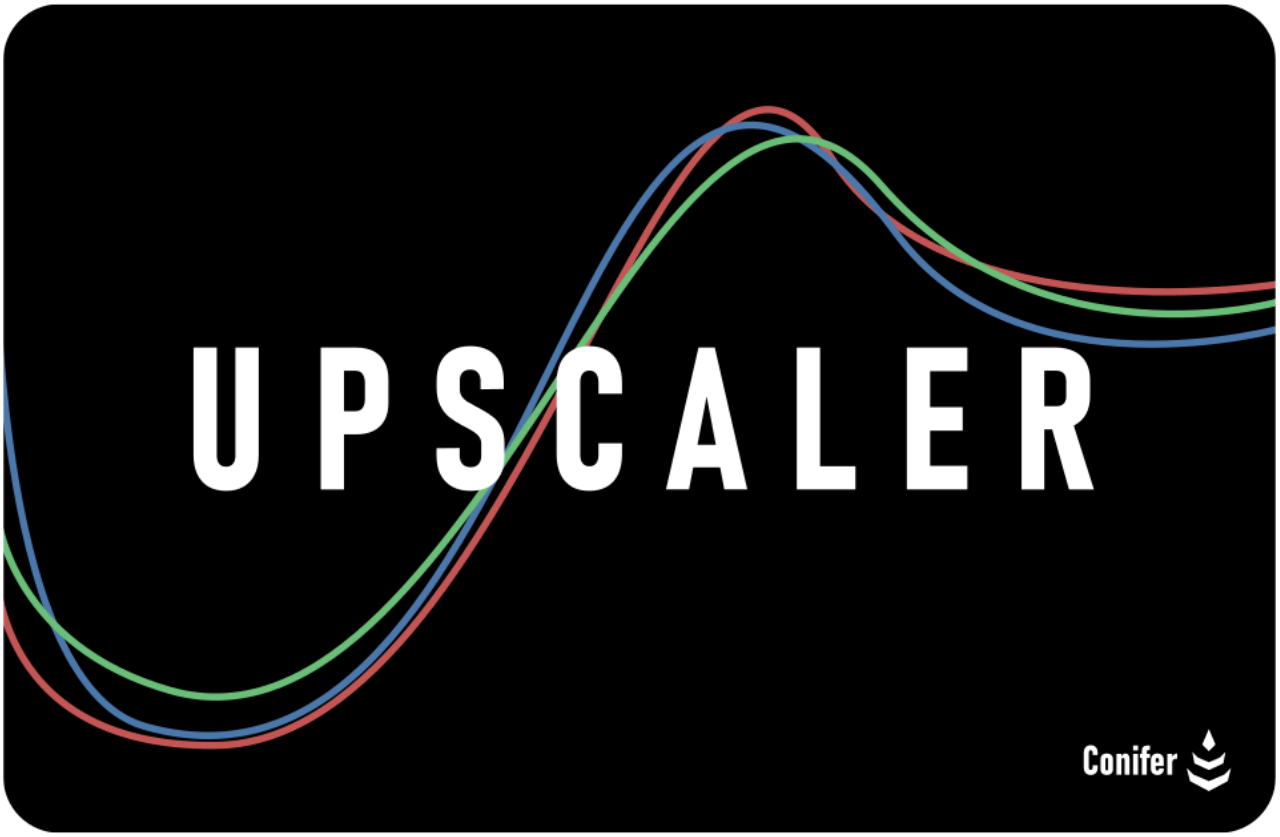
Conifer



Upscaler User Manual

v1.1.1

Conifer

Table of Contents

1 Changes

1. **v1.1.1**

NEW

- Updated to NVIDIA Streamline 2.4.15

IMPROVED

- Greatly simplified update and installation processes

2. **v1.1.0**

NEW

- Updated to FSR 3.1
- Updated to NVIDIA Streamline
- Updated to XeSS 1.3.1
- Dropped Linux support

IMPROVED

- Improved Inspector GUI
- Improved update process
- Improved performance
- Improved quality
- Reduced VRAM consumption

FIXED

- Bugs resulting in crashes
- Bugs related to installation

3. **v1.0.0**

NEW

- FSR 2.2.1, XeSS 1.3, DLSS 3.7.10
- Windows and Linux
- Vulkan, DirectX 12, and DirectX 11

2 Getting Started

After importing Upscaler go to the `Assets` → `Conifer` → `Upscaler` → `Runtime` directory and drag and drop the **`Upscaler.cs`** script onto the camera that you want to upscale. Next, Unity must be restarted. If you neglect to restart Unity at this point, expect Unity to crash as soon as you try to use *Upscaler*.

