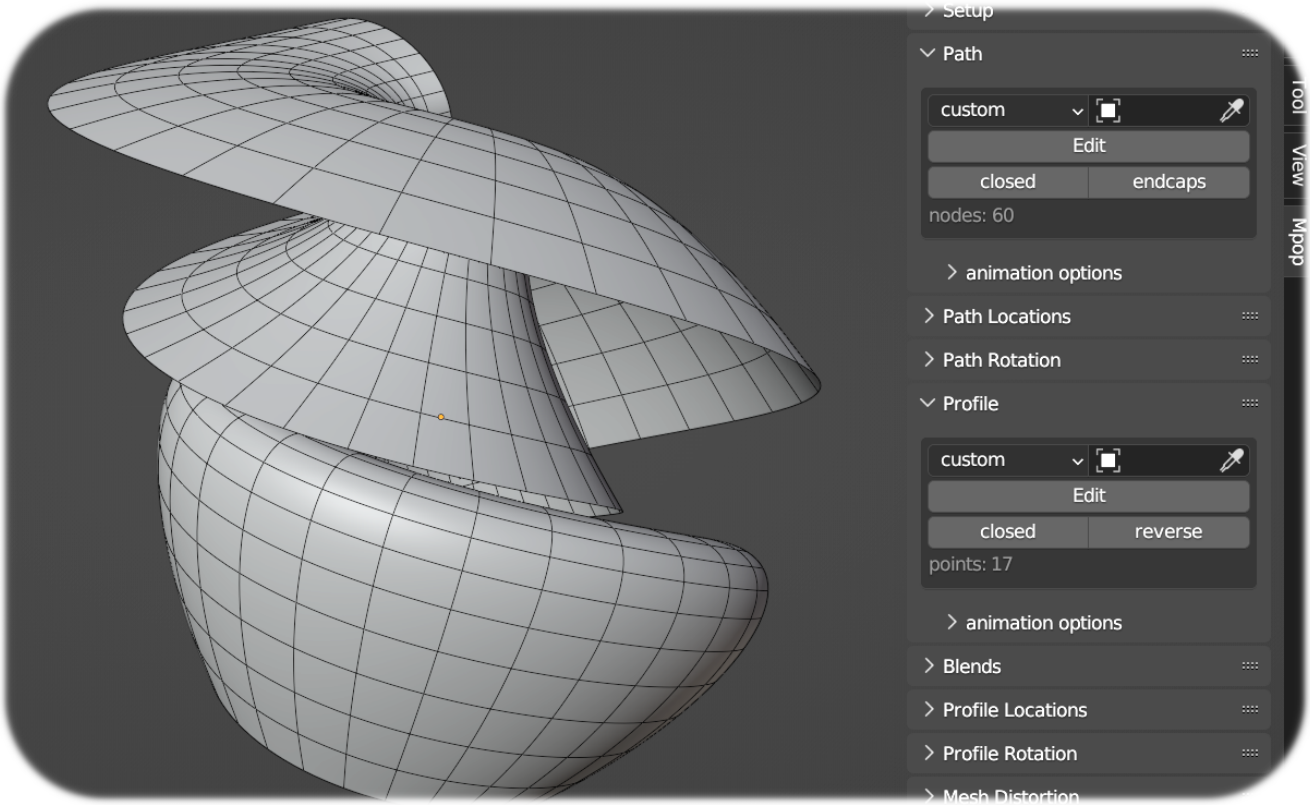
POP MESH 2.5

User Guide - March 2024



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1 INTRODUCTION

Thank you for downloading PopMesh 2.5, the mesh generator/animator add-on for Blender 3d software. Since the first release in June 2023, I have had the time to test, update and restructure parts of the code and I finally decided to publish this new version which is more representative of the original idea. In addition to code updates and optimizations, version 2.5 features a more compact and ergonomic interface, new path and profile providers, several new design and animation options and over 30 sample-settings files.

I hope you have a pleasurable experience using PopMesh.

P. T.

2 LICENSE

3 INSTALLATION

PopMesh 2.5 may work with various Blender versions, however it was tested only on Blender 3.6 LTS.

- Start Blender and open the 'Preferences' window from the 'Edit' menu. Select the 'Add-ons' tab.
- If you have installed a previous version of PopMesh, disable and remove it before installing this version.
- Click 'Install...', find and select the downloaded 'PTDBLNPOPM.zip' file, then click 'Install Add-on'.
- Enable the add-on by ticking the checkbox next to its name.

4 QUICK START

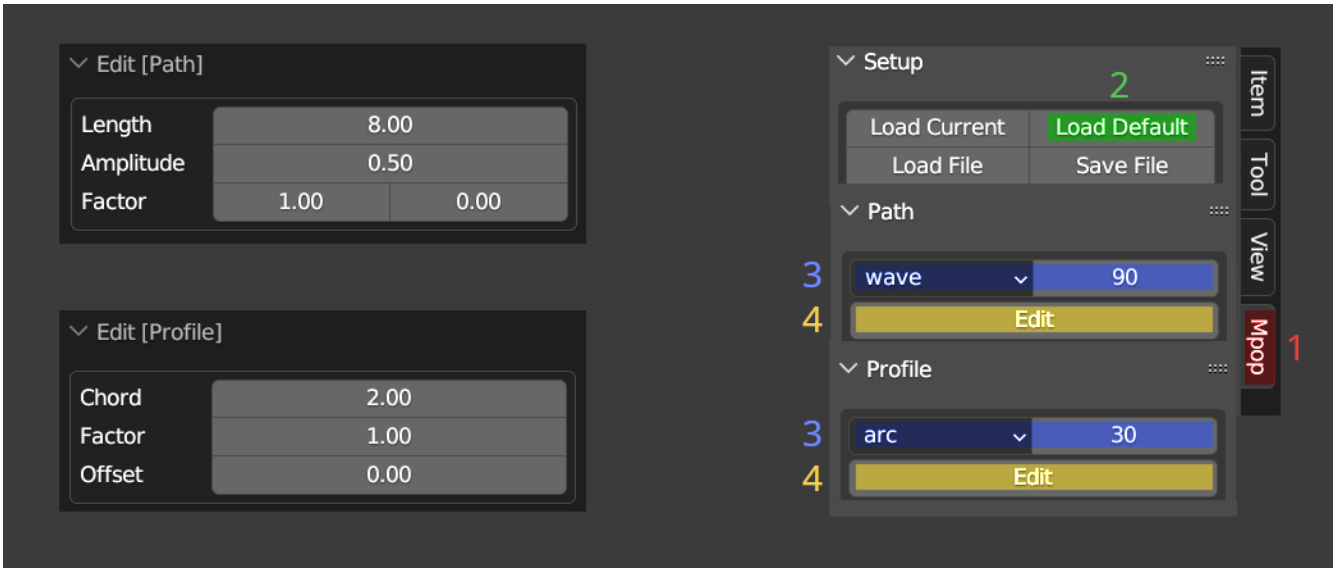


Figure 4.1: Quick Start path & profile settings

1. PopMesh is available in Object Mode. You will find it on the Side Panel (N-Panel) of the 3D Viewport, under the **Mpop** tab.
2. First, click the **Load Default** button in the **Setup** panel to initialize the program.
3. Select a path and profile from the list of providers in the respective panels. Set the path and profile resolution in the field next to the provider.
4. Click the **Edit** button to modify path and profile parameters.

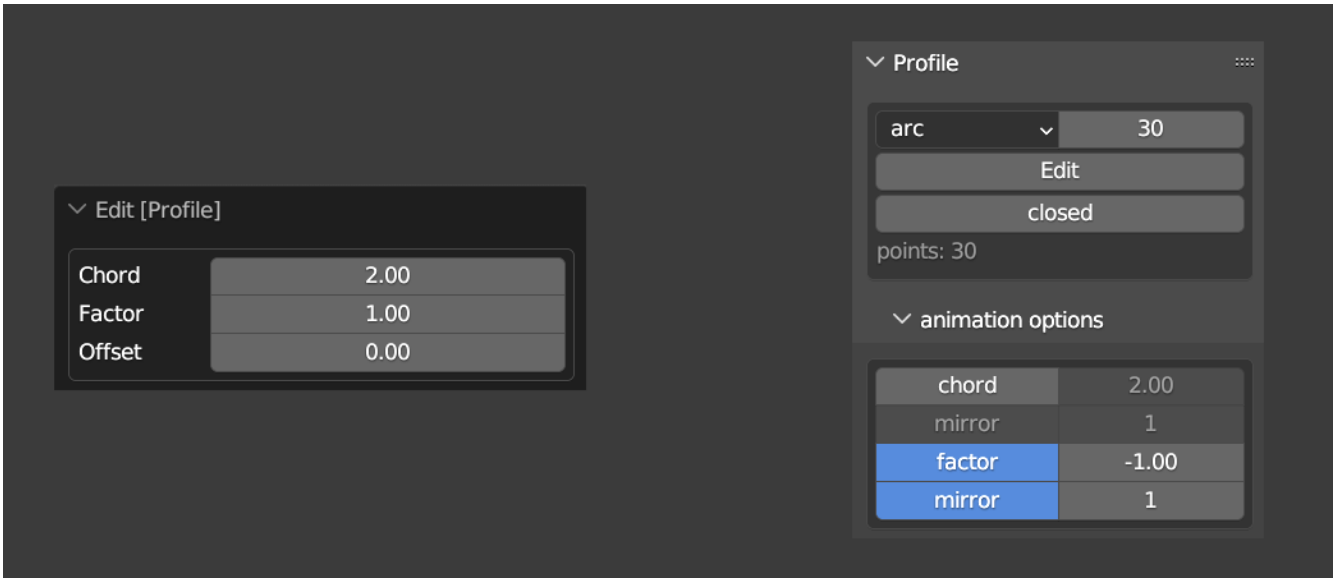


Figure 4.2: Quick Start profile animation options

To animate a parameter, expand the **animation options** sub-panel, select the parameter(s) that you want to animate and set a target value in the adjacent field. Optionally, you may select the **mirror** checkbox if you want the animation to loop between the original and target values a set number of times.

To create the animation, follow the steps below:

1. Expand the **Animation** panel and click **Enter Animode** to enable animation mode.
2. Select a number of keyframes and click **Set Frame Range** to set the frame range in the Timeline.
3. Click **Add** to create a new animation action track.

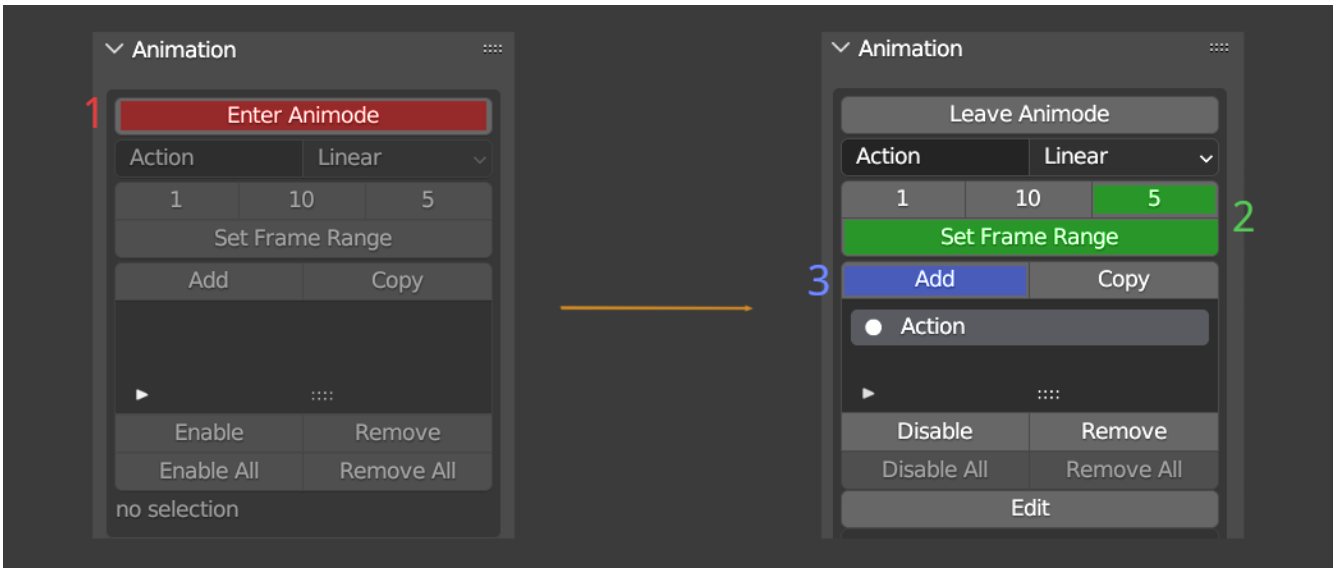


Figure 4.3: Quick Start Animation Mode

5 USER GUIDE

The following sections provide information about concepts and conventions, the interface panels and some tips to facilitate the process of using the program.

- Concepts
  - Paths & Profiles
  - Collection Edits
  - Rotation & Orientation
  - Animation Options
  - Program Settings
- Interface
  - Setup Panel
  - Path Panel
  - Path Locations Panel
  - Path Rotation Panel
  - Profile Panel
  - Blends Panel
  - Profile Locations Panel
  - Profile Rotation Panel
  - Mesh Distortion Panel
  - Mesh Rotation Panel
  - Face Range Panel
  - Anicalc Panel
  - Animation Panel
- Implementation

5.1 CONCEPTS

PopMesh generates a 3d mesh object by sweeping a 2d path (a shape on the x-y plane) along another path in 3d space such that the normal vector of the 2d path corresponds to the tangent vector at each point of the 3d path. This technique is similar to 'path extrusion' and is also known by several other names like 'sweep mesh', 'sweep surface', and so on. The acronym 'Pop' is short for path-on-path. To avoid confusion, we use the name **path** for the (extrusion) path, and **profile** for the (extruded) 2d path. These are the two main components that determine the resulting mesh object.

