HEIGHT
LAB

USER MANUAL

Developed By:

LITTLE DREAMER
GAMES®

Contents

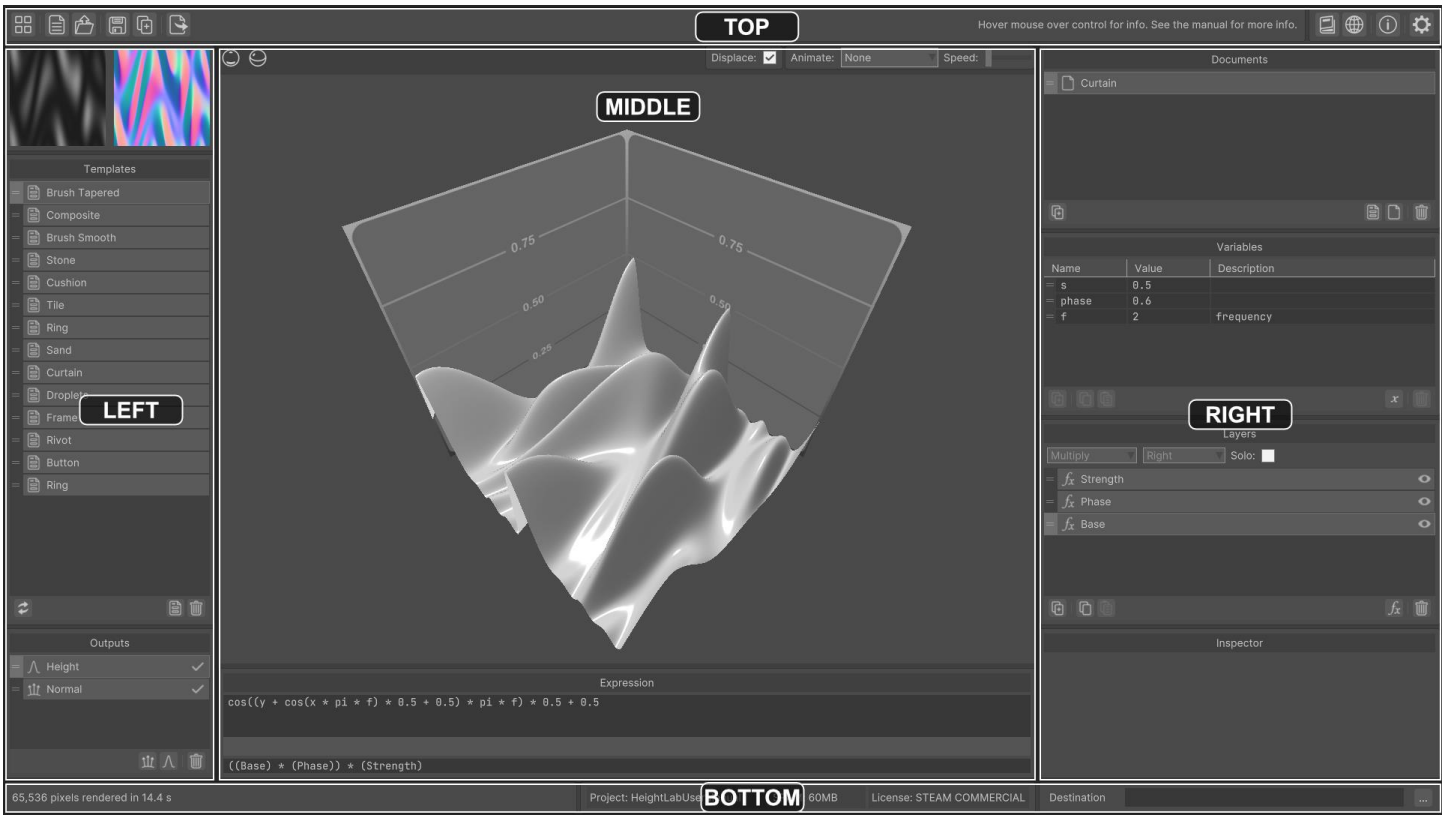
Introduction

Height Lab is used to create height maps and normal maps from hand typed expressions. Save the result as an image for use in your own projects or use them to create brushes or stamps for your favorite 2D/3D paint program.

Save height maps and normal maps to the following file types: JPG, PNG, TGA, EXR16, EXR32, EXR16SRGB, or EXR32SRGB.

Height Lab is good for procedurally creating height maps, normal maps, brushes (normal and height), particles, and masks. These are good for: games, simulators, 2D and 3D paint programs, shader effects, and various unique transition effects.

Layout



The overall layout is simple and broken up into the following sections:

1. **Top**: File Operation Buttons, Tooltips, Online Manual, Website Button, About Button, Settings
2. **Left**: Height Preview, Normal Preview, Templates, Outputs
3. **Right**: Documents, Variables, Expression Layers, Properties Inspector
4. **Middle**: Viewport, Viewport Options, Expression Edit Box, Expression Error Text, Layer Expression Preview
5. **Bottom**: Application Feedback, Project Name, System RAM Usage, Output path

Panel Buttons

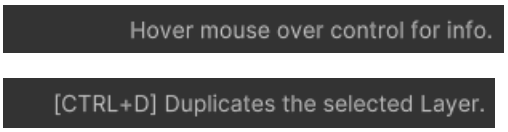
Most panels contain a set of buttons at the bottom. The right most button is always "delete", and the buttons just to the left of that are buttons that "add" an item, whether it be a document, expression layer, etc. On the left side are buttons that can: copy, paste, or duplicate items.

File Operation Buttons

These buttons are your typical file operation buttons. They are for:

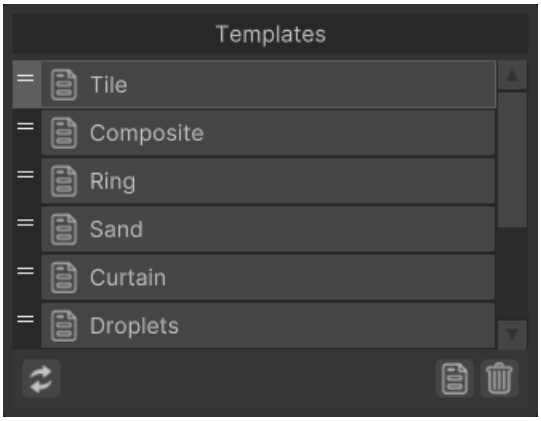
- Welcome Dialog
  - New Project
  - Open Project
  - Recent History
  - Examples
  - Function Legend
- New Project
- Open Project
- Save Project
  - If the project has not been saved yet, then this acts like New Project
- Duplicate Project
  - Save As
- Export
  - Exports the selected Document. The Export button will be enabled when a project has been saved, the height map is done rendering, and when at least one output is defined.