Consult Upscaler Settings for information on how to control the upscaling from the Unity Editor. See Changing Settings to learn how to control the upscaling from within your

scripts. Finally, check out GUI Integration in order to add upscaling controls to your game's GUI.

3 Using the Unity Editor GUI

This section provides detailed descriptions on the uses of each of the elements in *Upscaler*'s Inspector GUI.

3.1 Upscaler Settings

The "Upscaler" dropdown menu allows you to select one of the available upscalers (referred to as `technique`s in the code to avoid confusion). The "None" upscaler forces the game to render at the output resolution. It entirely removes *Upscaler* from Unity's render pipeline. It disregards all of the other settings; ultimately, it behaves as an off switch for *Upscaler*. Selecting "Deep Learning Super Sampling" will enable the DLSS on this camera. DLSS passes motion vectors, the depth buffer, and the color buffer through a neural network to quickly perform high quality upscaling. DLSS is only available on NVIDIA GPUs. Selecting "Fidelity FX Super Resolution" will enable FSR on this camera. FSR is an open source project backed by AMD. It takes motion vectors, the depth buffer, and the color buffer, and processes them with cross-platform, cross-vendor, handcrafted upscaling algorithms. Selecting "Xe Super Sampling" will enable X^{e}SS. X^{e}SS is an AI powered upscaling algorithm that is developed by Intel. While it is able to work on any vendor's GPUs it is specially designed to leverage the acceleration hardware found on Intel's GPUs. Use an Intel GPU for best results.

The "Quality" dropdown menu allows you to select a quality mode at which to run the upscaler. This setting is ignored if the "Upscaler" option is set to "None".

Consult the charts below for more information. Note that actual numbers may slightly vary depending on the resolution due to the fact that images are sized with a whole number of pixels.

DLSS has six quality modes, five of which scale by a constant amount, and “Auto”.

DLSS Quality Mode Effects on Render Resolution

Quality Mode	% of pixels rendered per-axis	% of pixels rendered
AntiAliasing	100%	100%
Quality	66.6%	44.4%
Balanced	58%	33.6%
Performance	50%	25%
Ultra Performance[1]	33.3%	11.1%

FSR 3.1 has five quality modes, four of which scale by a constant amount and “Auto”.

FSR 3.1 Quality Mode Effects on Render Resolution

Quality Mode	% of pixels rendered per-axis	% of total pixels rendered
AntiAliasing	100%	100%
Quality	66.6%	44.4%
Balanced	58.8%	34.6%
Performance	50%	25%
Ultra Performance	33.3%	11.1%

X^{e}SS has eight quality modes, seven of which scale by a constant amount and “Auto”.

X^{e}SS Quality Mode Effects on Render Resolution

Quality Mode	% of pixels rendered per-axis	% of total pixels rendered
AntiAliasing[2]	100%	100%
Ultra Quality Plus	76.9%	59.2%
Ultra Quality	66.7%	44.5%
Quality	58.8%	34.4%
Balanced	50%	25%
Performance	43.5%	18.9%
Ultra Performance	33.3%	11.1%

The comparisons shown in the charts above are always between the total number of pixels in the given resolution and the total number of pixels in the output resolution.

[1] DLSS’ ‘Ultra Performance’ quality mode does **not** support dynamic resolution scaling.
[2] X^{e}SS’ ‘AntiAliasing’ quality mode does **not** support dynamic resolution scaling.

The ‘Auto’ quality mode applies to each upscaler in the same way. This particular method of determining the chosen quality mode is suggested in the DLSS Developer Guide.

“Auto” Quality Mode

Output Resolution	Chosen Quality Mode
Less than or equal to 2560x1440	Quality
Less than or equal to 3840x2160	Performance
Greater than 3840x2160	Ultra Performance

3.2 Advanced Settings

Upscaler’s advanced settings change based on the selected Upscaler. Note that XeSS does not have an advanced settings foldout menu.