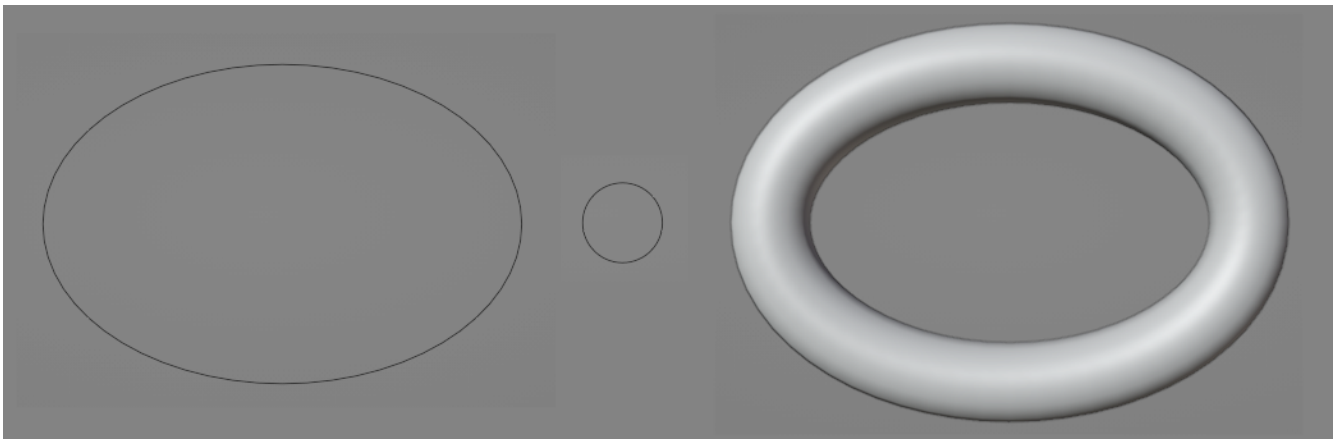


Figure 5.1.1: Simple extrusion of circle profile along ellipse path

Before we go any further, you should be aware of some conventions used throughout this guide. The names we use to reference the various elements (components) on the User Interface panels are listed below:

Action Buttons: *Always invoke operation, first letter is capitalized*
Check Boxes: *Boolean state (ON/OFF), may invoke operation, all lowercase letters*
Input Fields: *Text or numeric (integer/float) input, may invoke operation*
Object Selection Fields: *Select mesh object, always invoke operation*
Enumerated Lists: *Select from a list of options, may invoke operation*
Collection Items Lists: *Display/Select/Rename items in a collection*
Information Labels: *Display feedback*
Component Groups: *Groupings of one or more of the above types*

Bold font types are used for UI elements (the **Edit** action button, the **closed** check box) and for names with special meaning (**preset/custom provider, path nodes,** etc). **Blue bold fonts** are used for links to different sections in the Guide.

5.1.1 PATHS & PROFILES

The program offers seven **preset** shapes and one **custom** option that you may use as **path** or **profile providers:**

Provider	Type	Parameters	Default drawing
Line	path, profile	• Length ◦ type: float • Interpolation ease ◦ type: enumerated list • Interpolation exponent ◦ type: float in [0.5, 5]	straight line along x-axis, from x=length/2
Wave	path, profile	• Length ◦ type: float • Amplitude ◦ type: float • Frequency ◦ type: float • Phase ◦ type: float	sine wave on x-y plane, from x=length/2, y=0
Arc	path, profile	• Chord ◦ type: float • Factor ◦ type: float • Offset ◦ type: float	circular arc on x-y plane, counterclockwise from x=chord/2, y=0
Ellipse	path, profile	• Size ◦ type: list of float [x, y] • Interpolation steps ◦ type: integer • Factor ◦ type: float • Interpolation exponent ◦ type: float in [0.5, 5]	ellipse on x-y plane, counterclockwise from x=size[0]/2, y=0
Polygon	path, profile	• Size ◦ type: list of float [x, y] • Sides ◦ type: integer in [3, 20] • Bevel offset ◦ type: float >= 0.001 • Bevel segments ◦ type: integer • Start angle ◦ type: float • Interpolation ease ◦ type: enumerated list • Interpolation exponent ◦ type: float in [0.5, 5]	polygon on x-y plane, counterclockwise from x=size[0]/2, y=0

Provider	Type	Parameters	Default drawing
Helix	path	• Size ◦ type: list of float [x, y] • Length ◦ type: float • Frequency ◦ type: float • Factor ◦ type: float • Phase ◦ type: float • Interpolation ease ◦ type: enumerated list • Interpolation exponent ◦ type: float in [0.5, 5] • Interpolation mirror ◦ type: boolean	helix, counterclockwise from x=size[0]/2, y=0, z=length/2
Spiral	path	• Diameter ◦ type: float • Frequency ◦ type: float	spherical spiral, counterclockwise from x=0, y=0, z=diameter/2
Custom	path, profile	• Size ◦ type: list of float ▪ path: [x, y, z] ▪ profile: [x, y] • Pivot ◦ type: list of float [x, y, z]	user-selected mesh object

You may see the **parameters** listed in the table above being referred to as **properties** in some sections of this guide. The meaning is exactly the same, they are path and profile **attributes.**

Additionally, there are attributes shared among all path and profile providers:

Path shared attributes	Profile shared attributes

• Fixed up-axis orientation
  ◦ type: boolean
• Up-axis selection
  ◦ type: enumerated list
• Closed or open path
  ◦ type: boolean
• Endcaps (polygonal faces) for open paths
  ◦ type: boolean
	• Index offset (Blend profiles only)
	  ◦ type: integer
	• Alignment angle (Blend profiles only)
	  ◦ type: float
	• Closed or open profile (all profiles)
	  ◦ type: boolean

The resolution of **preset providers** is set in the corresponding fields of the **Path Panel** and the **Profile Panel**.
The resolution of **custom providers** is determined by the user-selected object.

2d **preset providers** are drawn in the x-y plane. Although there is no restriction for your 2d **custom providers,** you should be aware that the program will ignore the z-dimension of **custom profiles**.

The **Pivot** attribute is used to place a **custom provider** shape in Blender's world. The program interprets this 3d vector as the custom shape's origin.

5.1.2 COLLECTION EDITS

In addition to modifying path and profile parameters, you can further customize the resulting mesh by using **blend** profiles and/or manipulating the coordinates of path and profile vertices. Since these are frequent operations it is important to make the distinction between **path nodes** and **profile points.** It may help to think of a path node as the origin of a profile copy. Remember that we do not see the path nodes in the resulting mesh, but a series of profiles along the path.

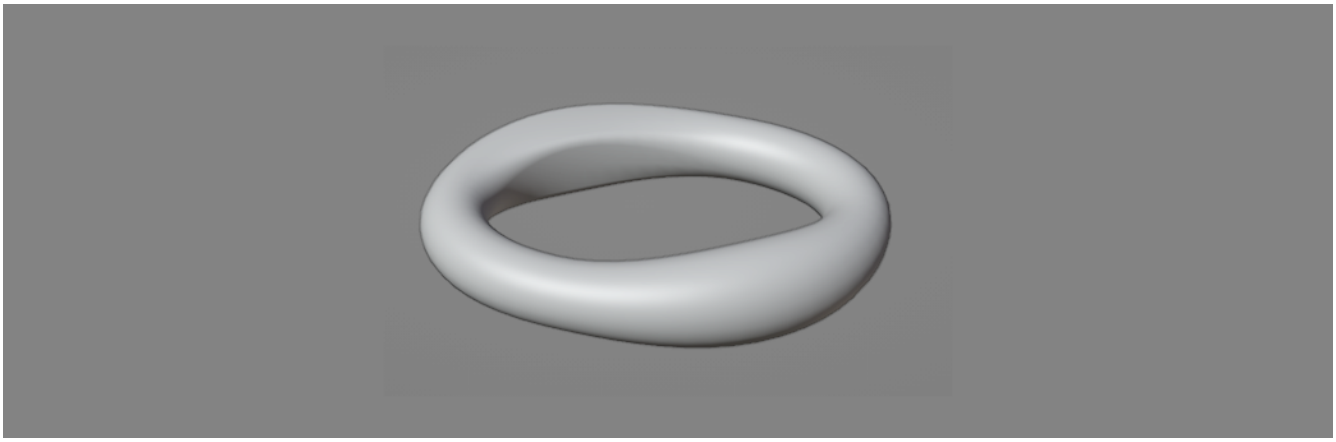


Figure 5.1.2.1: Simple extrusion with two blends

Blend profiles, available from the **Blends Panel**, offer an intuitive way of morphing two or more profile shapes. When you combine them with edits from the **Path Locations Panel** and the **Profile Locations Panel** you will be able to create many different variations in the resulting mesh object.

The **Blend**, **Path Locations** and **Profile Locations** editors use the morph/transform algorithm described below:

Figure 5.1.2.2: Transform Component Groups: Path Nodes (left), Profile Points (right)

The two component groups in *Figure 5.1.2.2* above look identical with the exception of the Title in the first row (**Nodes** for path and **Points** for profile). The same algorithm is used in both instances, however the range of available input field values is determined by the path and profile resolutions respectively.

Nodes and Points transform options:

Title	Field 1	Field 2	Field 3
Nodes / Points	Start index type: integer	Number of group items type: integer	Number of items between groups type: integer
Groups	Number of groups type: integer	Group falloff factor type: float	Group falloff step: type: integer
Lerp	Interpolation ease type: enumerated list	Interpolation exponent type: float in [0.2, 5]	Last increment exclusion type: boolean
Style	Interpolation mirror type: boolean	Inverted interpolation type: enumerated list	Reverse direction type: boolean

All of the fields in the first row and the first field in the second row will allow values based on the available number of **Path Nodes** or **Profile Points**. The 'interpolation types' are [off, linear, in, out, in-out] and the 'inverted interpolation types' are [none, all, highs, lows]. Of course, you will need to experiment with the different options to see their effect. Here is a demonstration of the **Path Locations Editor**:

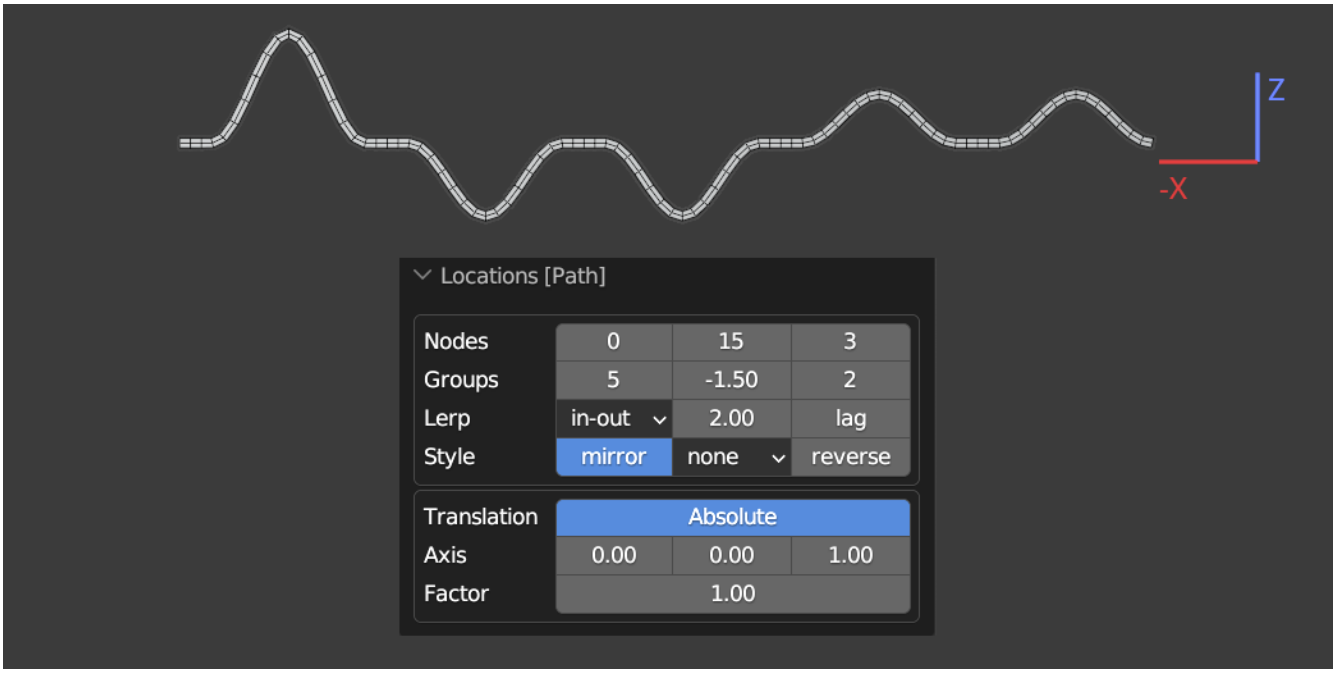


Figure 5.1.2.3: Path Locations Editor

As you can see in *Figure 5.1.2.3*, an absolute translation of factor 1.0 along the Z axis is applied to the 90 nodes of a Line path. The 'start Index' is 0, there are 15 items in a group and 3 items between groups; this means that the maximum available 'number of groups' is 5, (15 + 3) * 5 = 90. Notice how the negative sign in the 'group falloff factor' alternates the direction of the falloff effect between sets of 2 groups determined by the 'group falloff step' value. The example uses a 'mirror' interpolation type of 'in-out' with an exponent value of 2.0.

It is also important to note that **Blends, Path Locations** and **Profile Locations** are **Collection Editors.** This means that you can add as many edits as you want to these collections. The program features one more collection for animation tracks (see the **Animation Panel** for more information). The following image shows how such **component groups** are drawn in the UI**.**

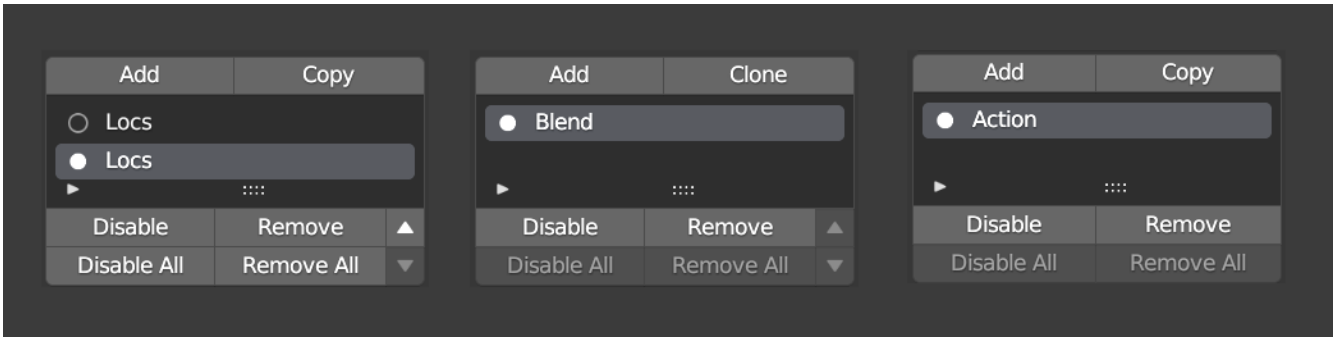


Figure 5.1.2.4: Collection Component Groups: (from left) Path/Profile Locations, Blends, Animation Tracks

All three component groups have a horizontal strip with two action buttons at the top, followed by the collection items list and two rows with additional actions:

- **Add**
  - type: action button
  - function: add new edit to the collection
  - notes: the new edit is added at the end of the list in disabled state (Path Locations, Profile Locations, Blends); the new edit is added at the start of the list in enabled state (Animation Tracks).
- **Copy (Path Locations, Profile Locations, Animation Tracks)**
  - type: action button
  - function: add new edit to the collection (copy of the selected item in the list)
  - notes: the new edit is added at the end of the list in disabled state (Path Locations, Profile Locations); the new edit is added at the start of the list in enabled state (Animation Tracks).
- **Clone (Blends)**
  - type: action button
  - function: add new edit to the collection (copy of the main Profile Provider)
  - notes: the new edit is added at the end of the list in disabled state
- **List of Edits**
  - type: collection items list
  - function: display/select/rename edits
  - notes: single-click item to select, double-click item to rename.
- **Enable / Disable**
  - type: action button
  - function: enable or disable the selected edit
- **Enable All / Disable All**
  - type: action button
  - function: enable or disable all edits

- **Remove**
  - type: action button
  - function: remove the selected edit from the collection
- **Remove All**
  - type: action button
  - function: remove all edits (clear the collection)
- **Up / Down arrow (Path Locations, Profile Locations, Blends)**
  - type: action button
  - function: move the selected edit higher (lower index) or lower (higher index) in the list
  - notes: change the order of items in the collection

5.1.3 ROTATION & ORIENTATION

The main types of rotations are available from the **Path Rotation Panel**, the **Profile Rotation Panel** and the **Mesh Rotation Panel**. All three of them, plus the **alignment rotation** for **profiles,** affect the resulting mesh object's shape and placement in the 3d world. However, there is more to be said about rotations. First of all, there is a **fixed up** orientation option in the **Path** panel. Then, the **Path / Profile Locations Editor** panels have the option to select a **relative** or **absolute** translation in **path / profile space.**

Orientation is defined as the 'imaginary' rotation needed to move an object from a reference placement to its current placement.

