

Pointwise Analysis Interface Module (AIM) Manual

Marshall Galbraith
MIT ACDL

February 28, 2025

0.1 Introduction	1
0.1.1 Pointwise AIM Overview	1
0.2 AIM Attributes	1
0.3 AIM Inputs	3
0.4 AIM Outputs	5
0.5 Mesh Sizing	6
0.5.1 JSON String Dictionary	6
0.5.2 Single Value String	7

0.1 Introduction

0.1.1 Pointwise AIM Overview

A module in the Computational Aircraft Prototype Syntheses (CAPS) has been developed to interact with the general grid generator [Pointwise](#).

The Pointwise AIM provides the CAPS users with the ability to generate volume meshes mostly suitable for CFD analysis. This includes both inviscid analysis and viscous analysis with boundary layers using the pointwise T-Rex algorithm. 2D mesh generation is currently not available.

An outline of the AIM's inputs, outputs and attributes are provided in [AIM Inputs](#) and [AIM Outputs](#) and [AIM Attributes](#), respectively.

Files output:

- caps.egads - Pointwise egads file generated
- capsUserDefaults.glf - Glyph script with parameters set with [AIM Inputs](#)

Pointwise should be executed on Linux/macOS with the command line:

```
pointwise -b $CAPS_GLYPH/GeomToMesh.glf caps.egads capsUserDefaults.glf
```

and on Windows with:

```
%PW_HOME%\win64\bin\tclsh.exe %CAPS_GLYPH%\GeomToMesh.glf caps.egads capsUserDefaults.glf
```

0.2 AIM Attributes

The following list of attributes are available to guide the mesh generation with the Pointwise AIM.

Key	Value	Geometry Location	Description
PW:NodeSpacing	> 0.0	Node	Specified connector end-point spacing for a node.
PW:ConnectorMaxEdge	> 0.0	Edge	Maximum Edge Length in connector.
PW:ConnectorEnd↔ Spacing	> 0.0	Edge	Specified connector end-point spacing.
PW:ConnectorDimension	> 0	Edge	Specify connector dimension.
PW:ConnectorAverageDS	> 0.0	Edge	Specified average delta spacing for connector dimension.
PW:ConnectorMaxAngle	[0, 180)	Edge	Connector Maximum Angle. (0.0 = NOT APPLIED)
PW:ConnectorMax↔ Deviation	[0, infinity)	Edge	Connector Maximum Deviation. (0.0 = NOT APPLIED)
PW:ConnectorAdapt↔ Source	\$true or \$false	Edge	Set connector up for adaptation as a source
PW:Name	Set by pointwiseAIM to the value of capsGroup	Face	Boundary name for domain or collection of domains.

Key	Value	Geometry Location	Description
PW:QuiltName	Quilting is not supported with CAPS, but input files are generated	Face	Name to give one or more quilts that are assembled into a single quilt. No angle test is performed.
PW:Baffle	\$Baffle or \$Intersect	Face	Either a true baffle surface or a surface intersected by a baffle.
PW:DomainAlgorithm	\$Delaunay, \$AdvancingFront, \$AdvancingFrontOrtho	Face	Surface meshing algorithm.
PW:DomainIsoType	\$Triangle, \$TriangleQuad	Face	Surface cell type. Global default is Triangle.
PW:DomainMinEdge	> 0.0	Face	Cell Minimum Equilateral Edge Length in domain. (0.0 = USE BOUNDARY)
PW:DomainMaxEdge	> 0.0	Face	Cell Maximum Equilateral Edge Length in domain. (0.0 = USE BOUNDARY)
PW:DomainMaxAngle	[0, 180)	Face	Cell Maximum Angle in domain (0.0 = NOT APPLIED)
PW:DomainMaxDeviation	[0, infinity)	Face	Cell Maximum Deviation in domain (0.0 = NOT APPLIED)
PW:DomainSwapCells	\$true or \$false	Face	Swap cells with no interior points.
PW:DomainQuadMax↔Angle	(90, 180)	Face	Quad Maximum Included Angle in domain.
PW:DomainQuadMax↔Warp	(0, 90)	Face	Cell Maximum Warp Angle in domain.
PW:DomainDecay	[0, 1]	Face	Boundary decay applied on domain.
PW:DomainMaxLayers	[0, infinity)	Face	Maximum T-Rex layers in domain.
PW:DomainFullLayers	[0, infinity)	Face	Number of full T-Rex layers in domain. (0 allows multi-normals)
PW:DomainTRex↔GrowthRate	[1, infinity)	Face	T-Rex growth rate in domain.
PW:DomainTRexType	\$Triangle, \$TriangleQuad	Face	Cell types in T-Rex layers in domain.
PW:DomainTRexIso↔Height	> 0.0	Face	Isotropic height for T-Rex cells in domain. Default is 1.0.
PW:PeriodicTranslate	"tx; ty; tz"	Face	Periodic domain with given translation vector.
PW:PeriodicRotate	"px; py; pz; nx; ny; nz; angle"	Face	Periodic domain with given point, normal and rotation angle.