3.2.1 Advanced DLSS Settings

The “DLSS Preset” dropdown menu gives you several options to help DLSS work better with your game. Most games will not need to deviate from the “Default” preset, but some games may benefit from them.

- Use “Stable” if the contents of your camera’s view changes slowly. This option favors older information for better antialiasing at the expense of a higher probability of ghosting. It may show a sharper image when used with the “AntiAliasing” quality mode.
- Use “Fast Paced” if the contents of your camera’s view changes quickly. This option favors new information for better clarity at the expense of antialiasing quality.
- Use “Anti Ghosting” if some of the contents of your camera’s view lacks motion vectors. This can be useful when working with third party plugins that do not correctly handle motion vectors.

3.2.2 Advanced FSR Settings

A non-zero “Sharpness” value adds FSR’s internal sharpening pass after upscaling. The value of the slider controls the amount of sharpening that FSR will perform. Conifer recommends increasing the sharpness as the upscaling ratio becomes more extreme.

The “Use Reactive Mask” checkbox enables automatic reactive mask generation in FSR. Though default FSR configurations will work acceptably in many scenarios, this opens up a number of fine tuning options. The defaults for these options are set to values that Conifer found works well for our test scene, though AMD also recommends that each title refine the numbers to provide the best results.

- The “Reactivity Max” setting can be used to set the maximum reactivity value that the automatic generation process can produce. More reactivity favors newer information at the expense of aliased and blocky results.
- The “Reactivity Scale” setting can be used to scale the results of the automatic generation process. Larger values will result in a more reactive pixel
- The “Reactivity Threshold” setting can be used to control which parts of the image are made reactive. Increase this to make more of the image reactive.

3.3 Debug Settings

- ‘View Debug Images’ shows all the inputs that FSR is receiving, and what its internal phases are outputting. This is only available when using the FSR upscaler.
- ‘Overlay Rendering Area’ allows you to visualize the screen area that is actually being rendered. This can be useful for visualizing Dynamic Resolution changes while testing.
- ‘Force History Reset’ instructs *Upscaler* to clear the history every frame. This can be useful for a variety of things such as better understanding how clearing the history behaves or seeing how long it takes the upscaler to recover from a history reset.
- ‘Dynamic Resolution’ allows you to change the render resolution straight from the Unity Editor.
- ‘Global Log Level’ allows filtering out excess log messages that may be irrelevant from Upscaler. Log messages from Unity’s initialization phases are only given after the ‘Global Log Level’ is set (probably the first time the *Upscaler* Inspector GUI is opened).

4 URP Integration

While integrating with the URP, it is not only important to add the `Upscaler` script to the camera, but the `UpscalerRendererFeature` must also be added to the URP Renderer which that camera is using. Failing to do either will result in an error. A help box will appear in the *Upscaler*’s Inspector GUI on the camera when an `UpscalerRendererFeature` is not present in that camera’s URP Renderer.

The `UpscalerRenderPass` is bound to the `RenderPassEvent.BeforeRenderingPostProcessing` event. After performing upscaling, it blits the depth buffer into a present resolution image, then binds that along with the upscaled results as the camera’s target.

4.1 Screen Space Ambient Occlusion

If using the Screen Space Ambient Occlusion (SSAO) Renderer Feature, 'After Opaque' must be enabled to make it compatible with *Upscaler*. Please note that SSAO works at a high resolution, but that work is thrown away when it is blitted onto the render resolution image.

5 Jitter

Jitter values are queried from the C++ backend then added to the camera's projection matrix to offset the camera by that many pixels. When integrating *Upscaler* into your rendering system, be aware that `Camera.ResetProjectionMatrix` is called in the `Update` method. This happens so that the last jitter values are cleared from the projection matrix before we add new ones.

6 Dynamic Resolution

Change the resolution using the `Upscaler.RenderResolution` property. There is no need to call `Upscaler.ApplySettings()` when updating the dynamic resolution. The resolution will be clamped to within a valid range as defined by `MaxRenderResolution` and `MinRenderResolution`. While Upscaler does support dynamic resolution, not all quality modes support it. Attempting to adjust dynamic resolution while using a quality mode that does not support dynamic resolution will fail as Upscaler will clamp the requested resolution to the only allowed value. See Upscaler Settings for more information about quality modes.. Upscaler's Editor GUI will notify you when such a quality mode is in use.