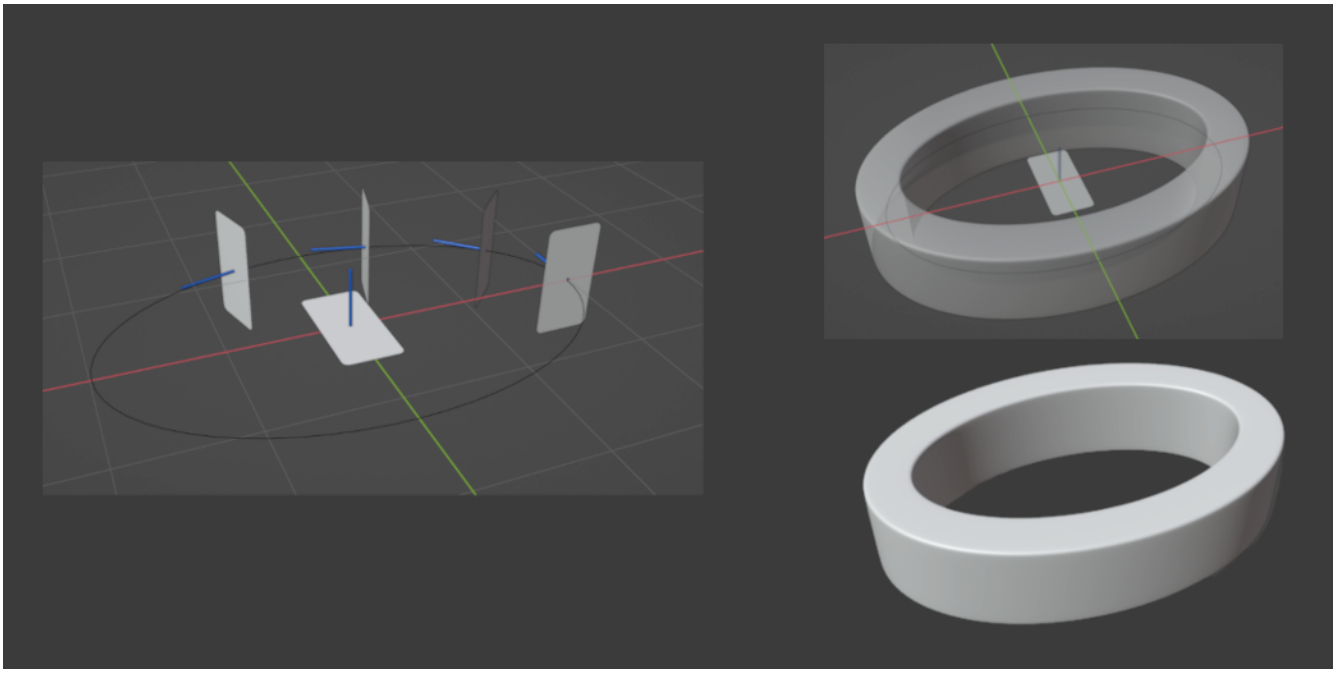


Figure 5.1.3.1: Round-rectangle profile along ellipse path.

Figure 5.1.3.1 shows how a (flat) 2d **profile,** drawn on the x-y plane with its normal pointing in the Z axis, is rotated to follow the nodes of a **path** in 3d space. Of course, we need as many **profile** copies as there are **path nodes** and we must rotate each copy such that the normal now points in the direction of the tangent at each of the **path nodes.** After rotating the **profile** copies we move them to the location of corresponding **path nodes**. Since there are various additional rotation and translation options, the final placement of each **profile** copy is the result of several transforms.

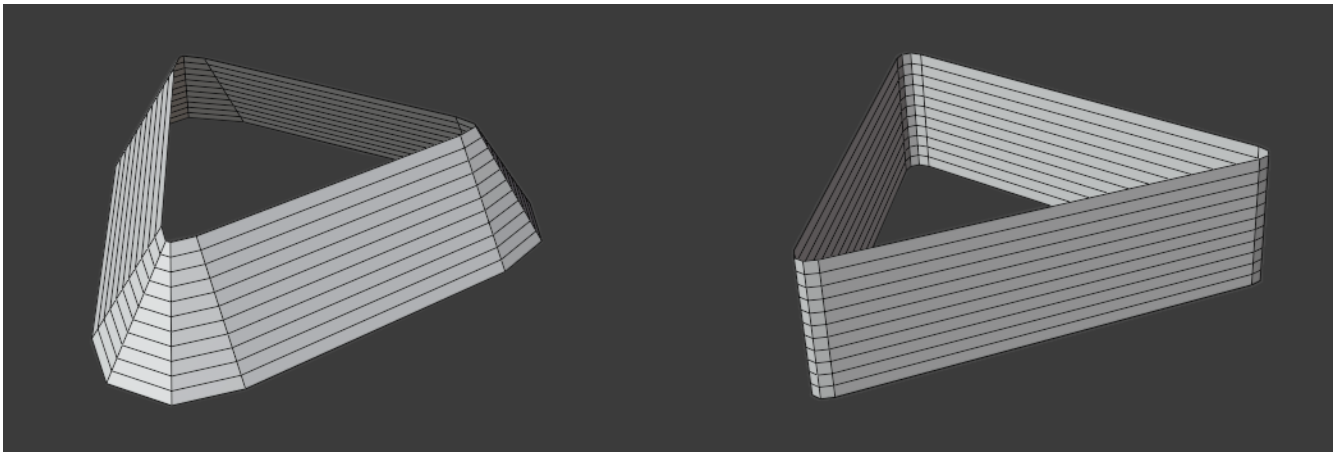


Figure 5.1.3.2: ***Fixed up*** *is OFF (left),* ***fixed up axis*** *is X (right)*

Profile orientation is affected by the rotation it takes to align its normal with the tangent at a path node. It is sometimes desirable, depending on design considerations, to constrain the up-axis of that rotation. With the **fixed up** option enabled in the **Path** panel, you can set either X or Y to be the fixed **up-axis.**

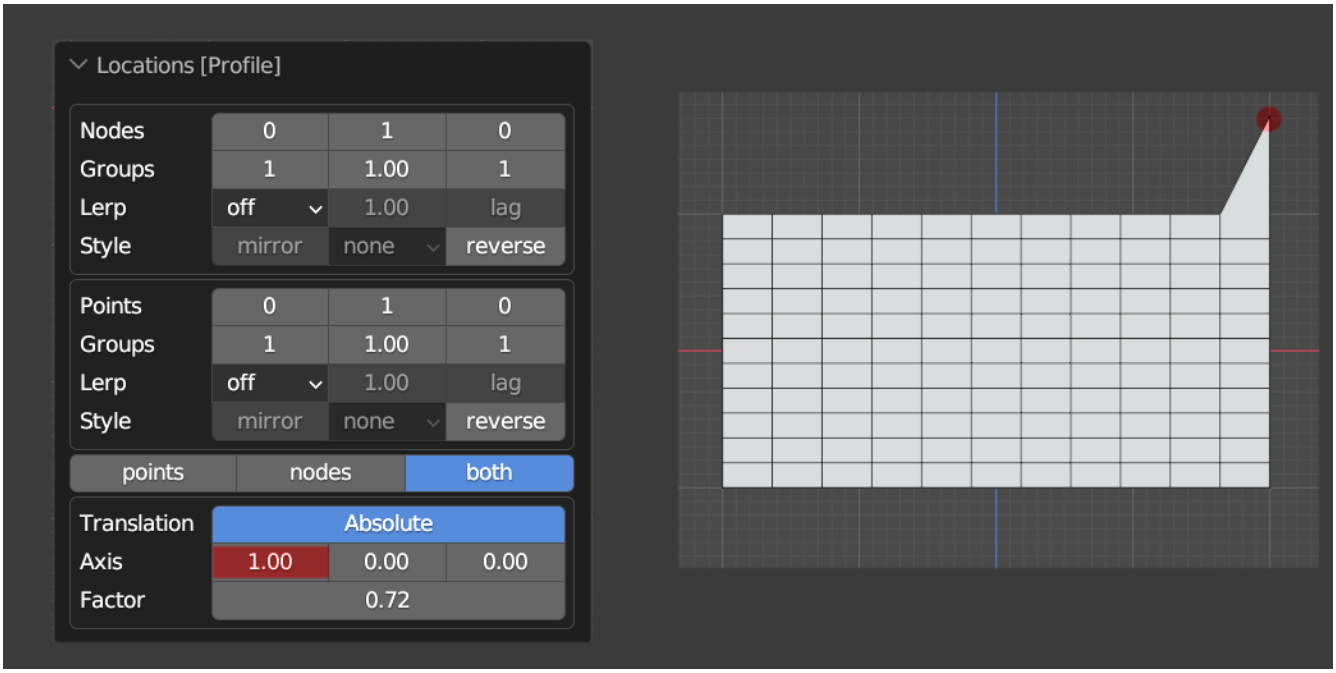


Figure 5.1.3.3: Line profile with its local X axis pointing in the direction of the global Z axis

When you work with **Editor** panels, the transform axes will not always correspond to the global X, Y, Z axes. This is expected, hence the reference to **path / profile space**, because of the various rotations which affect the orientation of **path** and **profile** shapes in the 3d world.

5.1.4 ANIMATION OPTIONS

The **animation options** in the UI panels may be used to animate values of path and profile properties, rotation angles, translation factors and indices. There are also some effects to customize the animations:

Value type	Effect component	Effect description
Dimension, Factor	• **mirror:** check box • **cycles:** input field	**Mirror:** Interpolate from original to target value and back a set number of times (**cycles**).
Rotation Angle	• **start:** input field • **end:** input field	**Limit:** Restrict animation within start / end keyframe range.
Index offset	• **random:** check box • **seed:** input field	**Random**: Select random index in the range [idx-offset, idx+offset] where idx is the original index value.
	• **start:** input field • **step:** input field	**Steps:** Set start keyframe and keyframe step
Noise amplitude	• **noise:** check box • **clock seed:** check box	**Noise:** Select random value in the range [-amp, amp] where amp is the amplitude set in the Noise Editor, using original or system clock random seed
	• **blend-in:** input field • **blend-out:** input field • **step:** input field	**Noise-blend:** Set number of keyframes-to-full-effect (blend-in), number of keyframes-to-no-effect (blend-out) and keyframe step

The **animation options** sub-panels of the **Path** and **Profile** panels host the properties listed below:

- Line: length, exponent
- Wave: length, amplitude, frequency, phase
- Arc: chord, factor
- Ellipse: size, factor
- Polygon: size
- Helix: size, length, factor, frequency, phase
- Spiral: diameter, frequency
- Custom: size

All of the above properties, depending on the Path or Profile Provider, appear in groups of two rows. The first row has a check box with the property name, which indicates the animation-ready state, followed by the input field for the target value. The second row has a **Mirror** effect component.

The **animation options** of the **Path Rotation, Profile Rotation** and **Mesh Rotation** panels appear in a group of two rows. The first row has a check box with the name **rotation (for Path/Mesh)** or **roll (for Profile)**, which indicates the animation-ready state, followed by the input field for the target value which in this case is the degrees to rotate per keyframe. The second row has a **Limit** effect component. Note that the **end** value of the **Limit** effect will be ignored if it is less than or equal to the **start** value. For an animation range of 10 keyframes: **start** = 1, **end** = 1 is exactly the same as: **start** = 1, **end** = 10; it will run through the whole animation.

The **animation options** sub-panels of the **Path Locations, Blends** and **Profile Locations** panels have a factor group and a node index group. **Blends** and **Profile Locations** also have a point index group:

1. The factor group is similar to the Path and Profile component groups described above. The first row has a check box with the name **factor**, which indicates the animation-ready state, followed by the input field for the target value. The second row has a **Mirror** effect component.

2. The index groups have three rows. The first row has a check box with the name **node id** or **point id**, which indicates the animation-ready state, followed by the input field for the target value which in this case is the Index offset. The second row has a **Random** effect component and the third row has a **Steps** effect component. Note that if **random** is not checked, the index value will be incremented by the target offset for every keyframe **step.**

The **animation options** of the **Mesh Distortion** panel operate on the noise amplitude value which is set in the **Mesh Noise Editor**. The first row has a **Noise** effect component and the second row has a **Noise-blend** effect component.

When you animate values, you will sometimes want to create seamlessly looping animations. You can create perfect loops with the simple calculations listed below. For convenience, the **Anicalc Panel** offers an intuitive way to perform these calculations and get suitable target values. In the following list, **loop** refers to the total number of animation keyframes.

- **Dimension** or **Factor** value with **Mirror**: (for a perfect loop use odd **loop** values)
  - **cycles** = 1: any **loop** value, however even **loop** values will result in double mid-point delay
  - **cycles** > 1: odd **loop** values only, and the **cycles** value must be a factor of (**loop** – 1) / 2.
- **Index offset**
  - **random OFF:** the **target offset** must be a factor of items (**path nodes** or **profile points**)
  - **random ON:** automatic (the program will sync the first and last keyframes).
- **Noise Amplitude:** use the blend-in / blend-out values.

For more information about animating values see **Anicalc Panel** and **Animation Panel**

5.1.5 PROGRAM SETTINGS

PopMesh offers the option of saving program settings to a (.json) file which can be useful for easy access to frequently used settings or if you want to make an archive of settings for future reference. The commands to **Save** and **Load** program settings are available from the **Setup Panel**. There are also over 30 example settings files to get you started which you can download **here**.

5.2 INTERFACE

The User Interface in PopMesh version 2.5 consists of 13 main panels. Most of the panels have been re-designed in an effort to make the interface more intuitive and ergonomic. Five of the main panels (**Path, Profile, Path Locations, Profile Locations** and **Blends**) have their **animation options** in collapsible sub-panels while several redundant labels have been removed to make the panels more focused on their functional items. Floating tooltips provide additional information when you hover your mouse pointer over an item.