Key	Value	Geometry Location	Description
PW:PeriodicTarget	\$true or \$false	Face	Target domain of a translate or rotate periodic domain. This domain will be deleted before the creation of the periodic domain.
PW:DomainAdaptSource	\$true or \$false	Face	Set domain up for adaptation as a source
PW:DomainAdaptTarget	\$true or \$false	Face	Set domain up for adaptation as a target
PW:DomainShape↔Constraint	\$DataBase or \$Free	Face	Set the domain shape constraint
PW:WallSpacing	\$Wall or > 0.0	Face	Viscous normal spacing for T-Rex extrusion. \$↔Wall uses domParams(↔WallSpacing)

0.3 AIM Inputs

The following list outlines the Pointwise options along with their default value available through the AIM interface.

- **Proj_Name = NULL**
Output name prefix for meshes to be written in formats specified by Mesh_Format. These meshes are not linked to any analysis, but may be useful exploring meshing parameters.
- **Mesh_Format = NULL**
Optional list of string mesh formats to generate meshes not linked to analysis.
Available format names include: "exodus", "fast", "wavefront", "libMeshb", "stl", "bstl", "su2", "tecplot", "ugrid", "vtk", and "bvtk".
where the "b" prefix indicates binary version.
- **Mesh_Sizing = NULL**
These parameters are implemented by overriding PW: attributes. See [Mesh Sizing](#) for additional details.
- **Mesh_Length_Factor = 1**
Scaling factor to compute a meshing Reference_Length via:

$$\text{Reference_Length} = \text{capsMeshLength} * \text{Mesh_Length_Factor}$$

Reference_Length scales all input parameters with units of length
- **Connector_Initial_Dim = 11**
Initial connector dimension.
- **Connector_Max_Dim = 1024**
Maximum connector dimension.
- **Connector_Min_Dim = 4**
Minimum connector dimension.
- **Connector_Turn_Angle = 0.0**
Maximum turning angle [degree] on connectors for dimensioning (0 - not used). Influences connector resolution in high curvature regions. Suggested values from 5 to 20 degrees.

- **Connector_Deviation = 0.0**
Maximum deviation on connectors for dimensioning (0 - not used). This is the maximum distance between the center of a segment on the connector to the CAD surface. Influences connector resolution in high curvature regions.
- **Connector_Split_Angle = 0.0**
Turning angle on connectors to split (0 - not used).
- **Connector_Turn_Angle_Hard = 70**
Hard edge turning angle [degree] limit for domain T-Rex (0.0 - not used).
- **Connector_Prox_Growth_Rate = 1.3**
Connector proximity growth rate.
- **Connector_Adapt_Sources = False**
Compute sources using connectors.
- **Connector_Source_Spacing = False**
Use source cloud for adaptive pass on connectors V18.2+.
- **Domain_Algorithm = "Delaunay"**
Isotropic (Delaunay, AdvancingFront or AdvancingFrontOrtho).
- **Domain_Full_Layers = 0**
Domain full layers (0 for multi-normals, ≥ 1 for single normal).
- **Domain_Max_Layers = 0**
Domain maximum layers.
- **Domain_Growth_Rate = 1.3**
Domain growth rate for 2D T-Rex extrusion.
- **Domain_Iso_Type = "Triangle"**
Domain iso cell type (Triangle or TriangleQuad).
- **Domain_TRex_Type = "Triangle"**
Domain T-Rex cell type (Triangle or TriangleQuad).
- **Domain_TRex_ARLimit = 200.0**
Domain T-Rex maximum aspect ratio limit (0 - not used).
- **Domain_TRex_AngleBC = 0.0**
Domain T-Rex spacing from surface curvature.
- **Domain_Decay = 0.5**
Domain boundary decay.
- **Domain_Min_Edge = 0.0**
Domain minimum edge length (relative to capsMeshLength).
- **Domain_Max_Edge = 0.0**
Domain minimum edge length (relative to capsMeshLength).
- **Domain_Adapt = False**
Set up all domains for adaptation.
- **Domain_Wall_Spacing = 0.0**
Defined spacing when geometry attributed with PW:WallSpacing \$wall (relative to capsMeshLength)
- **Domain_Structure_AR_Convert = 0.0**
Aspect ratio to trigger converting domains to structured.
- **Domain_Algorithm = "Delaunay"**
Isotropic (Delaunay, Voxel) (V18.3+).