Tooltips



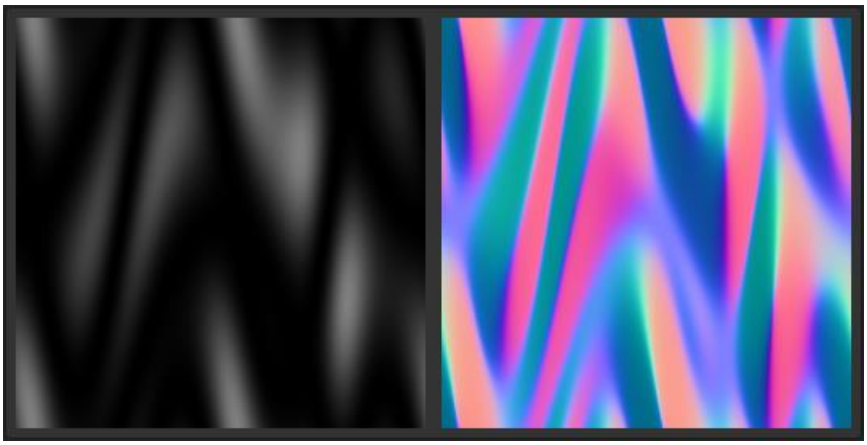
Hovering the mouse over a control will display a tooltip and shortcut (if there is one).

Document Templates



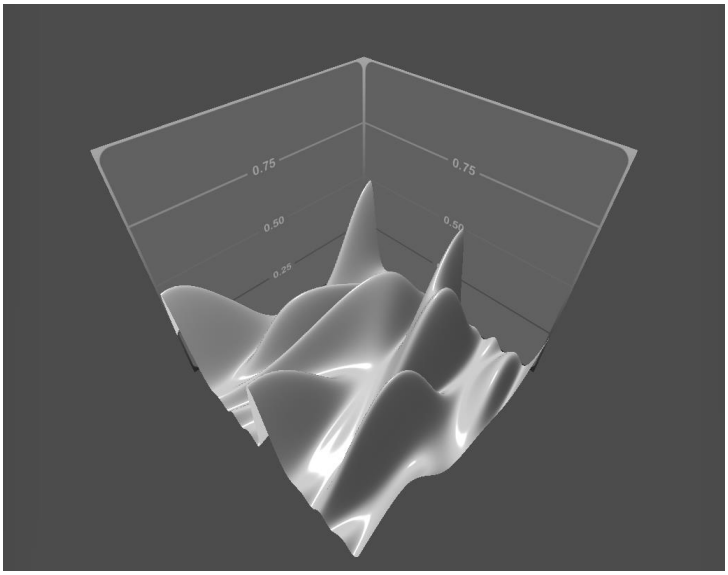
The templates panel contains all the templates made by the user from existing documents. Additionally, the document template can be deleted, or replaced. To replace a document template, select a document in the project, then press the replace button.

Height and Normal Preview



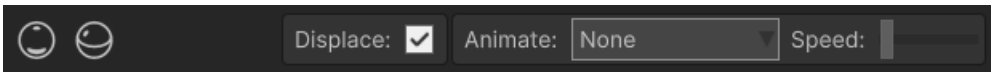
These are the real time flat previews of the two main outputs. Clicking the height map will display the horizontal cross section of the height map.

Viewport



The preview area for visualizing the height map. The height map is displayed as a normalized cube, which means the dimensions are 1,1,1. The sides are marked with 0.25, 0.50, and 0.75 to make it more convenient to know how tall the height map is.

Viewport Options



These viewport options are here to help assist in the creation of height maps. They are:

- Height Material
  - Several materials to choose from, including the outputs.
- Background
  - Environmental and solid color backgrounds.
- Displace
  - Enable this to visualize the height. Disable it to make it flat.
- Animate
  - None
  - U
  - V
  - Dissolve
- Animation Speed
  - Speed of the animation.

Expression Edit Box

This is where expressions are typed in for the selected layer. It supports the most common math functions, and custom ones that make it easy to create different common shapes like spheres and cones. They're all listed here under the Math heading in this document.

Expression Error Text

The area underneath the expression displays any errors found in the expression.

Layer Expression Preview

A visual representation of layers in expression form. This will make it easier to understand how layers are combined with each other, and the order they are evaluated.

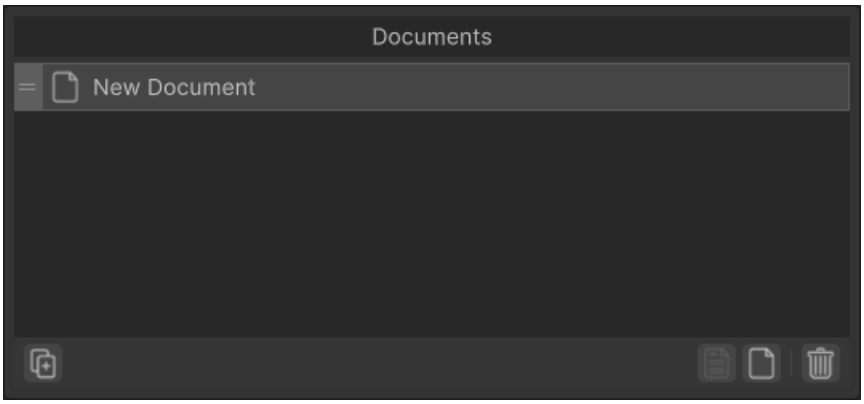
Shortcuts

Modifier	Key / Button	Action
Ctrl	/	Toggle Displacement
Alt	Enter	Toggle full screen
Ctrl	C	Copy item
Ctrl	D	Duplicate item
Ctrl	E	Export document outputs
Ctrl	Insert Layer Button	Insert layer below selected Layer
Ctrl	N	New project
Ctrl	O	Open project
Ctrl	S	Save project
Ctrl + Shift	D	Duplicate project (Save As)
Ctrl	V	Paste item
Ctrl	W	Welcome dialog
Ctrl	Z	Undo
Ctrl + Shift	Z	Redo
	Delete	Delete selected item

Project

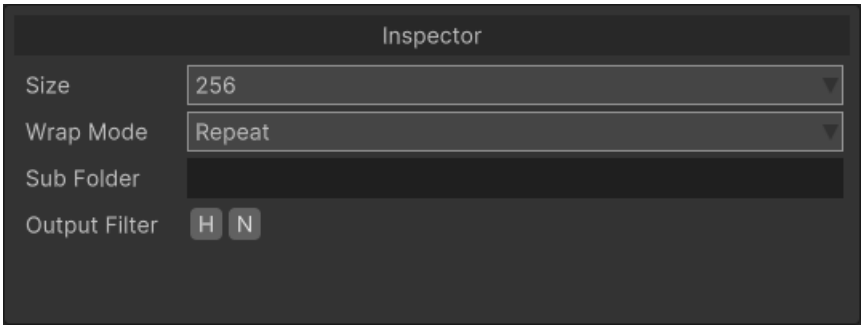
A Height Lab project is made up of *documents*, and each document is made up of expression *layers* and *variables*. Each project also defines project wide *outputs*.