7 Changing Settings

Upscaler allows you to change the settings through C# scripts using its API. Below is an example script that shows how one can get the Upscaler object, then use the API it provides to change upscaling settings on-the-fly.

Obtain an instance of the `Upscaler` class from the main camera. It is highly recommended that you ensure that the camera actually exists. The example below works, but is not error protected at all. Use it with caution.

```
Upscaler.Upscaler upscaler = Camera.main!.GetComponent<Upscaler.Upscaler>();
```

You can immediately change settings. For example to change the active `technique` use:

```
_upscaler.technique = Upscaler.Technique.FidelityFXSuperResolution;
```

Use `ApplySettings` to push your changes to the active upscaler immediately. This gives you a chance to handle errors right away. In the case that you do not call `ApplySettings` then your changes will be propagated during the `Upscaler`'s next `Update` call and any errors would then need to be handled by the registered error handler. See Handling Errors for more information about error handling.

```
upscaler.ApplySettings();
```

8 Handling Errors

Errors can occur when requesting a settings change. By default, when this happens the default error handler will reset the current upscaler to "None". This will remove the *Upscaler* plugin from the pipeline ensuring that *Upscaler* does not cause any rendering errors. If this is not the behavior that you want, you can choose to override the error handler. You may want to instead revert back to the last settings that worked, print the error to the console, or anything else.

First, to override the error handler, replace the empty lambda with the function that you wish to respond to errors in the code below.

```
Upscaler.Upscaler upscaler = Camera.main!.GetComponent<Upscaler.Upscaler>();
upscaler.ErrorCallback = (status, message) => { };
```

Next, if you wish to perform any settings changes within your error handler, refer to section Changing Settings. Note that error handlers should call the `ApplySettings` function after making any settings changes.. If there is still after the registered error callback is called then the active upscaler will be set to "None" to prevent fatal errors.

The error handler is always called from the `Update` method of the `Upscaler` class in the frame after the error to which it is responding occurs or, in the case of a settings related error, the same frame.

9 Things to be Aware of

The following is a list of advice from Conifer, NVIDIA, AMD, and Intel as given in the DLSS developer guide, FSR documentation pages, and XeSS developer guide.

1. When an upscaler is active, disable all other forms of anti-aliasing including but not limited to MSAA, TAA, FXAA, and SMAA. Upscaler will notify you if any Unity provided anti-aliasing is enabled, but it is up to you to ensure that other third party packages are not injecting their own anti-aliasing solutions.
2. Use *Upscaler* for rendering directly to the screen **OR** rendering to an image that will be post processed before being presented directly to the screen. Do **NOT** use *Upscaler* to upscale things such as:
    1. The view through portals.
    2. The view of a security camera onto a monitor.
    3. Static textures.
    4. Shadow maps.
    5. A depth pass.

    Or any number of possible non direct-to-screen views.
3. DLSS is incompatible with RenderDoc as of RenderDoc v1.33. Upscaler will still load correctly and FSR and XeSS will work, but DLSS will be unavailable. Use NVIDIA's Nsight Graphics for graphics debugging if you require debugging abilities with DLSS enabled. You can connect to Unity's Editor by launching it from Nsight Graphics. *Upscaler* will be able to load and use DLSS successfully, and will not interfere with any captures. Nsight Graphics was used to help create this plugin.
4. Read the relevant parts of the DLSS developer guide, FSR documentation pages, and XeSS developer guide for more information.

10 GUI Integration

Consult the DLSS UI Developer Guidelines PDF, the FidelityFX Naming Guidelines, and/or the XeSS developer guide for more information about integration with in-game GUIs.

Do note that in contrast to what is suggested in the above guidelines, the ‘Auto’ setting does not disable upscaling under any circumstances. Conifer chose to do this because we believe that the settings that the user selects should be honored. If the user wants upscaling off, they turn off upscaling. If you choose to follow the guidelines more closely you will need to perform the required resolution check yourself. Furthermore, in an effort to unify the settings between upscalers an ‘Auto’ setting has been added to FSR and X^{e}SS that follows the guidelines presented by the DLSS developer guide.

11 Contact

This document will be kept up-to-date with the latest releases of Upscaler. The document version number will be the same as the Upscaler version number. If any errors in this documentation are found or you have any further questions, please report them to briankirk@conifercomputing.com.