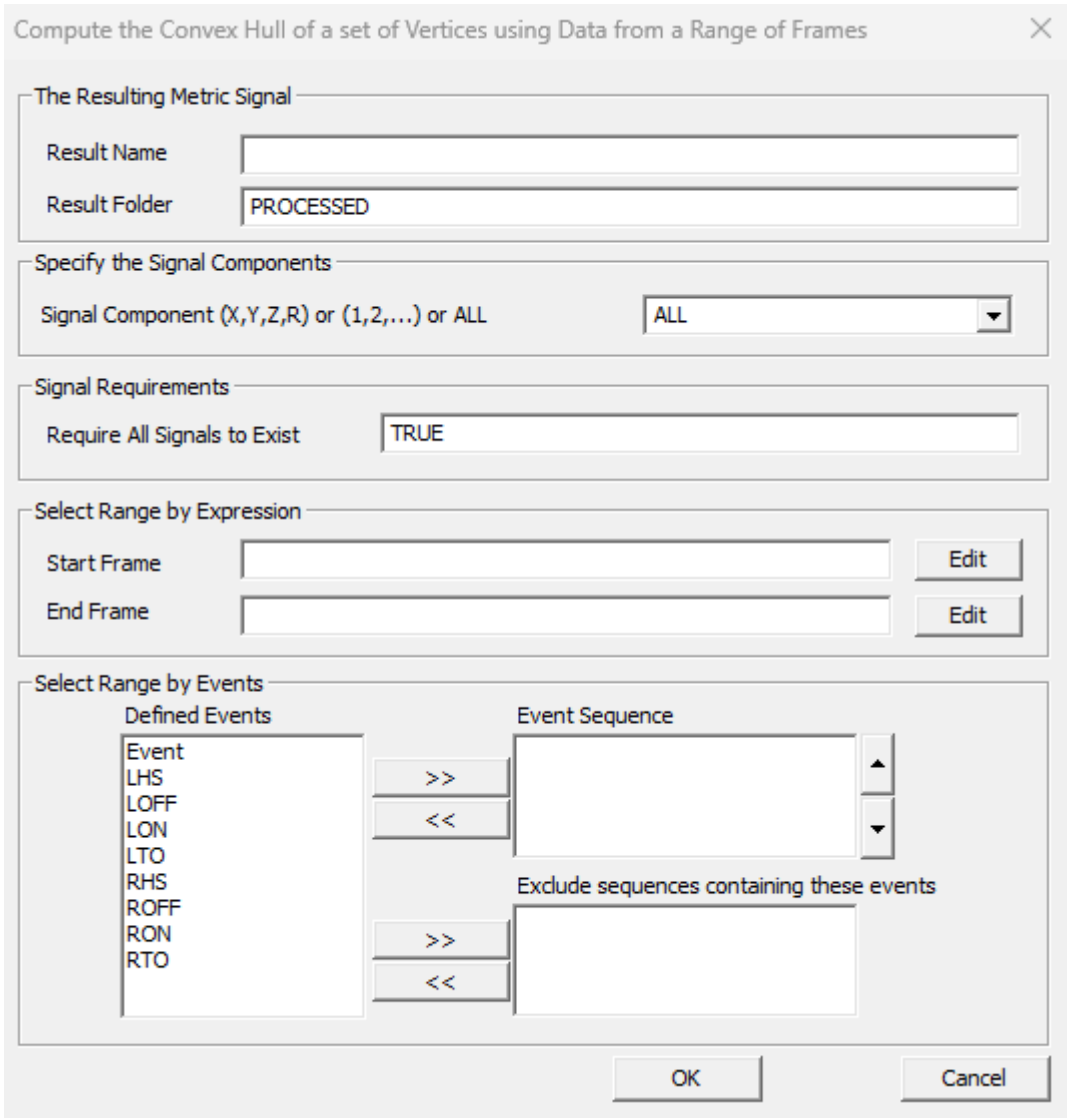
Command Parameters

The following table shows the command parameters seen above and their descriptions:

SIGNAL_TYPES	**Specify the signal type**
SIGNAL_FOLDER	**Specify the origin folder**
SIGNAL_NAMES	**Specify the Signal to be used**
RESULT_FOLDER	**The name of the result signal folder**
RESULT_NAME	**The name of the result signal**
NUMBER_OF_DIMENSIONS	**Number of dimensions the hull will be computed for (2 or 3)**
COMPONENT_SEQUENCE	**Specify the Signal components to be used (e.g. X + Y + Z or 0 + 1 + 2 etc)**
REQUIRE_ALL_SIGNALS	**True or False: require all signals to exist**
/START_FRAME=	**The frame at which to start recording data.**
END_FRAME=	**The frame at which to stop recording data.**
EVENT_SEQUENCE	**A list of events (separated by “+” signs). For example, LHS+RTO**
EXCLUDE_EVENTS	**If this event occurs before the first and last event, do not computed a metric**

Dialog

The command can be edited in a text editor or in a dialog form. To edit in the dialog pop up form either click on the **Edit** button in the pipeline workshop or double-click on the pipeline command. The dialog is shown below:



The dialog box allows you to assign values to the command parameters outlined above

Example: 2D convex hull

Here the **Metric Compute Volume of a Convex Hull Across Frames** command is used to compute the convex hull for right and left foot GRF data during a balance trial. By computing a 2 dimensional (X and Y) hull for the GRF at each foot we can make comparisons between sides while balancing and identify potential asymmetry.

The command is as so:

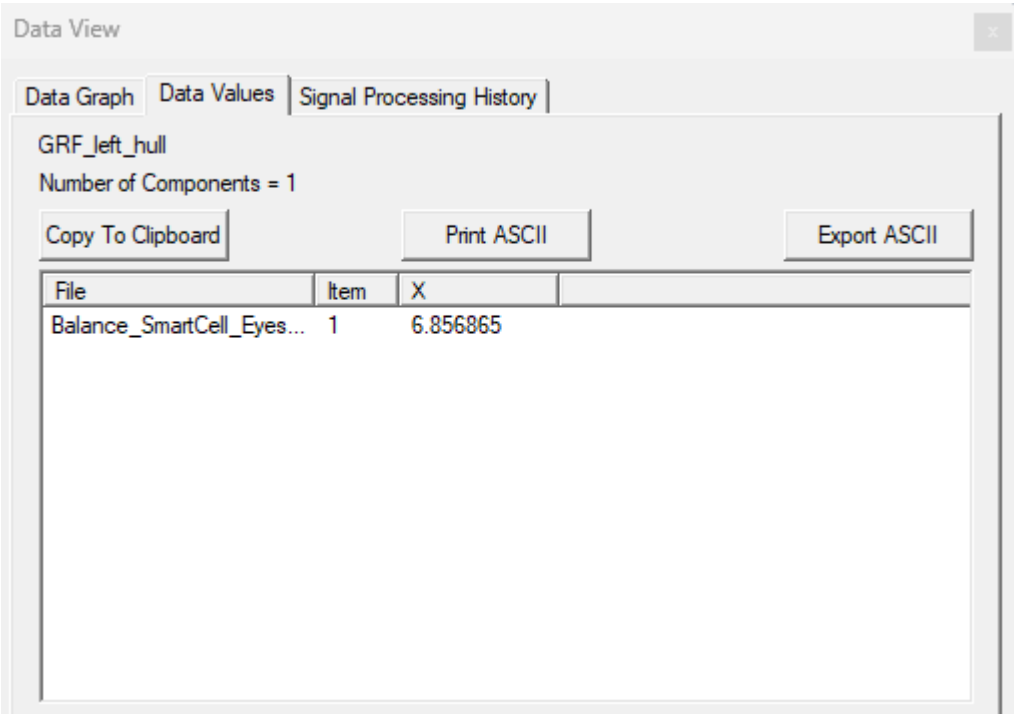
```
Metric_Compute_Volume_of_a_Convex_Hull_Across_Frames
/SIGNAL_TYPES=FORCE
/SIGNAL_FOLDER=ORIGINAL
/SIGNAL_NAMES=FP3
/RESULT_FOLDER=PROCESSED
/RESULT_NAME=GRF_right_hull
/NUMBER_OF_DIMENSIONS=2
/COMPONENT_SEQUENCE=X+Y
/REQUIRE_ALL_SIGNALS=TRUE
```