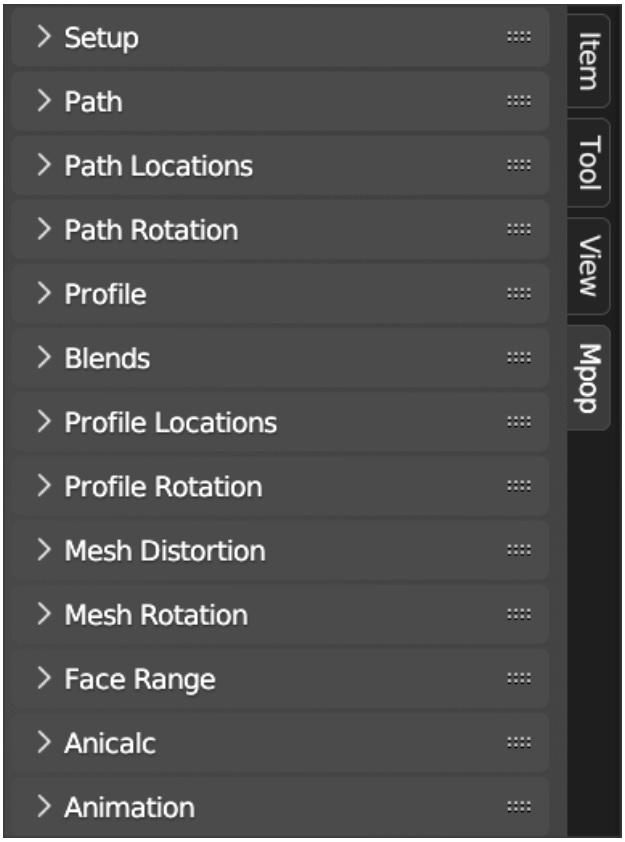


Figure 5.2.1: PopMesh 2.5 Interface

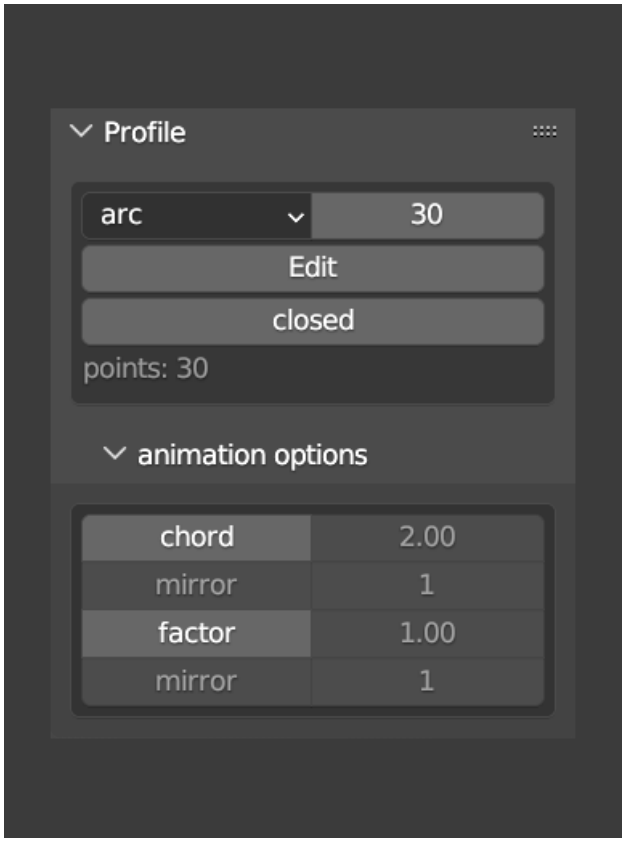


Figure 5.2.2: The Profile panel

As we mentioned in **Concepts**, there are several types of elements on the UI panels. For example, in *Figure 5.2.2* above, **Edit** is an action button, **closed** is a check box, and so on. The following sections describe these elements and their function in the context of their 'parent' UI panels.

5.2.1 SETUP PANEL

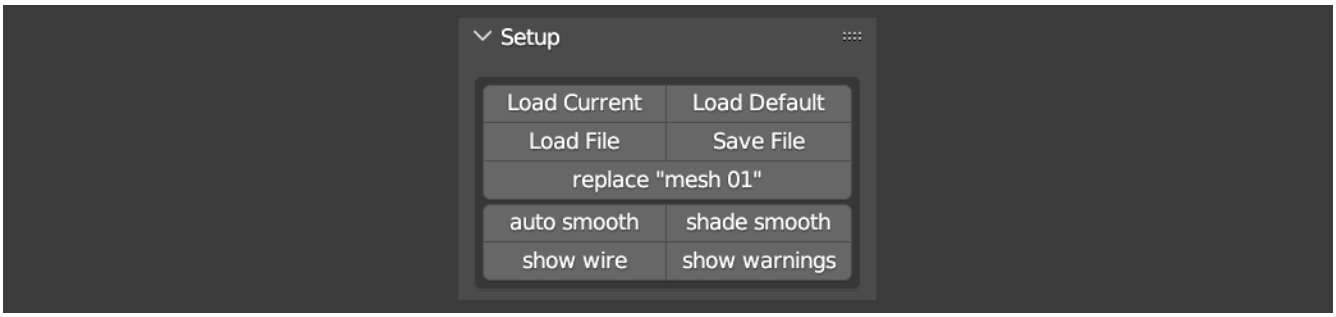


Figure 5.2.1.1: The Setup panel

The **Setup** panel is at the very top of the UI, however you may change the order of the panels at any time, to suit your workflow. This panel has four action buttons and five check boxes.

- **Load Current**
  - type: action button
  - function: re-load the current settings (useful when you create a new mesh reference)
- **Load Default**
  - type: action button
  - function; load the default settings
- **Load File**
  - type: action button
  - function: launch the 'Open File' dialog to load settings saved to a (.json) file
- **Save File**
  - type: action button
  - function: launch the 'Save File' dialog to save the current settings to a (.json) file
- **replace "mesh reference object name"**
  - type: check box
  - function: replace the current mesh reference object when loading settings from the three **Load...** action buttons (checked), or create and reference a new mesh object (unchecked).
- **auto smooth, shade smooth, show wire**
  - type: check box
  - function: display options for the current mesh reference object
- **show warnings**
  - type: check box
  - function: show a brief popup warning when you attempt to delete a collection item or perform an action which will overwrite the current mesh reference, etc.

The first time you enable PopMesh, you will only have access to the **Setup** panel. You will need to initialize the program by selecting either **Load Default** or **Load Preset**. You only have to do this once.

The ‘mesh reference object’ is associated with PopMesh. If you change the object’s name, for example, the new name will be reflected in the **replace “name”** check box. This association will persist if you close and re-open the (.blend) file or if you disable and then re-enable the add-on. However if you delete the reference, PopMesh will be in ‘disabled mode’ until you create a new mesh reference object using one of the **Load...** action buttons in the **Setup** panel.

The **replace “mesh reference object name”** check box does not invoke an operation by itself. It serves as a switch for the mesh object association with the program. Consider these two cases:

1. You are working with a mesh and don’t want to create new objects each time you hit one of the **Load...** action buttons. (keep **replace** checked)
2. You have finished working with a mesh and want to start working with a new one, or you simply want to break the current mesh object’s association with the program to avoid unwanted modifications. (make sure **replace** is unchecked and click **Load...** to reference new object)

5.2.2 PATH PANEL

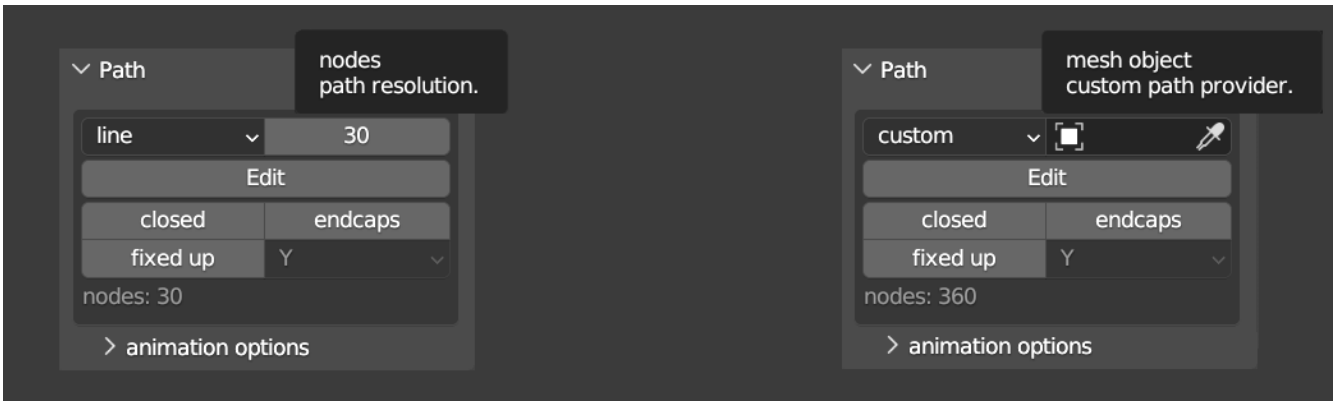
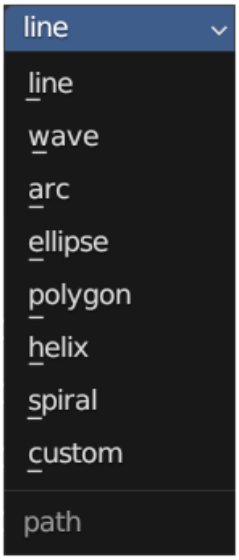


Figure 5.2.2.1: The Path Panel: Preset Provider (left), Custom Provider (right)

The **Path** panel consists of the following elements:



- **Provider**
  - type: enumerated list
  - function: select a path provider from [Line, Wave, Arc, Ellipse, Polygon, Helix, Spiral, Custom]. Path Providers and their properties are discussed in **Paths & Profiles**
- **Resolution (Preset Providers)**
  - type: input field (integer value)
  - function: set the path resolution (number of nodes)
- **Object Selection (Custom Provider)**
  - type: object selection field (mesh object)
  - function: set the path shape and resolution from selected object
- **Edit**
  - type: action button
  - function: launch the **Path Editor**
- **closed**
  - type: check box
  - function: indicate a closed (checked) or open (unchecked) path type
- **endcaps**
  - type: check box
  - function: indicate whether open paths have endcaps (checked) or not (unchecked)
- **fixed up**
  - type: check box
  - function: constrain the up-axis of profile copies along the path
- **up-axis**
  - type: enumerated list
  - function: select profile fixed up-axis from [X, Y]

Note that only mesh objects are eligible **Custom Providers**. The program does not keep a reference to the selected object; it stores vertex coordinates in memory and it will work even if you delete the provider object at a later time. If however you select a preset or another custom provider, the old coordinates are discarded.

Figure 5.2.2.2: Path Editor and Animation Options

The **Edit** action button invokes the **Path Editor** which allows you to customize the selected provider shape. The parameter fields of the **Path Editor** reflect the properties of the selected **Path Provider**. Some of these properties may also be set for animation by selecting the corresponding check boxes in the **animation options** sub-panel and setting a target value in the adjacent input fields. For more information about animating values and effects, see **Animation Options.**

If a property name is not immediately visible in the **Editor** panel, simply hover your mouse pointer over the input fields to show the tooltips.

5.2.3 PATH LOCATIONS PANEL

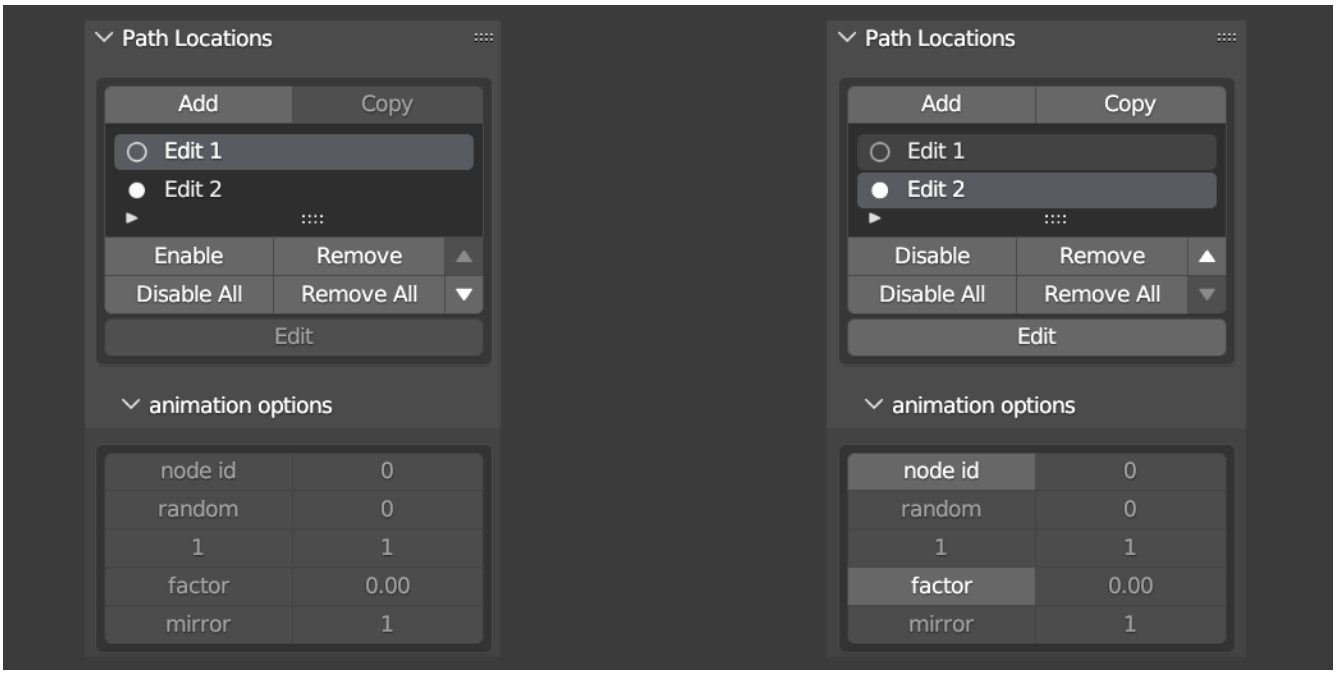


Figure 5.2.3.1: The Path Locations Panel: Disabled Edit (left), Enabled Edit (right).

The **Path Locations** panel consists of two main elements:

- **Path Locations Group**
  - type: collection component group
  - function: add/remove/enable/rename… location edits. More information in **collection edits**.
- **Edit**
  - type: action button
  - function: launch the **Path Locations Editor**

The **Copy** and **Edit** action buttons and the **animation options** sub-panel are not available when the selected Edit is disabled.

