Upscaler Offline Manual (PDF)

v1.0.0

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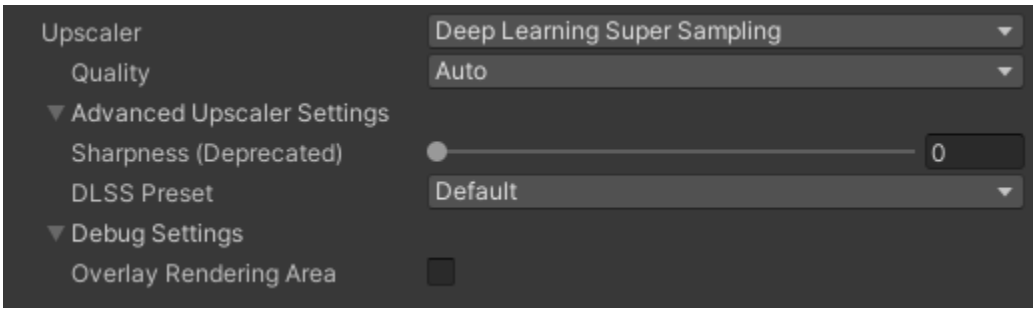
1 Getting Started

After importing Upscaler be sure to restart Unity. This must be done so that Upscaler's native plugin can load into memory. If you neglect to restart Unity at this point, expect Unity to crash as soon as you try to use Upscaler. After you have done that, go to the Assets→Conifer→Upscaler→Runtime directory and drag and drop the **`Upscaler.cs`** script onto the camera that you want to upscale.

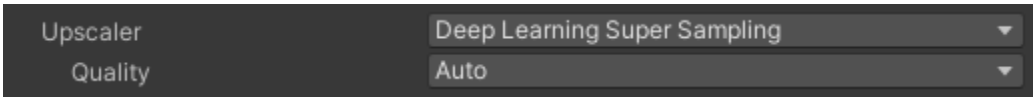
Consult Using the Unity Editor GUI for more information on how to control the upscaling from the Unity Editor. Consult Changing Settings to learn how to control the upscaling from within your scripts. Finally, check out GUI Integration in order to add upscaling controls to your game's GUI.

2 Using the Unity Editor GUI



When correctly attached to the camera, Upscaler's settings should appear as they do above in the camera's inspector. This section provides detailed descriptions on the uses of each of the elements in this GUI.

2.1 Upscaler Settings



The "Upscaler" dropdown menu allows you to select one of the available upscalers. 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. Selecting

“Fidelity FX Super Resolution 2” will enable FSR2 on this camera. FSR2 is an open source project backed by AMD. It takes motion vectors, the depth buffer, and the color buffer, and processes them with handcrafted upscaling algorithms.

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”.

DLSS has six quality modes, five of which scale by a constant amount, and “Auto”, which chooses another quality mode as given by the output resolution. Consult the charts below for more information.

DLSS Quality Mode Effects on Render Resolution

Quality Mode	% less rendered pixels per-axis	% of total pixels rendered
AntiAliasing	0%	100%
Quality	33.3$\overline{3}$%	44.4$\overline{4}$%
Balanced	42%	31%
Performance	50%	25%
Ultra Performance	66.6$\overline{7}$%	11.1$\overline{1}$%

FSR2 has five quality modes, four of which scale by a constant amount, and “Auto”.

FSR2 Quality Mode Effects on Render Resolution

Quality Mode	% less rendered pixels per-axis	% of total pixels rendered
Quality	33.3$\overline{3}$%	44.4$\overline{4}$%
Balanced	42%	31%
Performance	50%	25%
Ultra Performance	66.6$\overline{7}$%	11.1$\overline{1}$%

“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

2.2 Advanced Settings

Upscaler’s advanced settings change based on the selected Upscaler.

2.2.1 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.

2.2.2 Advanced FSR2 Settings

A non-zero “Sharpness” value adds FSR2’s internal sharpening pass after upscaling. The value of the slider controls the amount of sharpening that FSR2 will perform.

The “Use Reactive Mask” checkbox enables automatic reactive mask generation in FSR2. Though default FSR2 will work acceptably in many scenarios, this opens up a number of fine tuning options. The defaults for these options are set as recommended by AMD, though AMD also recommends that each title refine the numbers to provide the best results.

The “T/C Threshold” setting can be increased to provide a more stable image, or decreased to reduce ghosting.

The “T/C Scale” setting can be lowered to increase stability at hard edges of translucent objects.

The “Reactive Scale” setting can be increased to make FSR2 react to changes in the input image faster.

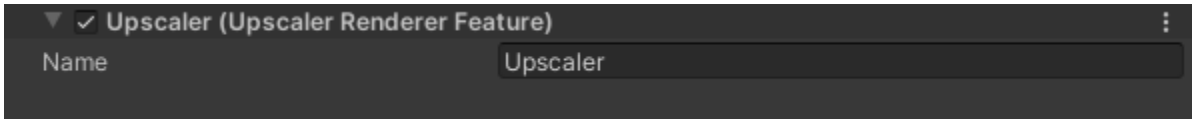
The “Reactive Max” setting can be used to cap the effect of the “Reactive Scale” setting.

2.3 Debug Settings

The only setting available here allows you to visualize the screen area that is actually being rendered. This can be useful for visualizing Dynamic Resolution changes while testing.

3 URP Integration

While integrating with the URP, it is not only important to add the `Upscaler` script to the camera; 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 Editor 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 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.

5 Dynamic Resolution

Change the resolution using `UniversalRenderPipelineAsset.renderScale`. Modifying this value will automatically update the resolution that Upscaler upscales from. Note that while upscaling is active Upscaler will clamp this value between the allowed values for the current 'Quality' mode as queried from the C++ native library. While Upscaler does support dynamic resolution, not all of DLSS' quality modes support it, namely Ultra

Performance mode. Attempting to adjust dynamic resolution while using a DLSS quality mode that does not support dynamic resolution will fail as Upscaler will clamp the renderScale to the only allowed value.

6 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>();
```

Use **`Upscaler.QuerySettings`** to get a copy of the settings currently in use by the upscaler object.

```
var settings = upscaler.QuerySettings();
```

Make your desired changes.

```
settings.upscaler = settings.upscaler == Settings.Upscaler.None ?
Settings.Upscaler.DLSS : Settings.Upscaler.None;
```

Use **`Upscaler.ApplySettings`** to push your changes to the active upscaler.

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

When calling this function, be aware that it can return **`Upscaler.Status`** errors if something goes wrong. It is advisable to handle errors that this function returns in-place.

7 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. If you do not perform any settings changes 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.

8 Things to be Aware of

The following is a list of advice from Conifer, NVIDIA, and AMD as given in their DLSS developer guide and FSR2 documentation pages.

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 v1.32. Upscaler will still load correctly and FSR2 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 is available for both Windows and Linux and was used to help create this plugin.

4. Read the DLSS developer guide and FSR2 documentation pages for more information.

9 GUI Integration

Consult the DLSS UI Developer Guidelines PDF or the FidelityFX Naming Guidelines for more information about integration with in-game GUIs.

Do note that in contrast to what is suggested in the above Guidelines PDF, the 'Auto' setting does not disable DLSS 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 DLSS off, they turn off DLSS. If you choose to follow the guidelines PDF more closely you will need to perform the required resolution check yourself.

Furthermore, in an effort to unify the settings between upscalers and 'Auto' setting has been added to FSR2 that follows the guidelines presented by DLSS.

10 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.