- **Block_Voxel_Layers = 3**
Number of Voxel transition layers if Algorithm set to Voxel (V18.3+).
- **Block_Boundary_Decay = 0.5**
Volumetric boundary decay.
- **Block_Collision_Buffer = 0.5**
Collision buffer for colliding T-Rex fronts.
- **Block_Max_Skew_Angle = 180.0**
Maximum skew angle for T-Rex extrusion.
- **Block_TRex_Skew_Delay = 0**
Number of layers to delay enforcement of skew criteria
- **Block_Edge_Max_Growth_Rate = 1.8**
Volumetric edge ratio.
- **Block_Full_Layers = 0**
Full layers (0 for multi-normals, ≥ 1 for single normal).
- **Block_Max_Layers = 0**
Maximum layers.
- **Block_Growth_Rate = 1.3**
Growth rate for volume T-Rex extrusion.
- **Block_TRexType = "TetPyramid"**
T-Rex cell type (TetPyramid, TetPyramidPrismHex, AllAndConvertWallDoms).
- **Gen_Source_Box_Length_Scale = 0.0**
Length scale of enclosed viscous walls in source box (0 - no box) (relative to capsMeshLength).
- **Gen_Source_Box_Direction = [1.0, 0.0, 0.0]**
Principal direction vector (i.e. normalized freestream vector).
- **Gen_Source_Box_Angle = 0.0**
Angle for widening source box in the assigned direction.
- **Gen_Source_Growth_Factor = 10.0**
Growth rate for spacing value along box.
- **Elevate_Cost_Threshold = 0.8**
Cost convergence threshold.
- **Elevate_Max_Include_Angle = 175.0**
Maximum included angle tolerance.
- **Elevate_Relax = 0.05**
Iteration relaxation factor.
- **Elevate_Smoothing_Passes = 1000**
Number of smoothing passes.
- **Elevate_WCN_Weight = 0.5**
WCN cost component weighting factor.
- **Elevate_WCN_Mode = "Calculate"**
WCN weight factor method (UseValue or Calculate).

0.4 AIM Outputs

The following list outlines the Pointwise AIM outputs available through the AIM interface.

- **Volume_Mesh**
The volume mesh for a link

0.5 Mesh Sizing

NOTE: Available mesh sizing parameters differ between mesh generators.

Structure for the mesh sizing tuple = ("CAPS Mesh Name", "Value"). "CAPS Mesh Name" defines the caps↔ Mesh on which the sizing information should be applied. The "Value" can either be a JSON String dictionary (see Section [JSON String Dictionary](#)) or a single string keyword string (see Section [Single Value String](#))

0.5.1 JSON String Dictionary

If "Value" is a JSON string dictionary (e.g. "Value" = {"edgeDistribution": "Even", "numEdgePoints": 100}) the following keywords (= default values) may be used:

- **numEdgePoints = 2**
Number of points along an edge including end points. Must be at least 2.
This overrides the PW:ConnectorDimension attribute on EDGES.
- **boundaryLayerSpacing = 0.0**
Initial spacing factor for boundary layer mesh growth on as face.
The spacing in the mesh is is given by
 $\text{meshBLS} = \text{capsMeshLength} * \text{boundaryLayerSpacing}$
This overrides the PW:WallSpacing attribute on FACES.
- **boundaryLayerMaxLayers = 0.0**
Maximum number of layers when growing a boundary layer.
This overrides the PW:DomainMaxLayers attribute on FACES.
- **boundaryLayerFullLayers = 0**
Number of complete layers.
This overrides the PW:DomainFullLayers attribute on FACES.
- **boundaryLayerGrowthRate = 1**
Growth rate for boundary layers.
This overrides the PW:DomainTRexGrowthRate attribute on FACES.
- **nodeSpacing = 0.0**
Spacing at a NODE or ends of an EDGE.
The spacing in the mesh is is given by
 $\text{meshNodeSpacing} = \text{capsMeshLength} * \text{nodeSpacing}$
This overrides the PW:NodeSpacing attribute on the NODEs and PW:ConnectorEndSpacing attribute on EDGES.
- **minSpacing = 0.0**
Minimum spacing on a FACE.
The spacing in the mesh is is given by
 $\text{meshMinSpacing} = \text{capsMeshLength} * \text{minSpacing}$
This overrides the PW:DomainMinEdge attribute on FACES.

- **maxSpacing = 0.0**

Maximum spacing on an EDGE or FACE.

The spacing in the mesh is given by

$\text{meshMaxSpacing} = \text{capsMeshLength} * \text{maxSpacing}$

This overrides the PW:ConnectorMaxEdge attribute on EDGES and PW:DomainMaxEdge attribute on FACES.

- **avgSpacing = 0.0**

Average spacing on an EDGE.

The spacing in the mesh is given by

$\text{meshAvgSpacing} = \text{capsMeshLength} * \text{avgSpacing}$

This overrides the PW:ConnectorAverageDS attribute on EDGES.

- **maxAngle = 0.0** [Range 0 to 180]

Maximum angle to set spacings on an EDGE.

This overrides the PW:ConnectorMaxAngle attribute on EDGES and PW:DomainMaxAngle attribute on FACES.

- **maxDeviation = 0.0**

Maximum deviation to set spacing on an EDGE or FACE.

The spacing in the mesh is given by

$\text{meshMaxDeviation} = \text{capsMeshLength} * \text{maxDeviation}$

This overrides the PW:ConnectorMaxDeviation attribute on EDGES and PW:DomainMaxDeviation attribute on FACES.

- **boundaryDecay = 0.0** [Range 0 to 1]

Decay of influence of the boundary spacing on the interior spacing.

This overrides the PW:DomainDecay attribute on FACES.

0.5.2 Single Value String

If "Value" is a single string, the following options maybe used:

- (NONE Currently)