Figure 5.2.3.2: Path Locations Editor and Animation Options

The **Edit** action button invokes the **Path Locations Editor** with the following elements.

- **Nodes**
  - type: transform component group
  - function: path node transform settings. More information in **collection edits**.
- **Translation**
  - type: check box
  - function: set translation type (**Relative** or **Absolute)**
- **Axis**
  - type: input fields (float in [-1.0, 1.0])
  - function: set axis influence
- **Factor**
  - type: input field (float)
  - function: set factor value

The **Node Index** and **Factor** values may be set for animation by selecting the corresponding check boxes in the **animation options** sub-panel and setting a target value in the adjacent input fields. For more information about animating values and effects, see **Animation Options.**

5.2.4 PATH ROTATION PANEL

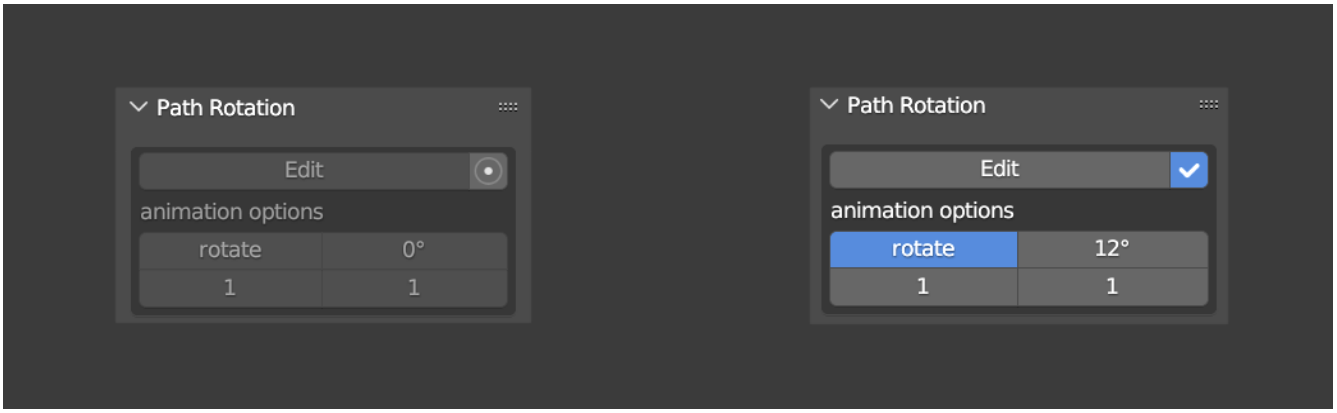


Figure 5.2.4.1: The Path Rotation Panel: Disabled State (left), Enabled State (right).

The **Path Rotation** panel has the following elements:

- **Edit**
  - type: action button
  - function: launch the **Path Rotation Editor**
- **toggle**
  - type: check box
  - function: enable / disable path rotation

The **Edit** action button and the **animation options** are not available when **toggle** is unchecked.

Figure 5.2.4.2: Path Rotation Editor and Animation Options

The **Edit** action button invokes the **Path Rotation Editor** with the following elements:

- **Axis**
  - type: input fields (float in [-1.0, 1.0])
  - function: set rotation axis
- **Angle**
  - type: input field (float)
  - function: set rotation angle
- **Order**
  - type: check box
  - function: rotation sequence (before of after orientation).
- **Pivot**
  - use path
    - type: check box
    - function: use path nodes average location vector as the rotation pivot
  - location vector (when use path is unchecked)
    - type: input fields (float)
    - function: set a 3d location as the rotation pivot

The **Rotation** may be animated by selecting the **rotate** check box in **animation options** and setting a value in the adjacent input field. For more information, see **Animation Options.**

5.2.5 PROFILE PANEL

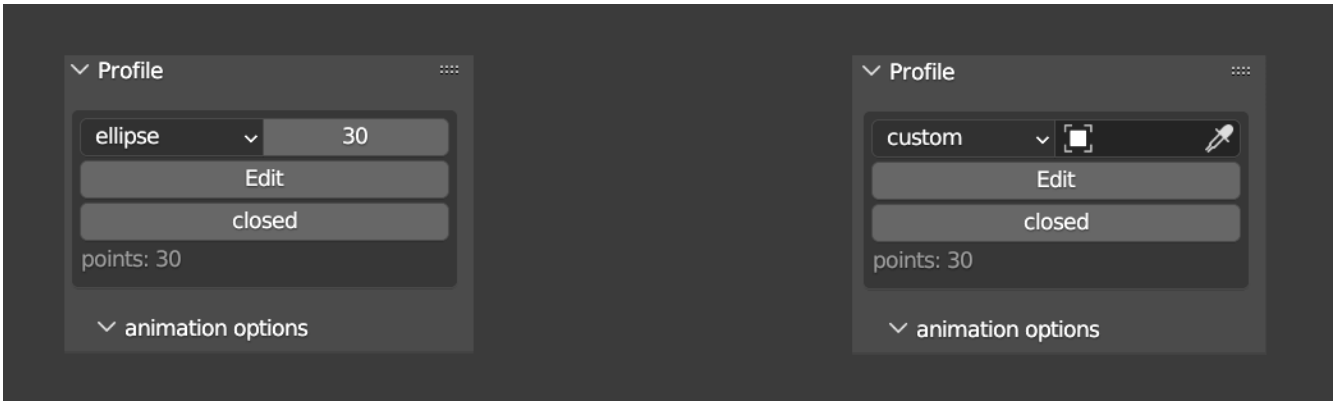
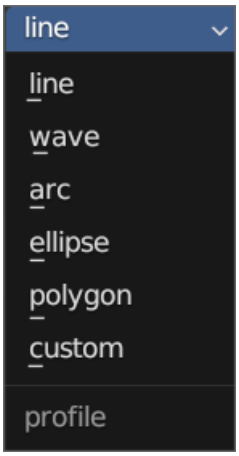


Figure 5.2.5.1: The Profile Panel: Preset Provider (left), Custom Provider (right)

The **Profile** panel consists of the following elements:



- **Provider**
  - type: enumerated list
  - function: select a profile provider from [Line, Wave, Arc, Ellipse, Polygon, Custom]. Profile Providers and their properties are discussed in **Paths & Profiles**
- **Resolution (Preset Providers)**
  - type: input field (integer value)
  - function: set the profile resolution (number of points)
- **Object Selection (Custom Provider)**
  - type: object selection field (mesh object)
  - function: set the profile shape and resolution from selected object
- **Edit**
  - type: action button
  - function: launch the **Profile Editor**
- **closed**
  - type: check box
  - function: indicate a closed (checked) or open (unchecked) profile type

Note that only mesh objects are eligible **Custom Providers**. The program does not keep a reference to the selected object; it stores vertex coordinates in memory and it will work even if you delete the provider object at a later time. If however you select a preset or another custom provider, the old coordinates are discarded.

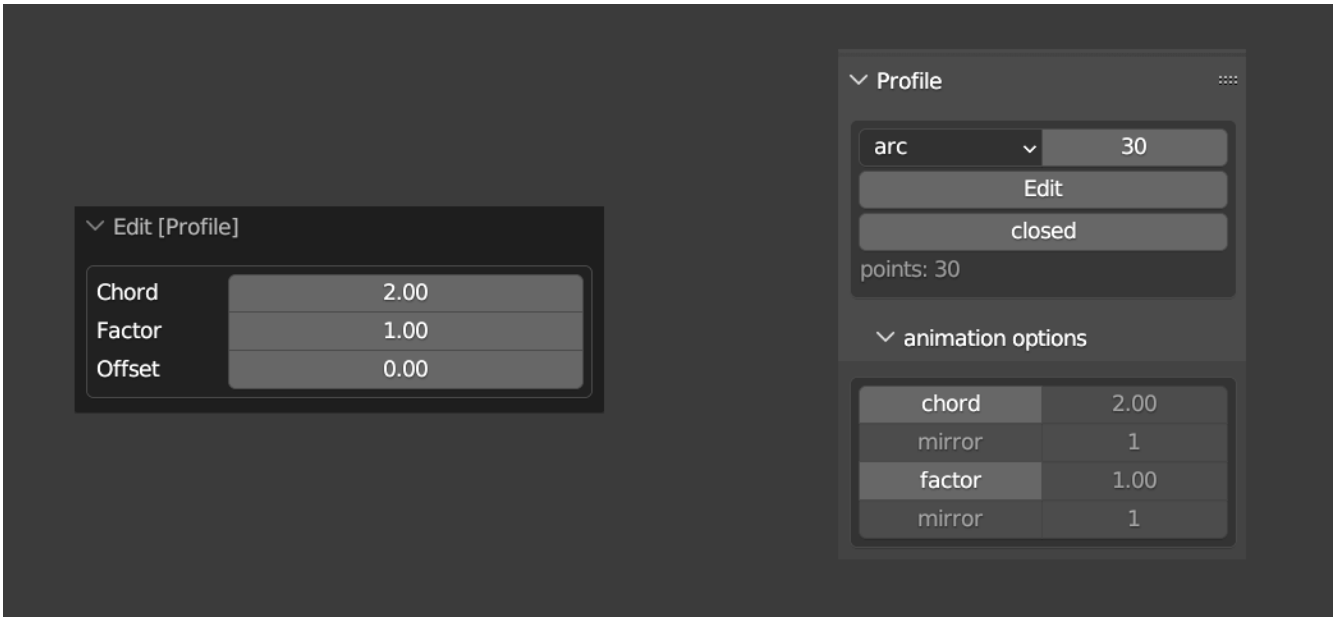


Figure 5.2.5.2: Profile Editor and Animation Options

The **Edit** action button invokes the **Profile Editor** which allows you to customize the selected provider shape. The parameter fields of the **Profile Editor** reflect the properties of the selected **Profile Provider**. Some of these properties may also be set for animation by selecting the corresponding check boxes in the **animation options** sub-panel and setting a target value in the adjacent input fields. For more information about animating values and effects, see **Animation Options.**

If a property name is not immediately visible in the **Editor** panel, simply hover your mouse pointer over the input fields to show the tooltips.

5.2.6 BLENDS PANEL

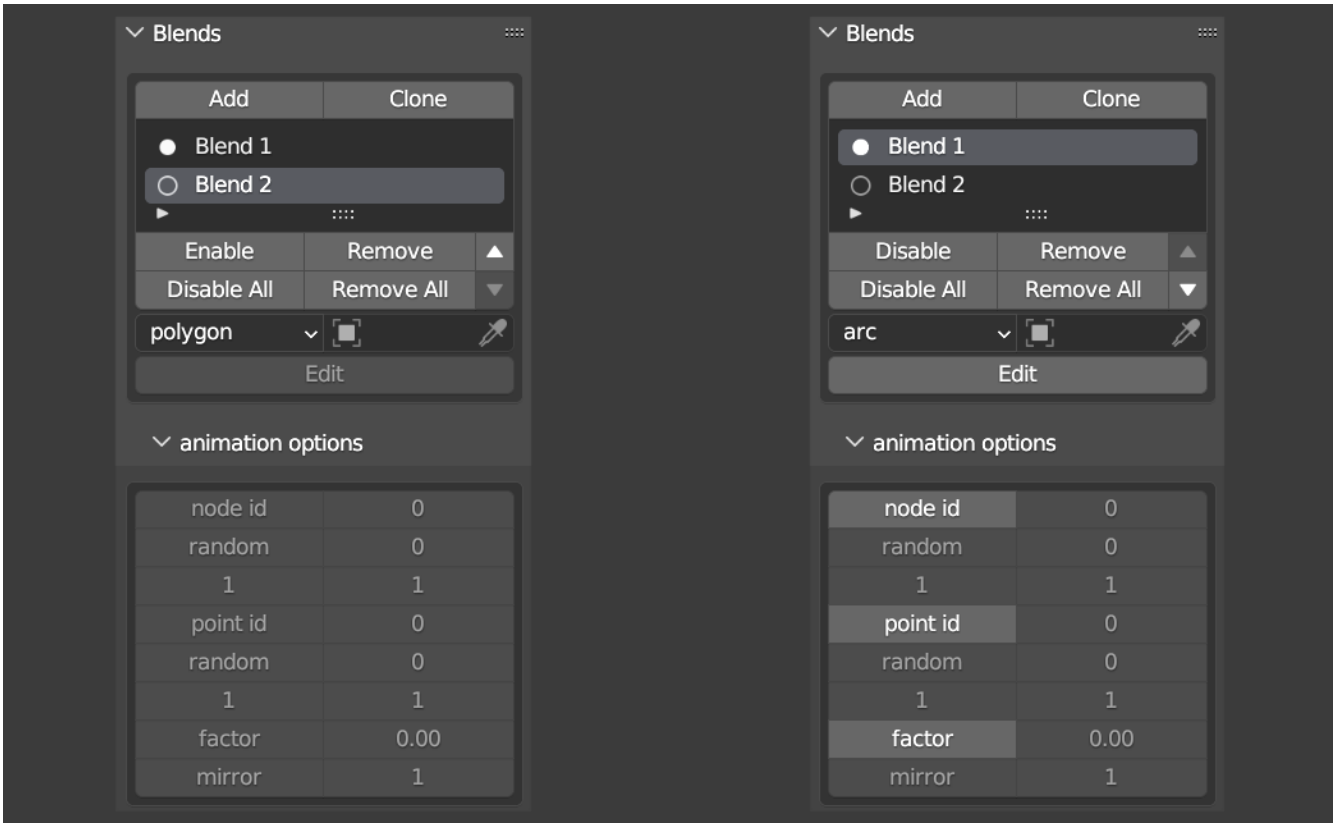


Figure 5.2.6.1: The Blends Panel: Disabled Edit (left), Enabled Edit (right).

The **Blends** panel consists of the following elements:

- **Blends Group**
  - type: collection component group
  - function: add/remove/enable/rename… blends. More information in **collection edits**.
- **Blend Profile Provider**
  - type: enumerated list
  - function: select a blend-profile provider from [Line, Wave, Arc, Ellipse, Polygon, Custom]. Profile Providers and their properties are discussed in **Paths & Profiles**
- **Object Selection (Custom Provider)**
  - type: object selection field (mesh object)
  - function: set the blend-profile shape from selected object
- **Edit**
  - type: action button
  - function: launch the **Blend Editor**

The **Edit** action button and the **animation options** sub-panel are not available when the selected Blend is disabled.

The resolution (number of points) of **Blends** is determined by the **Profile** resolution. For custom blend-profiles, the provider must have the same resolution as the main profile.

Note that only mesh objects are eligible **Custom Providers**. The program does not keep a reference to the selected object; it stores vertex coordinates in memory and it will work even if you delete the provider object at a later time. If however you select a preset or another custom provider, the old coordinates are discarded.