Documents



A document is a collection of expression layers, and all the layers make up a single height map. As many documents as needed may be created in a single project.

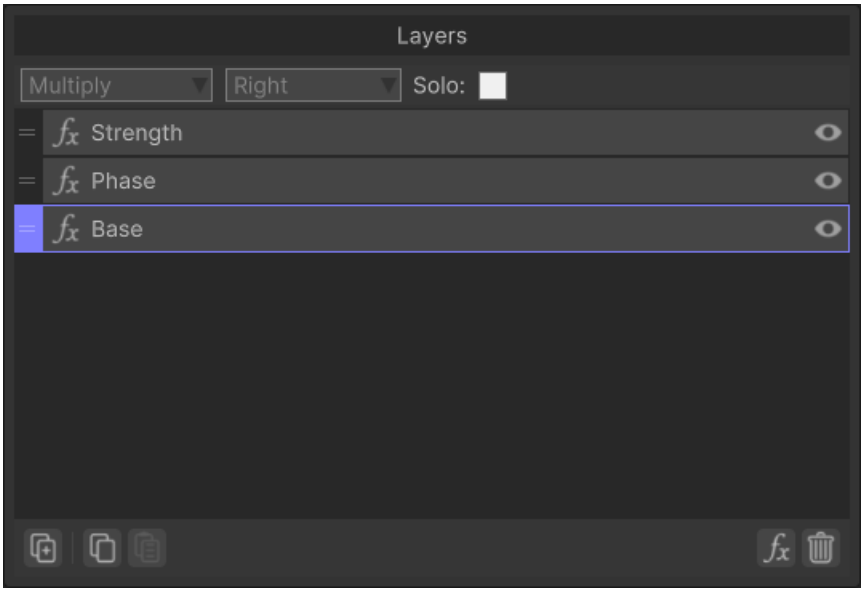
Document Properties



Each document has the following properties:

- Size
  - Specifies the square size of the height map. Ranges from 32 to 4096.
- Wrap Mode
  - Images can be rendered to wrap or repeat.
- Sub Folder
  - Optional Sub Folder appended to Destination folder for Outputs.
- Output Filter
  - Refine which Outputs get exported. Enable/disable Height (H), and Normal (N) per Document.

Expression Layers



Every layer is an expression, and each of them are evaluated from bottom to top. Each layer gives you properties on how a layer is combined with **all the previous layers**. Those properties are:

- Operator Type
  - Add, Subtract, Multiply, Divide, Min, and Max
- Operand Order
  - Right
  - Left
- Solo
  - Causes only the selected layer to render.

A layer expression in this context is an operand, and you can tell the operand to be placed on the *Right* or *Left* side of the operator. This option exists because not all operators are commutative.

For example, if in the above example *Phase* was set to *Multiply->Right*, and *Strength* set to *Subtract->Right*, the Layer Expression Preview would display:

```
((Base) * (Phase)) - (Strength)
```

However, if the *Operand Order* for *Strength* were set to *Left*, then the Layer Expression Preview would display:

```
(Strength) - ((Base) * (Phase))
```

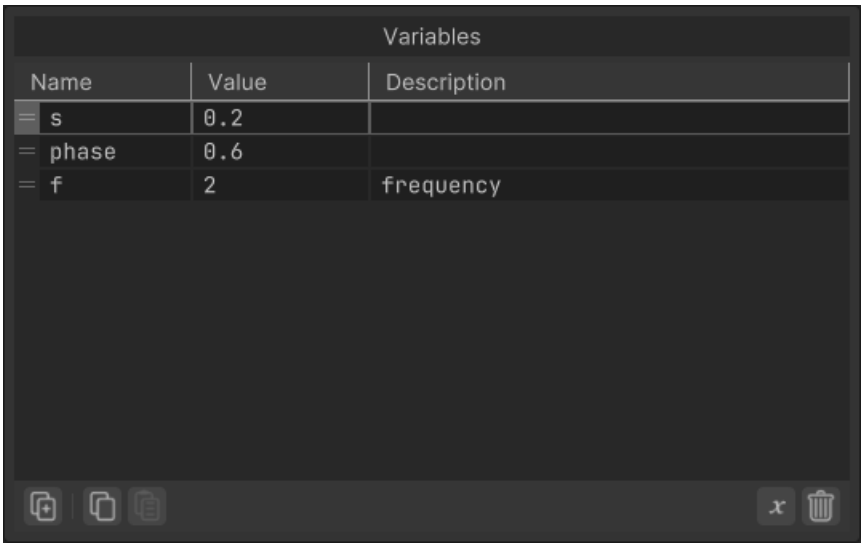
If it helps, you can read the *Operator Type* and *Operand Order* like this:

- Subtract, and place Layer to the Right
- Subtract, and place Layer to the Left

The *Operand Order* of the *Min* and *Max Operand Types* ignore the above rules since they just select a value depending on if one value is larger or smaller than the other.

Variables

Custom Variables



Each document contains a set of variables that can be used in the expression layers for the containing document. As many variables as needed can be created.

Each variable is made up of:

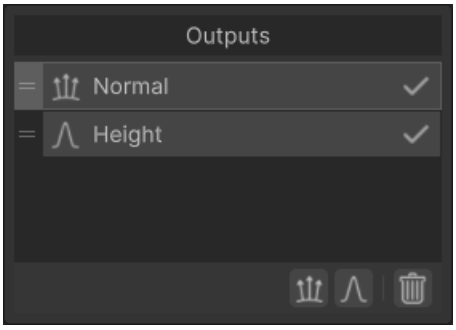
- Name
  - Names must start with a letter and may consist of letters and numbers. Invalid names will display in red. A name can become invalid when it doesn't follow the naming rules, or if they use a reserved name. Reserved names are built in math functions and constants that can be used in expressions.
- Value
  - A numerical value which may only contain numbers with or without a decimal point.
- Description
  - A place to describe the variable.