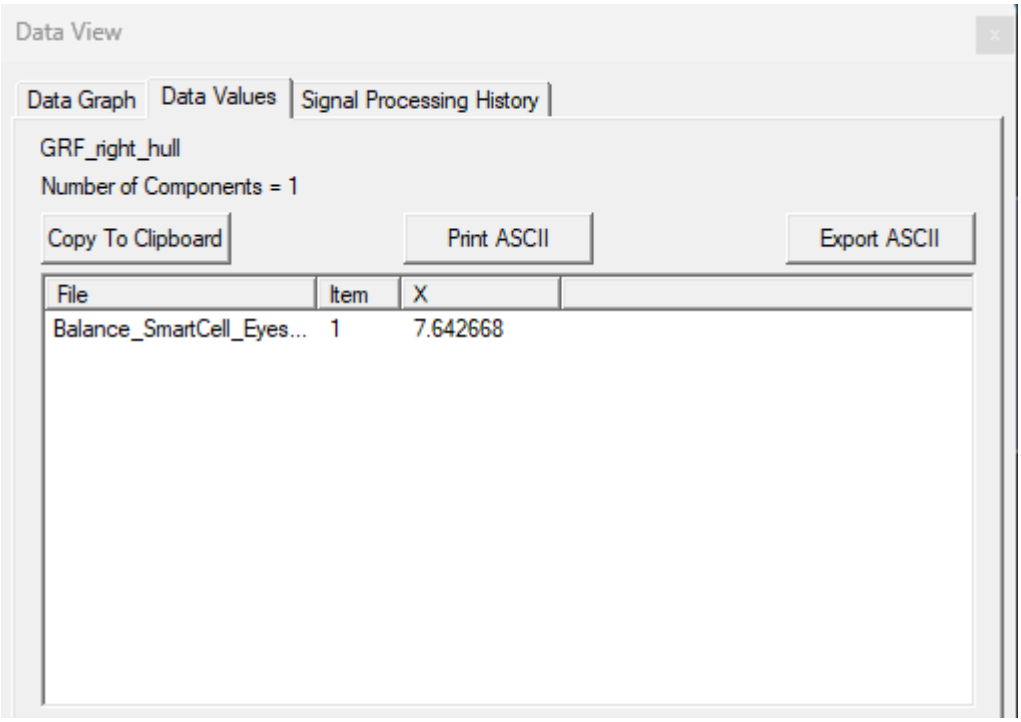
```
! /START_FRAME=
! /END_FRAME=
/EVENT_SEQUENCE=Start+End
! /EXCLUDE_EVENTS=
;

Metric_Compute_Volume_of_a_Convex_Hull_Across_Frames
/SIGNAL_TYPES=FORCE
/SIGNAL_FOLDER=ORIGINAL
/SIGNAL_NAMES=FP4
/RESULT_FOLDER=PROCESSED
/RESULT_NAME=GRF_left_hull
/NUMBER_OF_DIMENSIONS=2
/COMPONENT_SEQUENCE=X+Y
/REQUIRE_ALL_SIGNALS=TRUE
! /START_FRAME=
! /END_FRAME=
/EVENT_SEQUENCE=Start+End
! /EXCLUDE_EVENTS=
;
```

The resulting metrics show the area of the 2 dimensional hull created for each side, a larger area points to more variation in force during the trial.