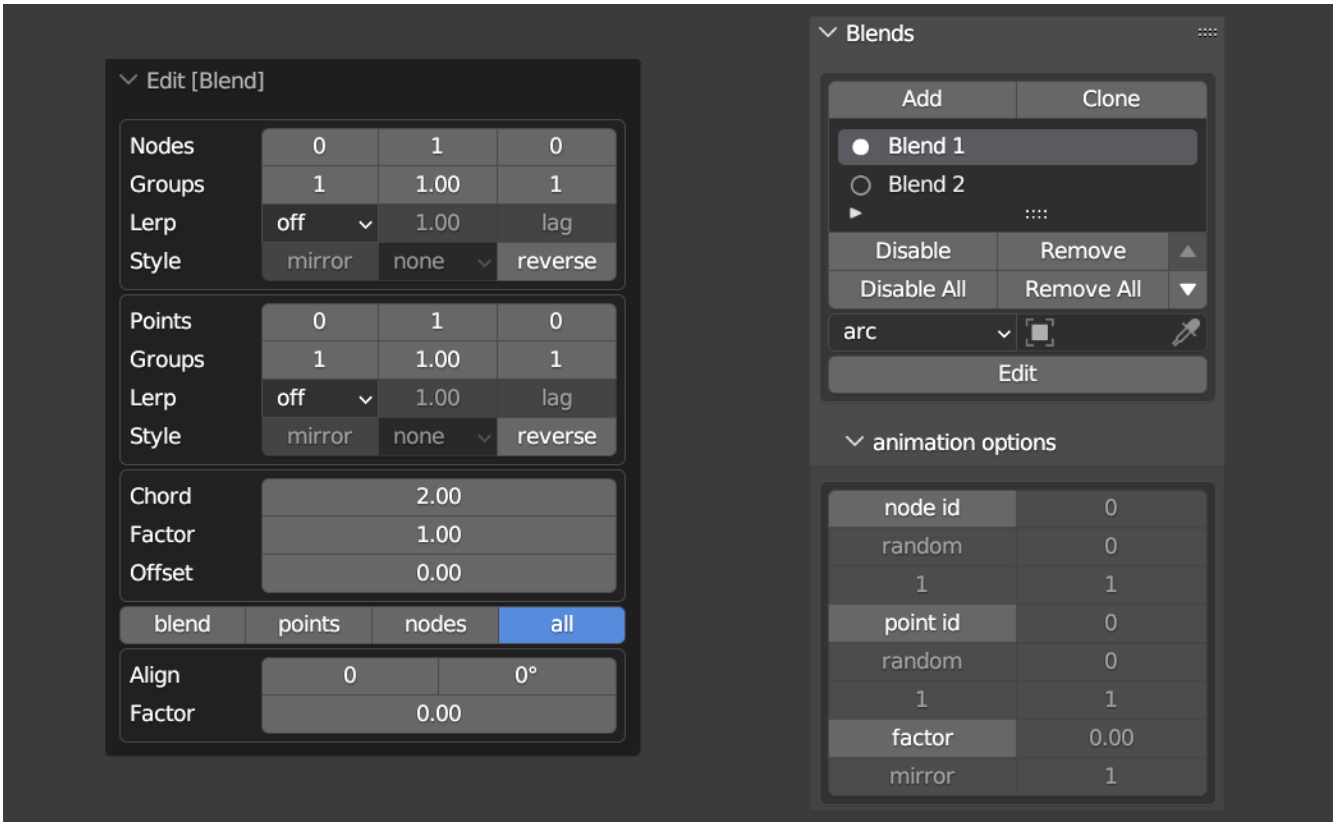


Figure 5.2.6.2: Blend Editor and Animation Options

The **Edit** action button invokes the **Blend Editor** with the following elements.

- **Nodes**
  - type: transform component group
  - function: path node transform settings. More information in **collection edits**.

- **Points**
  - type: transform component group
  - function: profile point transform settings. More information in **collection edits**.
- **Blend Profile Editor**
  - type: blend-profile parameters
  - function: customize blend-profile shape
  - notes: parameter fields reflect the properties of the selected **Blend Profile Provider**.
- **View Selection Strip**
  - type: expanded enumerated list
  - function: select custom view of the Editor
- **Align**
  - type: input fields [int, float]
  - function: align blend profile index (left column) and/or rotation angle (right column)
- **Factor**
  - type: input field (float in [-1.0, 1.0])
  - function: set factor value

The **Node Index, Point Index** and blend **Factor** values may be set for animation by selecting the corresponding check boxes in the **animation options** sub-panel and setting a target value in the adjacent input fields. For more information about animating values and effects, see **Animation Options.**

If a property name is not immediately visible in the **Editor** panel, simply hover your mouse pointer over the input fields to show the tooltips.

5.2.7 PROFILE LOCATIONS PANEL

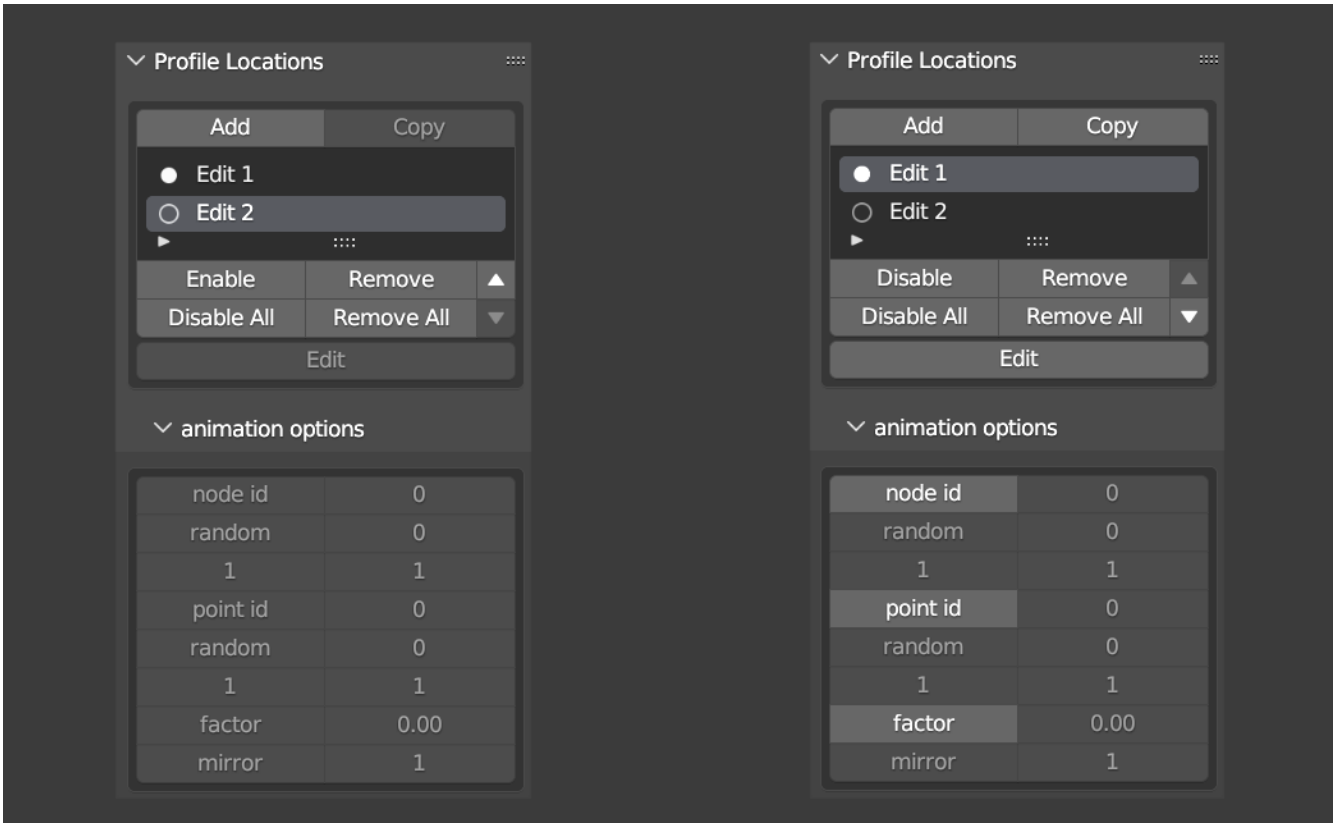


Figure 5.2.7.1: The Profile Locations Panel: Disabled Edit (left), Enabled Edit (right).

The **Profile Locations** panel consists of two main elements:

- **Profile Locations Group**
  - type: collection component group
  - function: add/remove/enable/rename… location edits. More information in **collection edits**.
- **Edit**
  - type: action button
  - function: launch the **Profile Locations Editor**

The **Copy** and **Edit** action buttons and the **animation options** sub-panel are not available when the selected Edit is disabled.

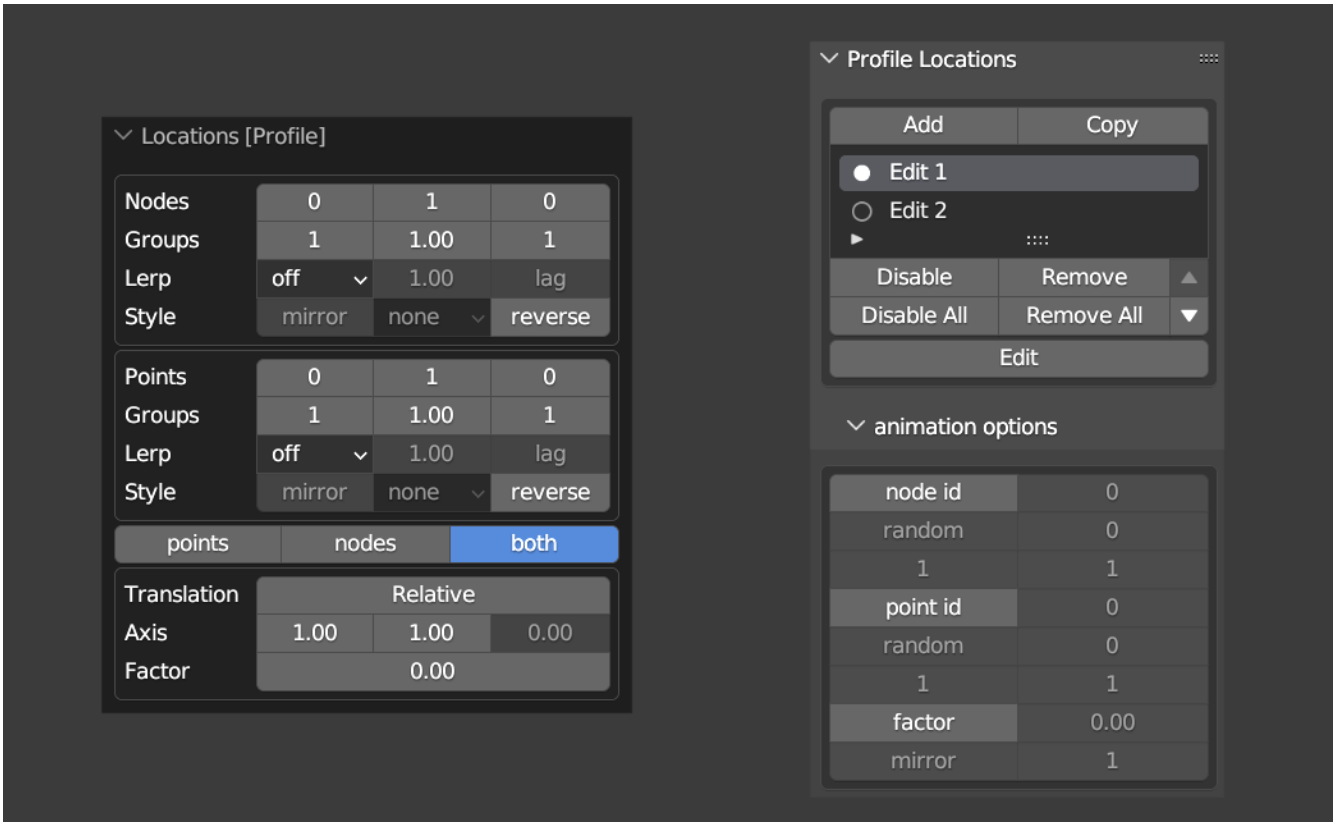


Figure 5.2.7.2: Profile Locations Editor and Animation Options

The **Edit** action button invokes the **Profile Locations Editor** with the following elements.

- **Nodes**
  - type: transform component group
  - function: path node transform settings. More information in **collection edits**.
- **Points**
  - type: transform component group
  - function: profile point transform settings. More information in **collection edits**.
- **View Selection Strip**
  - type: expanded enumerated list
  - function: select custom view of the Editor
- **Translation**
  - type: check box
  - function: set translation type (**Relative** or **Absolute)**
- **Axis**
  - type: input fields (float in [-1.0, 1.0])
  - function: set axis influence
- **Factor**
  - type: input field (float)
  - function: set factor value

The **Node Index, Point Index** and **Factor** values may be set for animation by selecting the corresponding check boxes in the **animation options** sub-panel and setting a target value in the adjacent input fields. For more information about animating values and effects, see **Animation Options.**

5.2.8 PROFILE ROTATION PANEL

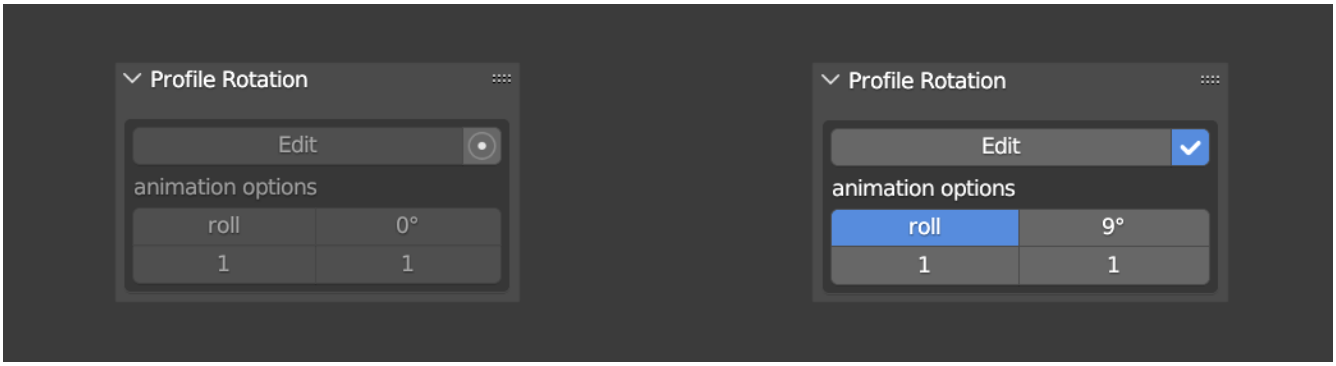


Figure 5.2.8.1: The Profile Rotation Panel: Disabled State (left), Enabled State (right).

The **Profile Rotation** panel has the following elements:

- **Edit**
  - type: action button
  - function: launch the **Profile Rotation Editor**
- **toggle**
  - type: check box
  - function: enable / disable profile rotation

The **Edit** action button and the **animation options** are not available when **toggle** is unchecked.