Predefined variables

The variables: `x`, `y`, `cx`, `cy`, `lyr`, and `lyrs` are all predefined, and are set by Height Lab. The variables x and y range from 0.0 to 1.0, and their origin is at the lower left-hand corner of the height map. The variables cx and cy are x and y offset by -0.5 so that they range from -0.5 to 0.5. `lyr` is the layer of the layer the expression lives in, and `lyrs` is the number of layers in the document.

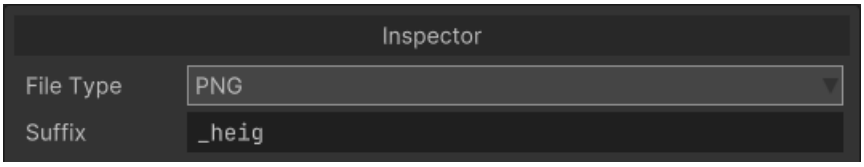
x, y, cx, and cy get set and used for each pixel in the height map. They are in normalized space to make it convenient to use in math functions and scaling.

Outputs Panel



Create project wide outputs for Height Map and Normal Maps. Use the buttons to add or delete them. Their names can be edited, and their outputs can be enabled or disabled by toggling the checkbox.

Shared Output Properties



The shared properties for all the outputs:

- File Type
  - JPG
  - PNG
  - TGA
  - EXR16
  - EXR32
  - EXR16SRGB
  - EXR32SRGB
- Suffix

Normal Map Properties

Leave XYZ disabled to export OpenGL textures. They are disabled by default. Enable just Y for D3D normal maps.

Height Map Properties

Enable to position and scale the values into the range 0 to 1.

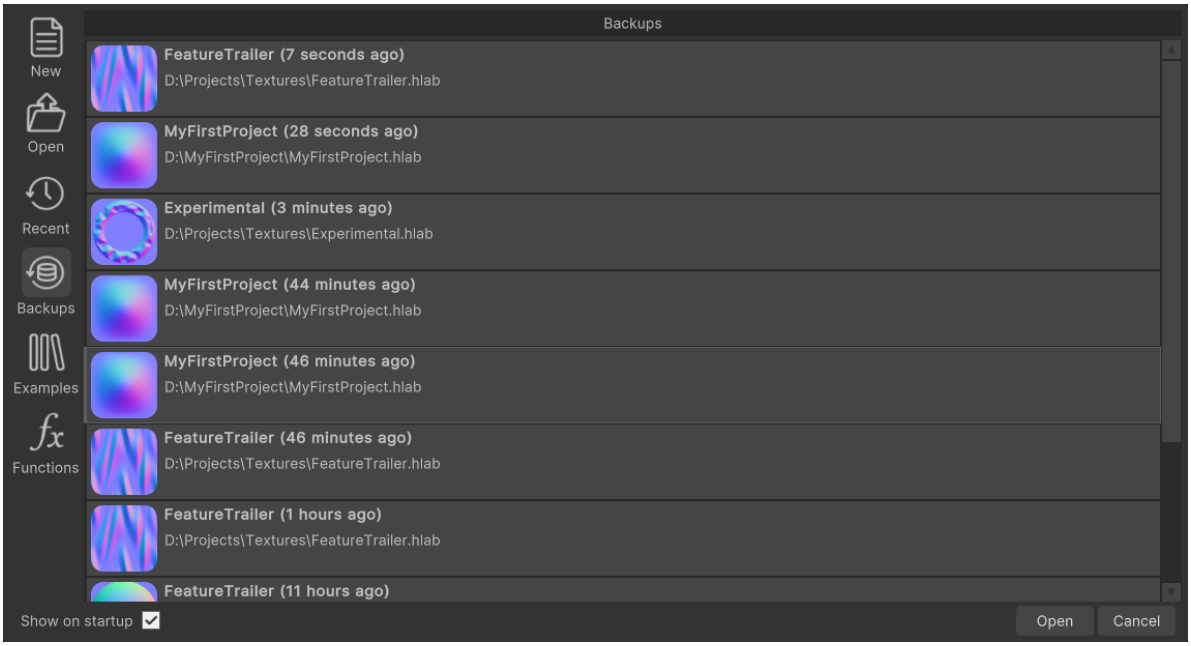
Output Path

Sets the output path for all the Outputs for the selected Document in the project.

The output path and name are constructed in this format:

- ProjectLocation + Destination + Document.SubFolder + Document.Name + Output.Suffix + Output.Filetype

Rolling Backup



Rolling backups are a safe way to save a limited number of local copies of the projects you work on. The number of backups will always be the same, and the latest copy will always be at the top of the list. This is handy in case you decide to roll back to an older project or need to recover from a failed save of the latest project.

How it works

When you save a project, it also gets saved as a backup into a backup folder managed by Height Lab. Height Lab will store a minimum of 3 backups, and a maximum of 10, depending on the settings. Each time a new backup is saved, previous backups increment by 1, and the oldest one gets deleted.

It's important to note that 10 backups do not necessarily equate to 10 versions of 1 project. It just means that 10 backups can be written, and that can mean 1 version for 10 projects, or 5 versions of project A and 5 of B, etc.

Restoring

Simply opening a backup doesn't restore the backup. This is by design. It means you can open the backup to preview it or duplicate it. To fully restore the backup to the original project, do the following:

1. Open the backup
2. Save the project

Now the original project is overwritten by the backup.

Math

List of the built-in predefined variables, constant variables, math functions, and shape functions built into Height Lab. These names are not case sensitive.

Predefined Dynamic Variables

Name	Value	Description
X	0.0 to 1.0	Normalized x value that increments for every coordinate in a row.
Y	0.0 to 1.0	Normalized y value that increments for every coordinate in a column.
CX	-0.5 to 0.5	Normalized x value offset by -0.5 that increments for every coordinate in a row.
CY	-0.5 to 0.5	Normalized y value offset by -0.5 that increments for every coordinate in a column.
LYR	1 to LYRS	Index of the layer the variable is used in.
LYRZ	0 to LYRS-1	Zeroth index of the layer the variable is used in.
LYRS	n	The number of layers in the document.