Results:





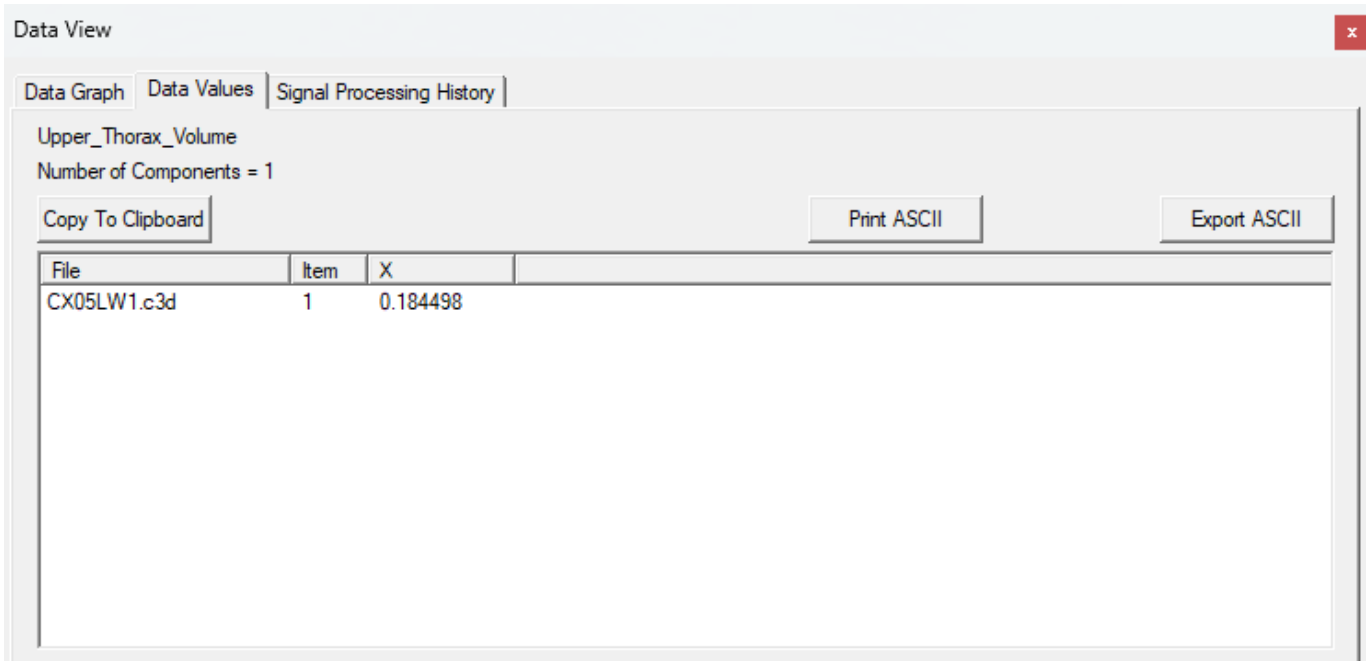
Example: 3D convex hull

In this example **Metric Compute Volume of a Convex Hull Across Frames** is used to find the volume of an individual's thorax segment as defined in the workspace.

The pipeline command is as follows:

```
Metric_Compute_Volume_of_a_Convex_Hull_Across_Frames
/SIGNAL_TYPES=TARGET
! /SIGNAL_FOLDER=ORIGINAL
/SIGNAL_NAMES=1+10+13+14+17+18+21+22+25+26+29+30+5+6+9
! /RESULT_FOLDER=PROCESSED
/RESULT_NAME=Upper_Thorax_Volume
/NUMBER_OF_DIMENSIONS=3
/COMPONENT_SEQUENCE=ALL
! /REQUIRE_ALL_SIGNALS=TRUE
! /START_FRAME=
! /END_FRAME=
/EVENT_SEQUENCE=START+END
! /EXCLUDE_EVENTS=
;
```

Here a 3 dimensional hull is used as the resulting metric will represent a 3 dimensional structure in space. The resulting metric value represents the approximate volume of the upper thorax segment as defined for this trial:



Additional Resources:

Delaunay Triangulation
Convex Hull Algorithm