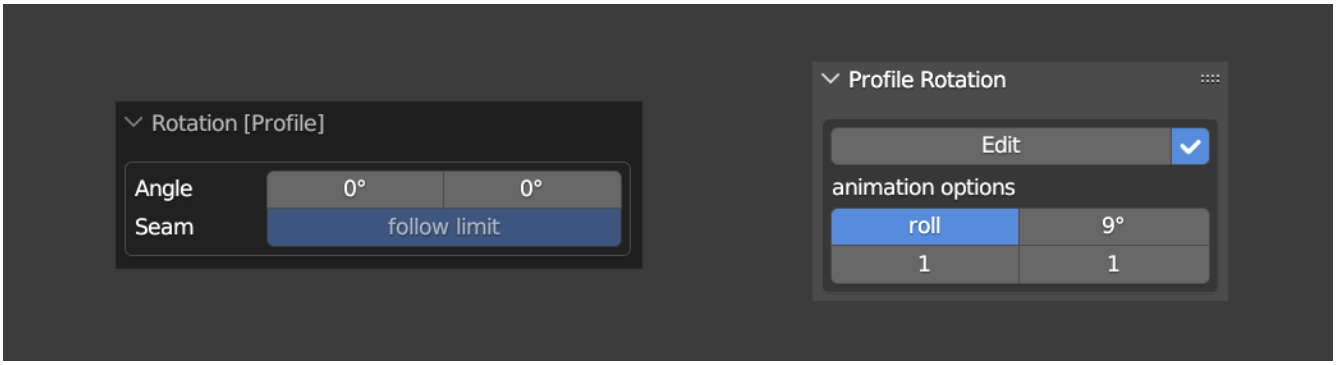


Figure 5.2.8.2: Profile Rotation Editor and Animation Options

The **Edit** action button invokes the **Profile Rotation Editor** with the following elements:

- **Angle**
  - type: input fields (float)
  - function: set twist (left) and roll (right) angles
  - notes: the twist angle is interpolated along the path nodes, rotation is around the Z axis.
- **Seam**
  - type: check box
  - function: set face-loop seam calculation method
  - notes: follow-limit is the default, it may be disabled only if the Path is closed and the Profile is open.

The **Rotation** may be animated by selecting the **roll** check box in **animation options** and setting a value in the adjacent input field. For more information, see **Animation Options.**

5.2.9 MESH DISTORTION PANEL

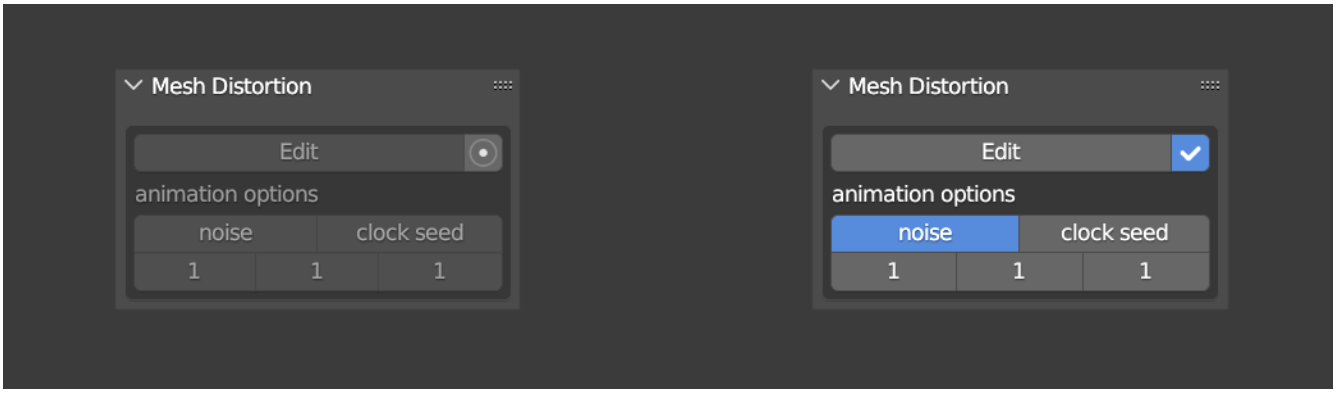


Figure 5.2.9.1: The Mesh Distortion Panel: Disabled State (left), Enabled State (right).

The **Mesh Distortion** panel has the following elements:

- **Edit**
  - type: action button
  - function: launch the **Mesh Noise Editor**
- **toggle**
  - type: check box
  - function: enable / disable mesh distortion

The **Edit** action button and the **animation options** are not available when **toggle** is unchecked.

Figure 5.2.9.2: Mesh Noise Editor and Animation Options

The **Edit** action button invokes the **Mesh Noise Editor** with the following elements:

- **Amplitude**
  - type: input field (float >= 0.0)
  - function: set noise amount
- **Seed**
  - type: input field (integer >= 0)
  - function: set a random seed
- **Influence**
  - type: input fields (float in [0.0, 1.0])
  - function: set axis influence

The **Amplitude** may be animated by selecting the **noise** check box in **animation options.** For more information, see **Animation Options.**

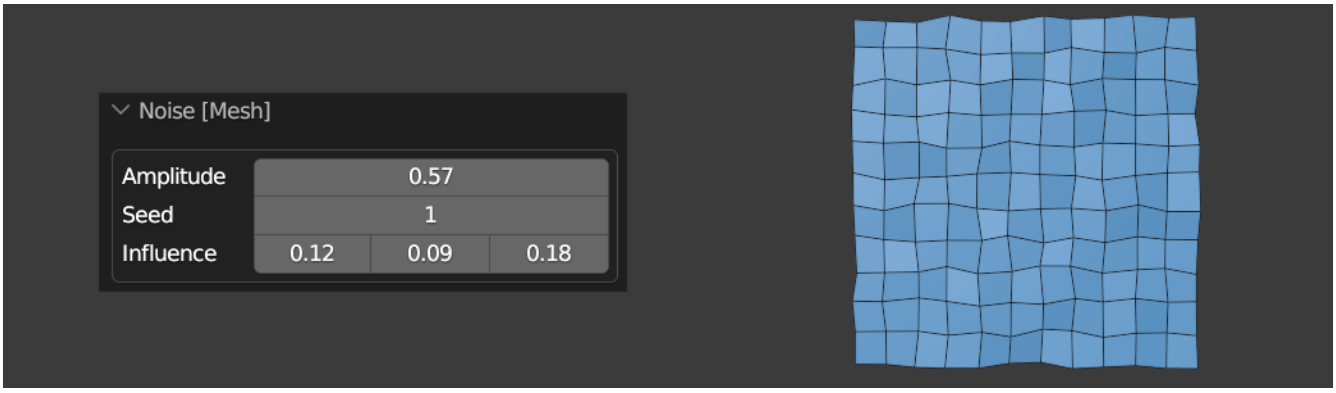


Figure 5.2.9.3: Mesh Noise Editor example of 12 nodes by 12 points grid

5.2.10 MESH ROTATION PANEL

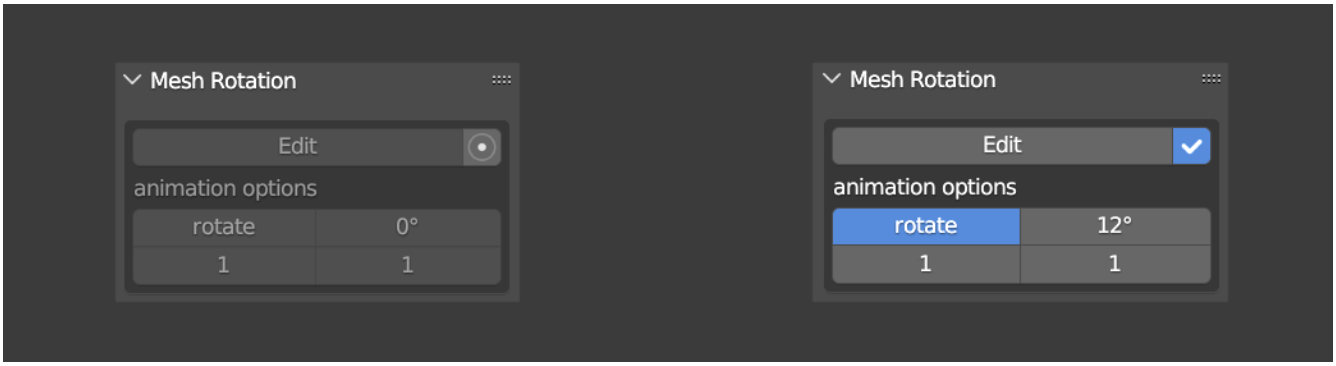


Figure 5.2.10.1: The Mesh Rotation Panel: Disabled State (left), Enabled State (right).

The **Mesh Rotation** panel has the following elements:

- **Edit**
  - type: action button
  - function: launch the **Mesh Rotation Editor**
- **toggle**
  - type: check box
  - function: enable / disable mesh rotation

The **Edit** action button and the **animation options** are not available when **toggle** is unchecked.

Figure 5.2.10.2: Mesh Rotation Editor and Animation Options

The **Edit** action button invokes the **Mesh Rotation Editor** with the following elements:

- **Axis**
  - type: input fields (float in [-1.0, 1.0])
  - function: set rotation axis
- **Angle**
  - type: input field (float)
  - function: set rotation angle
- **Pivot**
  - type: input fields (float)
  - function: set rotation pivot

The **Rotation** may be animated by selecting the **rotate** check box in **animation options** and setting a value in the adjacent input field. For more information, see **Animation Options.**

5.2.11 FACE RANGE PANEL

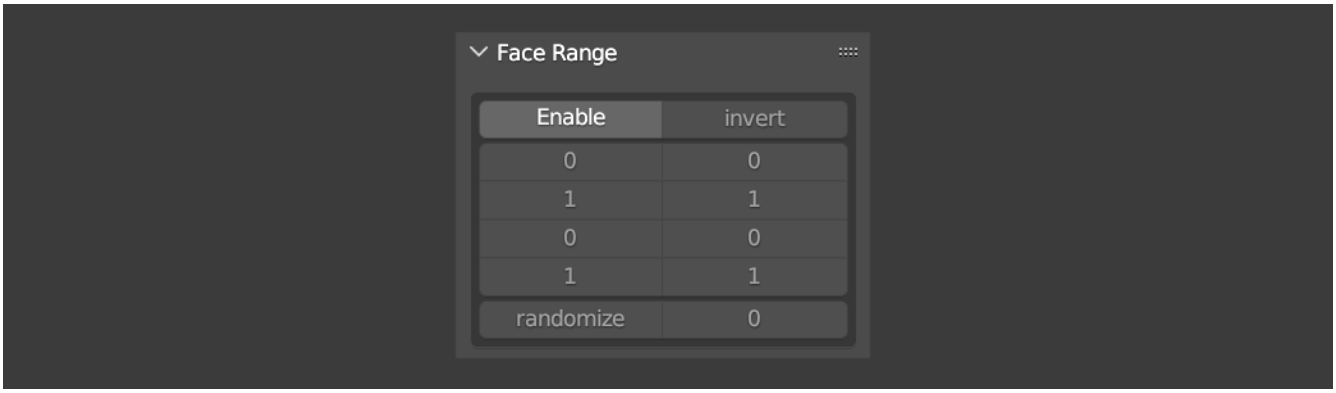


Figure 5.2.11.1: The Face Range Panel: Path nodes (left column), Profile points (right column)

The **Face Range** panel provides a way to create holes or disconnected mesh objects by removing faces outside of the selection range, including loose vertices. It is based on the morph/transform algorithm, with the following elements:

- **Enable/Disable**
  - type: action button
  - function: enable / disable
- **invert**
  - type: check box
  - function: invert selection range
- **offset**
  - type: input field (integer)
  - function: set start index
- **items**
  - type: input field (integer)
  - function: set group items
- **gap**
  - type: input field (integer)
  - function: set number of items between groups
- **groups**
  - type: input field (integer)
  - function: set number of groups
- **randomize**
  - type: check box
  - function: randomize selection range
- **seed**
  - type: input field (integer >= 0)
  - function: set random seed

Figure 5.2.11.2: The Face Range Panel: Example of 12 nodes by 12 points grid

Note: The left column is for Path nodes and the right column for Profile points.

5.2.12 ANICALC PANEL

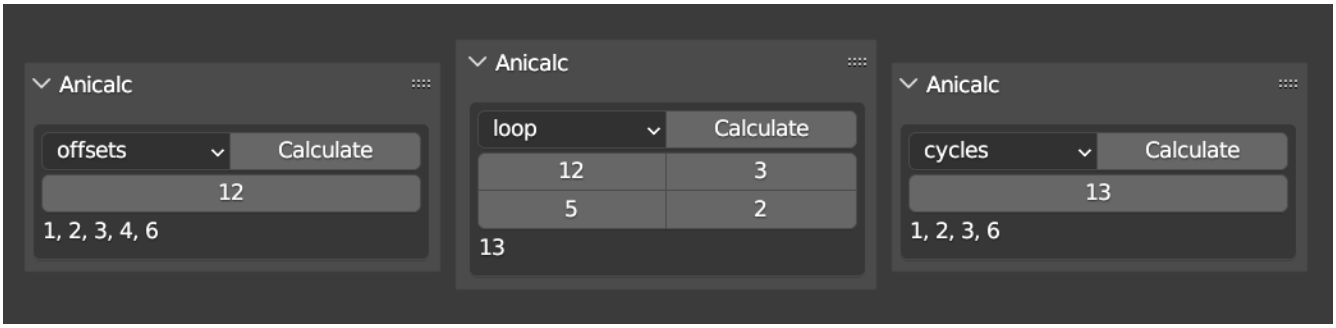


Figure 5.2.12.1: The Anicalc Panel

In **Animation Options**, we described target values and effects. We also mentioned that you may create perfect loops with simple calculations. The **Anicalc** panel can help you get suitable target values for the **cycles** field when you are using the **mirror** effect, and for the **index offset** field when you are not using the **random** effect. The **cycles** calculation is based on a specified **loop** value and the **offsets** calculation is based on a specified **items (path nodes** or **profile points)** value. You may also use a pair of items/offset values together with arbitrary **start** and **step** values to get a corresponding target value for the **loop**:

- **Calculation**
  - type: enumerated list
  - function: select a calculation from [cycles, offsets, loop].
- **Calculate**
  - type: action button
  - function: calculate and display suitable target values.
- **loop** (**cycles calculations**).
  - type: input field (odd integer >= 3)
  - function: set the loop value.
- **items** (**offsets and loop calculations**).
  - type: input field (integer >= 3)
  - function: set the items (**path nodes** or **profile points**) value
- **offset** (**loop calculations**).
  - type: input field (integer > 0)
  - function: set the index offset value
- **start** (**loop calculations**).
  - type: input field (integer > 0)
  - function: set the start keyframe value
- **step** (**loop calculations**).
  - type: input field (integer > 0)
  - function: set the keyframe step value
- **result**
  - type: information label
  - function: display target value(s)