Constants

Name	Value	Description
E	2.7182…	Eulers number
L2E	1.4426…	The base 2 logarithm of E
L10E	0.4342…	The base 10 logarithm of E
LN2	0.6931…	The natural logarithm of 2
LN10	2.3025…	The natural logarithm of 10
PI	3.1415…	Used for radian calculations
TAU	PI * 2	Used for radian calculations (shortcut for 2PI)
DTR	PI / 180	Degrees to radians
RTD	180 / PI	Radians to degrees
SQRT2	Sqrt(2)	The square root of 2

Math Functions

Name	Returns
Abs(x)	Positive *x*
Acos(x)	Inverse cosine of *x* radians
Acosh(x)	Inverse hyperbolic cosine of *x*
SignedAngle(x, y, cx, cy)	Signed angle of vector (*x-cx*, *y-cy*) in radians
Asin(x)	Inverse sine of *x* radians
Asinh(x)	Inverse hyperbolic sine of *x*
Atan(x)	Inverse tangent of *x* radians
Atan2(y, x)	Normalized angle of vector relative to *x* direction
Atanh(x)	Inverse hyperbolic tangent of *x*
Cbrt(x)	Cube root of *x*
Ceil(x)	*x* rounded up
Clamp(x, min, max)	A value equal to *x*, or no less than *min*, or no more than *max*
Clamp01(x)	A value equal to *x*, or no less than 0.0, or no more than 1.0

Cos(x)	Cosine of *x* radians
Cosh(x)	Hyperbolic cosine of *x*
Exp(x)	Base-e exponential of *x*
Exp2(x)	Base-2 exponential of *x*
Exp10(x)	Base-10 exponential of *x*
Floor(x)	*x* rounded down
Frac(x)	Fractional part of *x*
Length(x, y, cx, cy)	Length of vector (*x-cx*, *y-cy*)
Length(x, y, cx, cy, n)	Length of vector (*x-cx*, *y-cy*) and repeats *n* times
Length(x, y)	Length of vector (*x-0.5*, *y-0.5*)
Length(x, y, n)	Length of vector (*x-0.5*, *y-0.5*) and repeats *n* times
Log(x, b)	Base-*b* logarithm of *x*
Log(x)	Natural logarithm of *x*
Log2(x)	Base-2 logarithm of *x*
Log10(x)	Base-10 logarithm of *x*
Max(x, y)	*x* or *y*, whichever is lager
Min(x, y)	*x* or *y*, whichever is smaller
NoiseCellF1(x, y)	2D cellular noise F1 located at (*x*, *y*). Does not repeat.
NoiseCellF2(x, y)	2D cellular noise F2 located at (*x*, *y*). Does not repeat.
NoiseCellF1(x, y, z)	3D cellular noise F1 located at (*x*, *y*). Does not repeat.
NoiseCellF2(x, y, z)	3D cellular noise F2 located at (*x*, *y*). Does not repeat.
NoiseC(x, y)	Classic Perlin noise located at (*x*, *y*). Does not repeat.
NoiseP(x, y, rx, ry)	Repeating Perlin noise located at (*x*, *y*), and repeats along (*rx*, *ry*)
NoiseS(x, y)	Simplex noise located at (*x*, *y*). Does not repeat.
PingPong(x, r)	*x* adjusted to a value that oscillates between 0.0 and *r* range
PingPong(x)	*x* adjusted to a value that oscillates between 0.0 and 1.0
Pow(x, y)	*x* raised to the power of *y*
Rand(x, y)	Random number between *x* and *y*, inclusive
Repeat(x, r)	*x* adjusted to a value between 0.0 and *r* range
Rcp(x)	Reciprocal of *x: 1.0 / x*
Round(x, d)	*x* rounded to the specified number of *d* digits
Round(x)	*x* rounded to the nearest whole number
Rsqrt(x)	Reciprocal square root of *x*: *1.0 / sqrt(x)*
Sign(x)	Sign of *x*. -1 if less than zero, 0 if zero, and 1 if greater than 0.
Sin(x)	Sine of *x* radians
Sinh(x)	Hyperbolic sine of *x*
SmoothStep(a, b, x)	Smooth cubic spline value ranging from 0.0 to 1.0 when *x* is within the range [*a*, *b*]
Snapc(x, s)	Ceiling of *x* snapped to *s*

Snapf(x, s)	Floor of *x* snapped to *s*
Snapr(x, s)	Rounded of *x* snapped to *s*
Sqrt(x)	Square root of *x*
Step(a, b)	Value of 0 or 1. 0 when *a* < *b*, and 1 when *a* >= *b*
Tan(x)	Tangent of *x* radians
Tanh(x)	Hyperbolic tangent of *x*
Trunc(x)	*x* with the fractional part removed

Shape Functions

Name	Returns
Bar(x)	Height located at *x* that makes a bar
Bar(x, s)	Height located at *x* that makes a bar, with size *s*
Bar(x, s, n)	Height located at *x* that makes a bar, with size *s*, and repeats *n* times
Cone(x, y)	Height located at (*x*, *y*) that makes a cone
Cone(x, y, s)	Height located at (*x*, *y*) that makes a cone, with size *s*
Cone(x, y, s, n)	Height located at (*x*, *y*) that makes a cone, with size *s*, and repeats *n* times
Donut(x, y, od, cs)	Height located at (*x*, *y*) that makes a donut with a diameter of *od*, and cross section width of *cs*
Donut(x, y, od, cs, n)	Height located at (*x*, *y*) that makes a donut with a diameter of *od*, a cross section width of *cs*, and repeats *n* times.
Lens(x, y, s)	Lens located at (*x*, *y*) with sagitta *s*
Lens(x, y, s, l)	Lens located at (*x*, *y*) with sagitta *s*, and chord length *l*
Lens(x, y, s, l, n)	Lens located at (*x*, *y*) with sagitta *s*, chord length *l*, and repeats *n* times
Pyramid(x, y)	Height located at (*x*, *y*) that makes a pyramid
Pyramid(x, y, s)	Height located at (*x*, *y*) that makes a pyramid, with size *s*
Pyramid(x, y, s, n)	Height located at (*x*, *y*) that makes a pyramid, with size *s*, and repeats *n* times
Sphere(x, y)	Height located at (*x*, *y*) that makes a sphere
Sphere(x, y, s)	Height located at (*x*, *y*) that makes a sphere, with size *s*
Sphere(x, y, s, n)	Height located at (*x*, *y*) that makes a sphere, with size *s*, and repeats *n* times
SweepCCW(x, y, cx, cy, a)	Height located at (*x*, *y*) that makes a sweep shape starting at angle *a* in degrees, and with a center (*cx*, *cy*)
SweepCCW(x, y, cx, cy, a, s)	Height located at (*x*, *y*) that makes a sweep shape starting at angle a in degrees, with a center (cx, cy), and steps *s*
SweepCCW(x, y, a)	Height located at (*x*, *y*) that makes a sweep shape starting at angle *a* in degrees, and with a center (0.5, 0.5)
SweepCCW(x, y, a, s)	Height located at (*x*, *y*) that makes a sweep shape starting at angle *a* in degrees, with a center (0.5, 0.5), and steps *s*

Getting Started

This step by step will get you started exporting a height map and normal map. You'll create a height map document, some expression layers, a variable, set up outputs, and then export.

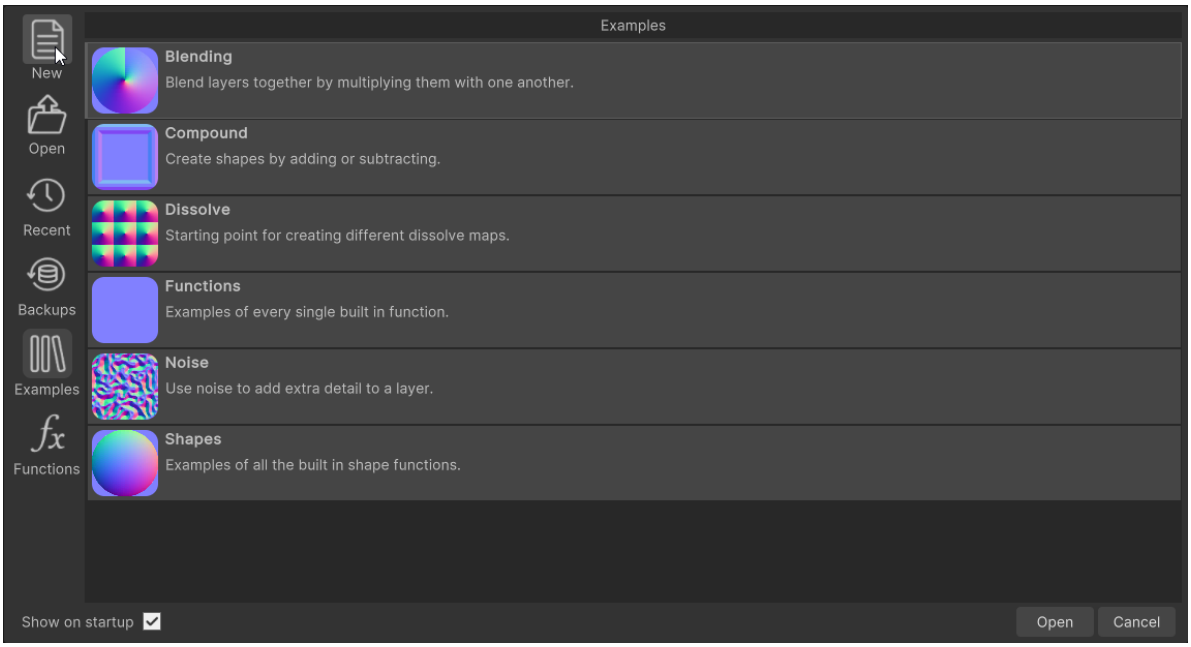
Create a new Project

There are three ways to start a new project:

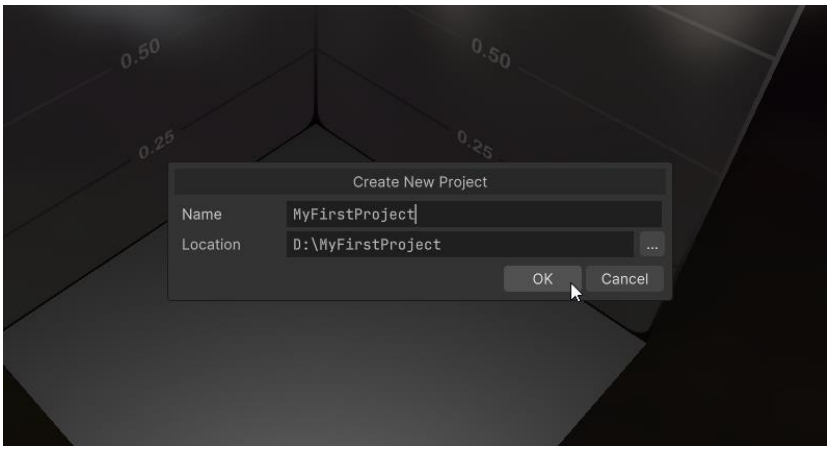
1. From the welcome dialog box.
2. From the menu bar.
3. From an empty project that has never been saved.

From the welcome dialog box

The first way is from the Welcome Dialog box. Click the button at the top left that looks like a piece of paper with lines on it:



You'll then be greeted with another dialog box asking where you'd like to store the project. Give the project a name, then browse to the location you want the project to live.



Click OK, and you've created your first project!

From the menu bar

From the menu bar click the button at the top left that looks like a piece of paper with lines on it:

Just like with the previous method you will be greeted with a dialog box asking where you'd like to store the project. Give the project a name, then browse to the location you want the project to live.

Click OK, and you've created your first project using the second method!

From an empty project that has never been saved

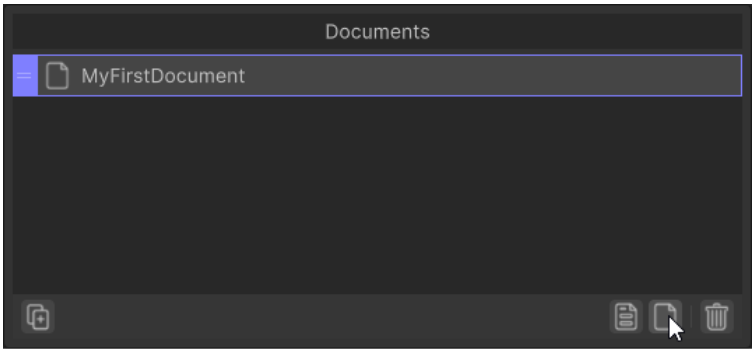
Height Lab will let you work without ever opening or creating a project, which means the third way to start a new project is to press the save button on a project for the first time.

Just like the previous two methods, give the project a name, then browse to the location you want the project to live.

Click OK and all your current work will be saved into the new project.