5.2.13 ANIMATION PANEL

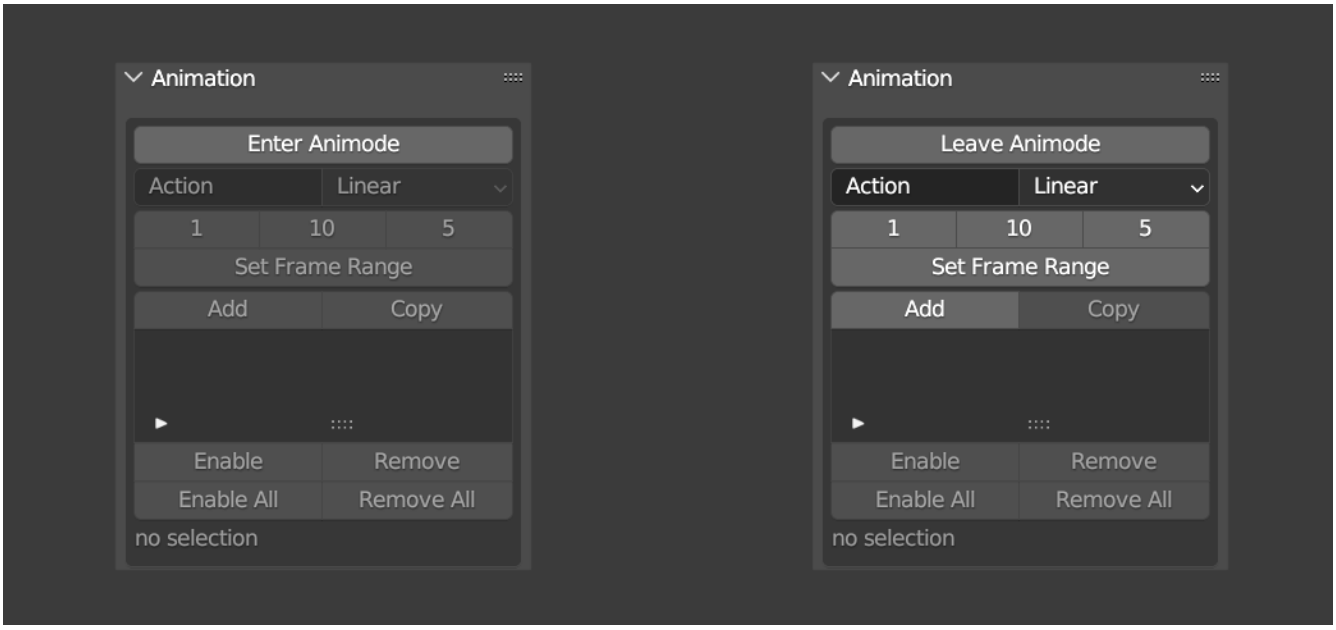


Figure 5.2.13.1: The Animation Panel: Disabled State (left), Enabled State (right).

The **Animation** panel is disabled by default. Typically, you would enable it after trying out some of the Editors to get a feel of the animation style you are after. The most important thing to remember is that once you are in Animation Mode, you will not have access to panels and properties that change the mesh resolution. The following sections of the UI are disabled in Animation Mode:

- **Face Range** panel
- **Provider**, **Resolution, Object Selection, closed, endcaps** elements of the **Path** panel. You will still be able to use the **Path Editor** and modify target values in the **animation options** sub-panel.
- **Provider, Resolution, Object Selection, closed** elements of the **Profile** panel. You will still be able to use the **Profile Editor** and modify target values in the **animation options** sub-panel.

To enable Animation Mode, click the **Enter Animode** action button (*Figure 5.2.13.1*). The text will change to **Leave Animode** and if you hover your mouse pointer over it, you will see the message 'remove all animation data'. This means that if you want to keep the animation data (actions) that you create here, you will have to break the association of the current mesh reference object by first making sure **replace...** is unchecked and then clicking one of the **Load...** action buttons in the **Setup Panel**. If you click **Leave Animode,** all animation data will be deleted and you will be back in 'default mode' with the **Animation** panel disabled.

Animation panel elements:

- **Action Name**
  - type: input field (text)
  - function: specify a name for the action you are about to create
- **Keyframe Interpolation**
  - type: enumerated list
  - function: select keyframe interpolation from [Constant, Linear, Bezier]
- **Start**
  - type: input field (integer > 0)
  - function: set first keyframe number
- **Step**
  - type: input field (integer > 0)
  - function: set frame-distance between two successive keyframes
- **Loop**
  - type: input field (integer > 1)
  - function: set number of keyframes to complete animation
- **Set Frame Range**
  - type: action button
  - function: set frame range in the Timeline
- **NLA Tracks Group**
  - type: collection component group
  - function: add/remove/enable… nla tracks. More information in **collection edits**.
- **Edit**
  - type: action button
  - function: launch the **Track Editor**
- **Track Information**
  - type: information label
  - function: display summary of selected track

If you attempt to **Add** a new track without having set any **animations options,** you will get the notification message “no animation values”.

Figure 5.2.13.2: Animation Track Editor

The **Edit** action button invokes the **Track Editor** to customize the selected track:

- **Action Range**
  - type: input fields (integer)
  - function: first frame from action to use (left), last frame from action to use (right)
  - notes: the action frame range is determined by the values for **Start, Step** and **Loop** that you specify in the **Animation** panel before you **Add** the track. The **action range** options allow you to start playback from a later frame and/or end playback before the last frame in that range.
- **Start Frame**
  - type: input field (integer > 0)
  - function: set start frame
  - notes: you can move the selected **strip** in the Timeline by setting an arbitrary value for the start frame.
- **Scale**
  - type: input field (float in [0.001, 100.0])
  - function: scaling factor
  - notes: a value of 1.0 means ‘normal speed’, values smaller than 1.0 play faster and values bigger than 1.0 play the animation at a slower speed.
- **Repeat**
  - type: input field (float in [1.0, 100.0])
  - function: number of times to repeat the selected frame range
- **Blend Type**
  - type: enumerated list
  - function: select method for combining **strips** from [replace, combine, add, subtract, multiply]

- **Auto Blend**
  - type: check box
  - function: use auto-blend
- **Blend In / Out**
  - type: input fields (integer)
  - function: set the number of frames for manual blend-in (left), blend-out (right).
- **Playback**
  - **extrapolation**
    - type: enumerated list
    - function: select action to take for gaps past the **strip** extents from [nothing, hold, hold forward]
  - **reverse**
    - type: check box
    - function: play in reverse

In Blender, **NLA tracks** are containers of one or more **NLA strips** which are customization layers for animation actions. PopMesh uses single-strip tracks, therefore the terms **track** and **strip** have the exact same meaning in this context.

5.3 IMPLEMENTATION

OVERVIEW

Path node locations are derived from the **path provider** shape and any modifications you apply in the **Path Editor**. They are subsequently modified by **Path location** edits in the order these are listed in the UI, starting from the top. Generally, the order of translations does not matter, however if you mix **relative** and **absolute** translations, the order may affect the result. After all translations have been applied, the locations are rotated in the **Path Rotation Editor.** Note that the path rotation order option affects the object orientation.

Profile point locations are derived from the **profile provider** shape and any modifications you apply in the **Profile Editor**. They are further modified, first by **Blend** edits and then by **Profile location** edits in the order these are listed in the UI, starting from the top. After all translations have been applied, the locations are rotated in the **Profile Rotation Editor**. Because **blend** and **location** edits are applied along the path, the program creates a profile copy for every path node.

The mesh object's vertex coordinates are calculated by combining **path nodes** and **profile points;** each profile copy is first rotated and then translated to fit the corresponding path node (see **Rotation & Orientation**). A final rotation is applied in the **Mesh Rotation Editor.**

PERFORMANCE

In PopMesh version 1.0 there was a hard limit for path nodes and profile points. In version 2.5 there are no hard limits; there is a soft upper limit at 100 nodes/points which can be overridden if you manually enter a higher value. It is therefore important to note that the more **active vertices** (**path nodes** x **profile points**) you operate on, the slower Blender's 3d viewport will respond. Also, bear in mind that PopMesh is essentially a collection of Python modules and Python is an interpreted language. Although performance does depend on system specifications, I think you will find that overall you can control the final shape better if you combine fewer active vertices with subsurface and/or bevel modifiers. This is especially true for animations, since each active vertex is calculated for every keyframe in order to create the fcurves required for the object data action.

The following pages show execution times measured with the 'timeit' module from the 'Text Editor', in Blender 3.6 LTS. The add-on should be faster. Test PC: Intel i5 CPU @ 2.80GHz with 8GB RAM, running Windows 10.

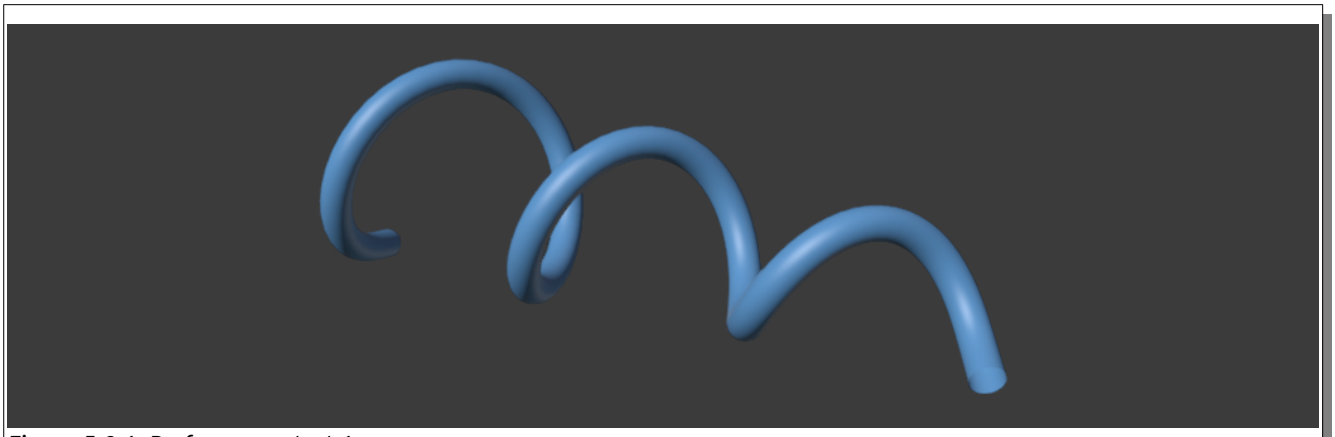


Figure 5.3.1: Performance test 1

Active vertices (30 nodes x 12 points)	360
Total vertices (with subsurface modifier, level 2)	5,616
Active transforms	Mesh Rotation
Average execution times	
Vertices:	0.000396200 secs
Faces:	0.000363700 secs
BMesh:	0.001329000 secs
Total:	0.002088900 secs

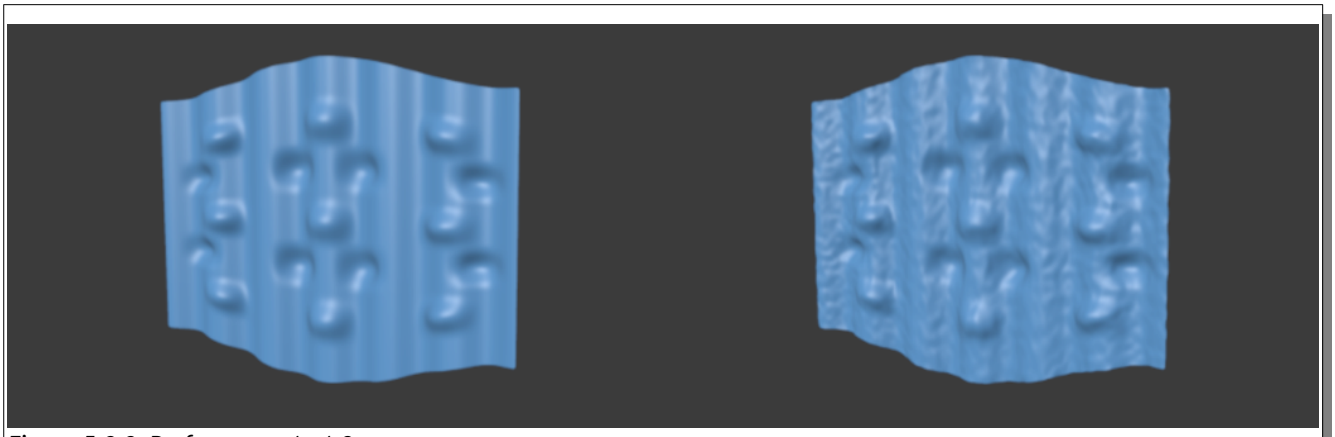


Figure 5.3.2: Performance test 2

Active vertices (90 nodes x 50 points)	4,500
Total vertices (with subsurface modifier, level 2)	70,329
Active transforms	Path Locations: 1 edit Blends: 1 edit Profile Locations: 3 edits

Average execution times		
Vertices:	0.006830200 secs	0.006944200 secs
Faces:	0.003853500 secs	0.003941000 secs
Noise:	---	0.008790200 secs
BMesh:	0.007251600 secs	0.007340400 secs
Total:	0.017935300 secs	0.027015800 secs

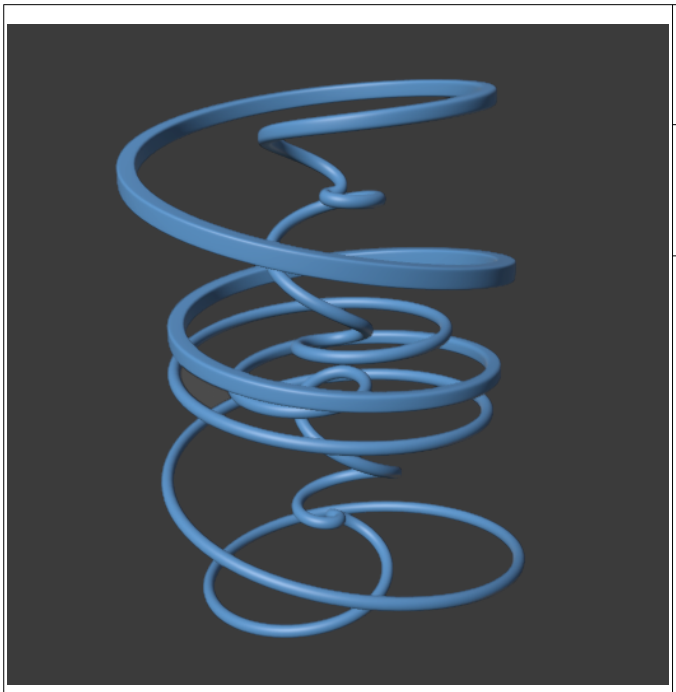


Figure 5.3.3: Performance test 3

Active vertices (120 nodes x 16 points)	1,920
Total vertices (with subsurface modifier, level 3)	122,880
Active transforms	Path Locations: 1 edit Path Rotation Blends: 1 edit

Average execution times	
Vertices:	0.002218400 secs
Faces:	0.001849100 secs
BMesh:	0.003545900 secs
Total:	0.007613400 secs