Creating a Document

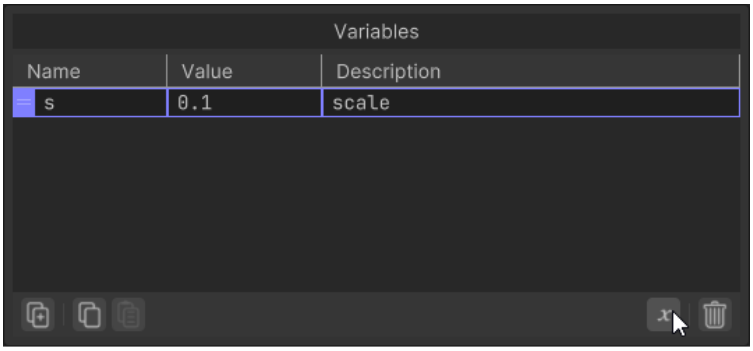
To create a height map document, press the blank paper button at the bottom right of the Documents panel. Name the layer the same as what is in the image.



Creating a Variable

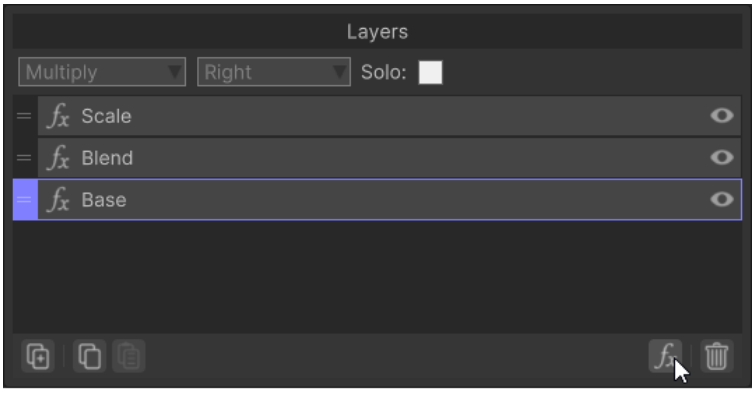
To make your height map a little more configurable, you can create variables and use them in your expressions for the current Document.

Like creating a document, you create a variable by clicking on the variable button at the bottom right of the Variables panel. Prefill it out to the names and values in the image below:



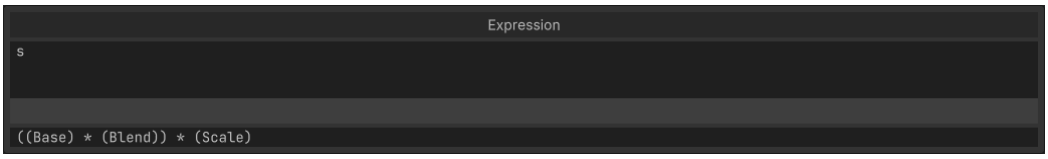
Creating Expression Layers

Now that we have a document, and a variable, it's time to create some expression layers. To create a layer, press the expression button at the bottom right of the Layers panel. Create two additional layers, then call them Base, Blend, and Scale. Layers are stacked, whereas the first layer is Base, the second layer is Blend, and so on. They are also evaluated in that order.



Adding Expressions

Now that we have our variable and layers, we can start filling in their expressions. The Expression panel is at the bottom of the preview area. Right now, it should look like this:



Select the **Base** layer and type in the following expression:

```
1 - (cos(x * pi * 2) * 0.5 + 0.5)
```

Select the **Blend** layer and type in the following expression:

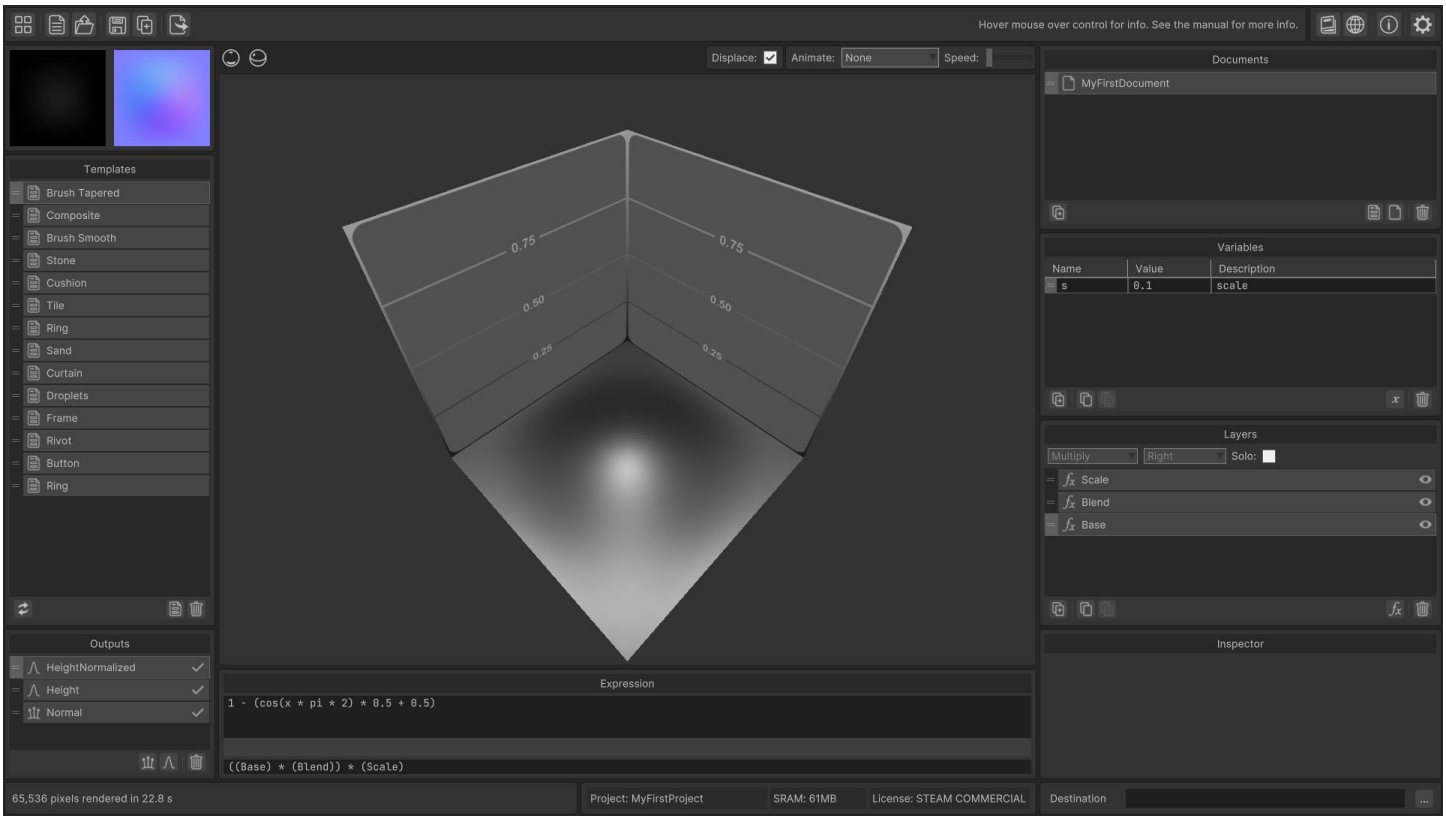
```
1 - (cos(y * pi * 2) * 0.5 + 0.5)
```

Select the **Scale** layer and type in the following expression:

```
s
```

These expressions get called once per pixel in the height map. That means x and y are set by Height Lab 65,536 times, which is 256x256, the size of the height map.

The result:



Soloing and Visibility

Now that there are a few layers to play around with you can try out the Solo toggle and Visibility buttons (the eyeballs).

Enabling Solo will cause Height Lab to only render the selected layer. This is convenient when trying to design a single layer isolated from the others.

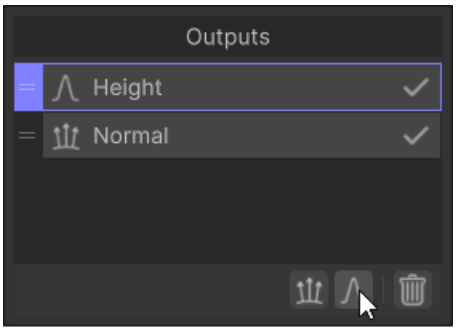
The visibility buttons can be used to disable layers temporarily or permanently. However, the visibility is ignored when soloing is enabled.

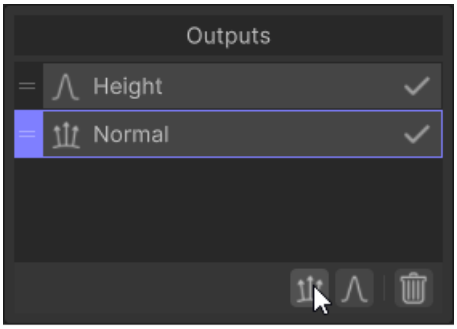
Exporting

Now that we have something to export, we need to tell Height Lab *what* to export.

Add Outputs

Add two outputs by clicking on the output button at the bottom right side of the Outputs panel. Copy the settings shown in the following images. Leaving the Destination blank will cause the outputs to export directly into the project folder:





Export

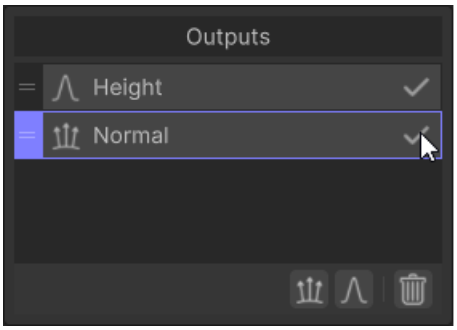
Now that the outputs have been added, Height Lab is ready to export. The Export button will be enabled when a project has been saved, the height map is done rendering, and when at least one output is defined.

Click the Export button to export the selected document:

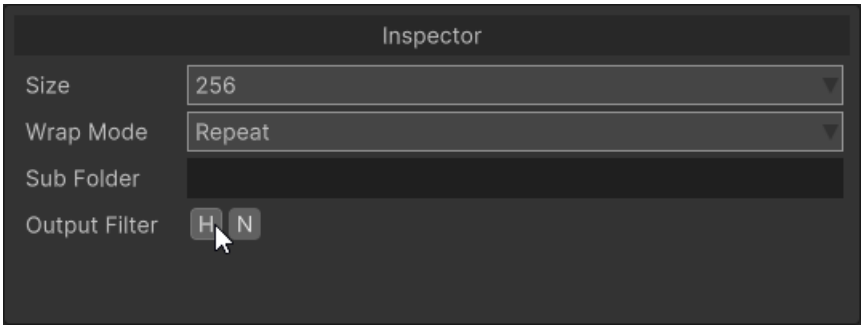
Enable and disable Outputs

As you work on your project, you may or may not need to export every single output. To accommodate this there are two places to handle whether outputs export or not.

To keep an output from exporting for all documents, you can click on the checkmark directly on the output:



To further refine whether to export an output, there is an Output Filter property for each Document. The H toggle is for Height, and N is for Normal:

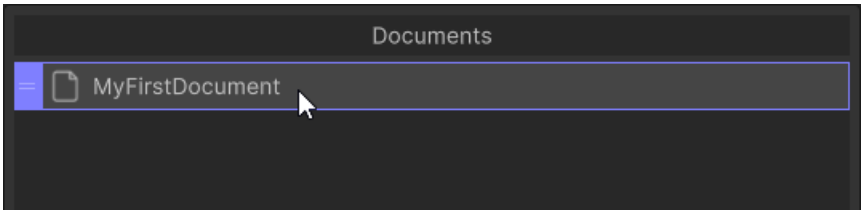


We'll leave them both enabled for this demonstration.

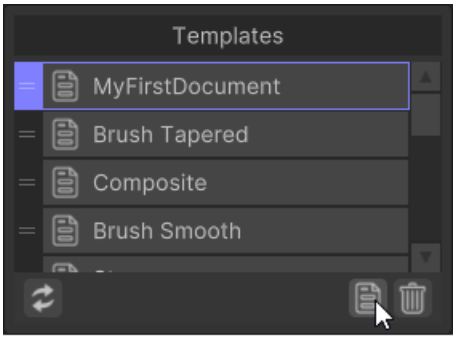
Document Templates

Finally, you can turn any document into a template for use in any project.

Click on the Document you wish to turn into a template:

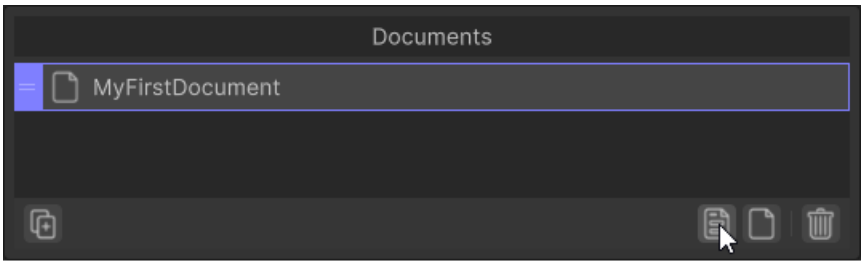


Press the add template button under Templates:



Alternatively, to create a Template under Documents:

Select the Template like in the previous figure, and then press the add template button under Documents:



To replace the template with the current document, first select the document, then the template you want to replace, then press the replace template button: