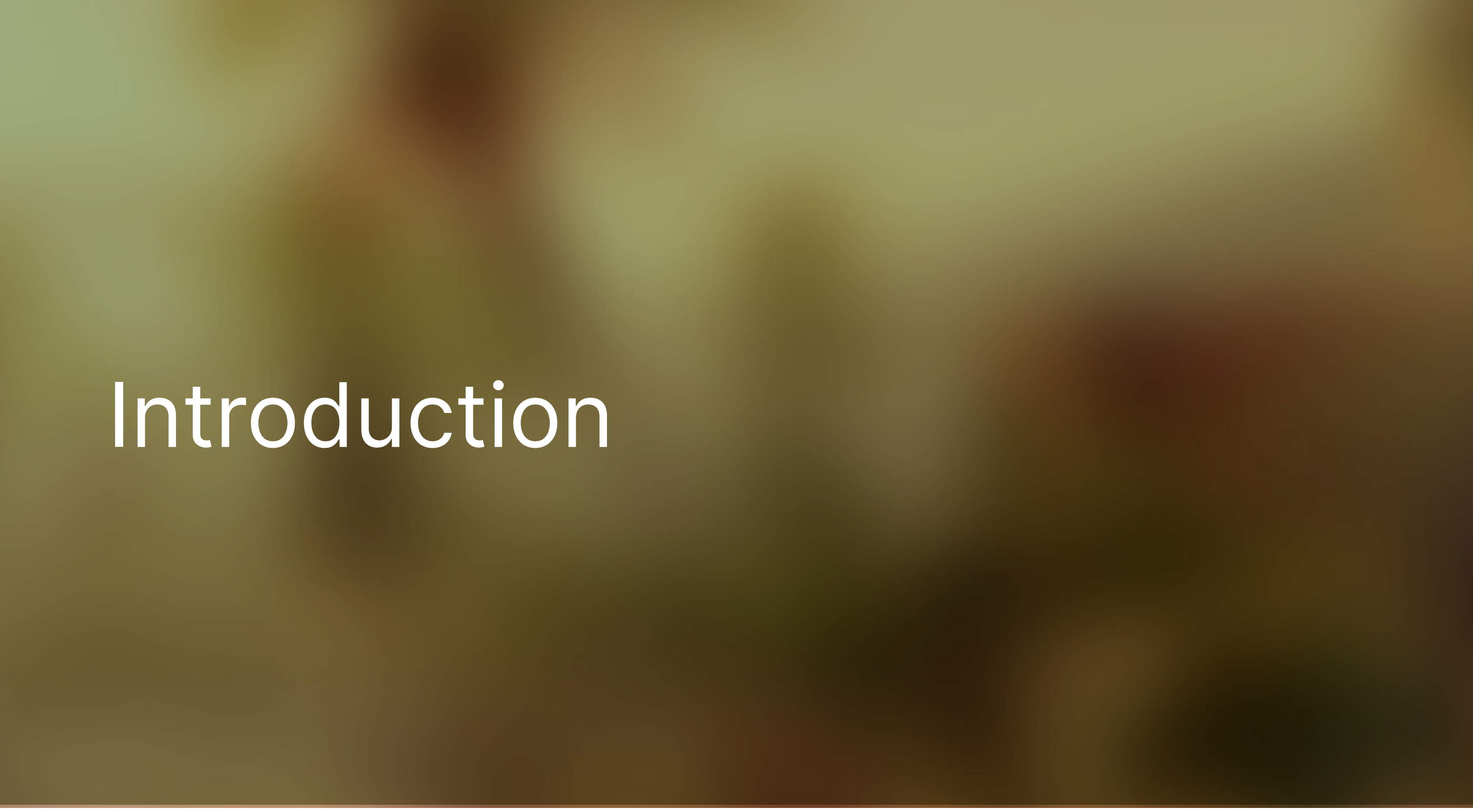
UNITY 2022 LTS EDITION → E-BOOK

80+ tips to increase productivity with Unity 2022 LTS

Contents



Introduction

This guide provides over 80 tips on how to work faster with Unity's programmer and artist toolsets. It covers many of the new features in Unity 2022 LTS along with plenty of time-saving steps and workflows that have been a part of Unity for years.

When you work in Unity every day, each second or mouse click adds up. We want you to be able to waste less time and be more productive. Whether you're a new or experienced Unity developer, this guide can help you to speed up workflows in every stage of your game development.

Go to the Unity 2022 LTS site or to the New in Unity 2022 section of Unity documentation to get the full story of its new features and capabilities.

Many teams at Unity work to improve the quality of life for our creators, such as the Accelerate Solutions team, who contributed their valuable knowledge to this guide. The Accelerate Solutions team supports a plethora of Unity customers to help them get the most out of the engine. They identify, and help to optimize, critical points in projects for speed, stability, and efficiency.

Editor workflows

Unity 2022 LTS includes multiple improvements that speed up Editor workflows, such as new search options to help you find things faster, granular capabilities for the Shortcut Manager, optimizations for large-scale projects, improvements to Play mode, more flexible layouts and advanced styling options in UI Toolkit, and much more.

Collectively, these improvements can save you hours of work over days and weeks because you can iterate faster and develop more efficiently. Try out these tips and shortcuts to go faster in Unity.

Here are some of the behind-the-scenes Editor improvements in Unity 2022 LTS:

— Improved package retrieval process when loading Editor window

— Less time to enter Play mode

— Less time taken by static batching when entering Play mode or making a build

— Improved performance of picking large objects in Scene view

— Improved performance of Scene view with many LODGroups selected

— Optimized prefab editing: 20% off the cost of changing a large prefab

— Editor workflow optimizations for large scale projects:

    — Faster hierarchy scrolling and picking of objects

    — Optimized multi-selection of GameObjects

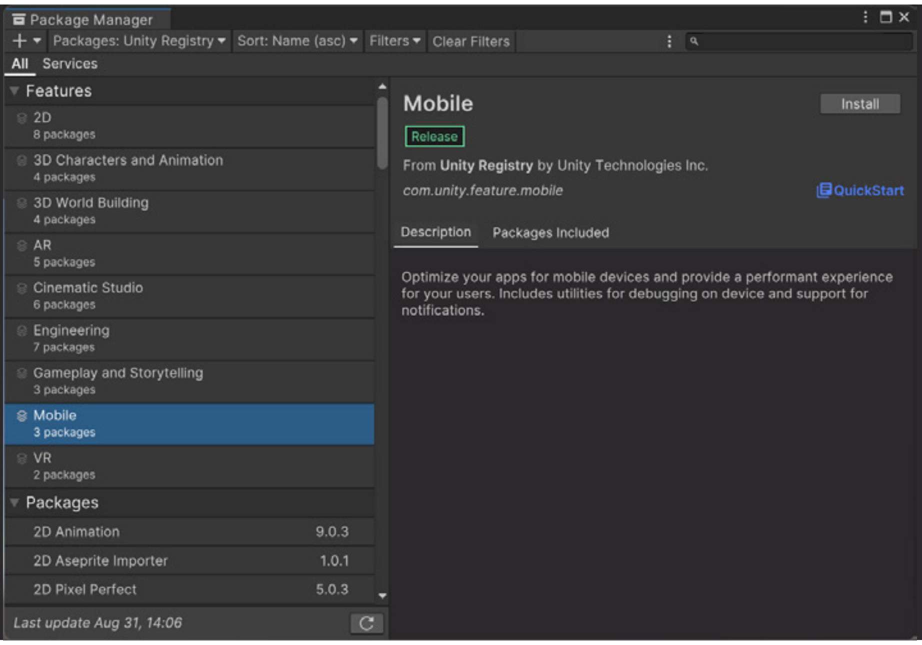
    — Improved performance when you preview many textures

— Reduced hitches when you change to large prefabs

— Improved performance when creating a new asset (especially in a large project)

— Optimized StripPrefabObjectsWhichAreNotUsed: 28% speedup for large scenes

The Package Manager



Optimize your apps for mobile devices and provide a performant experience for your users. Includes utilities for debugging on device and support for notifications.

The updated Package Manager interface

Updates to the Package Manager in Unity 2022 LTS help you save time while you import and organize your packages:

— Support for multiple selection in the Package Manager window; apply the same operation to multiple packages at once, rather than applying each operation individually

— Improvements to the workflow for importing complete projects from the Asset Store; import complete projects into a temporary project where you can safely explore the content without impact to your main project

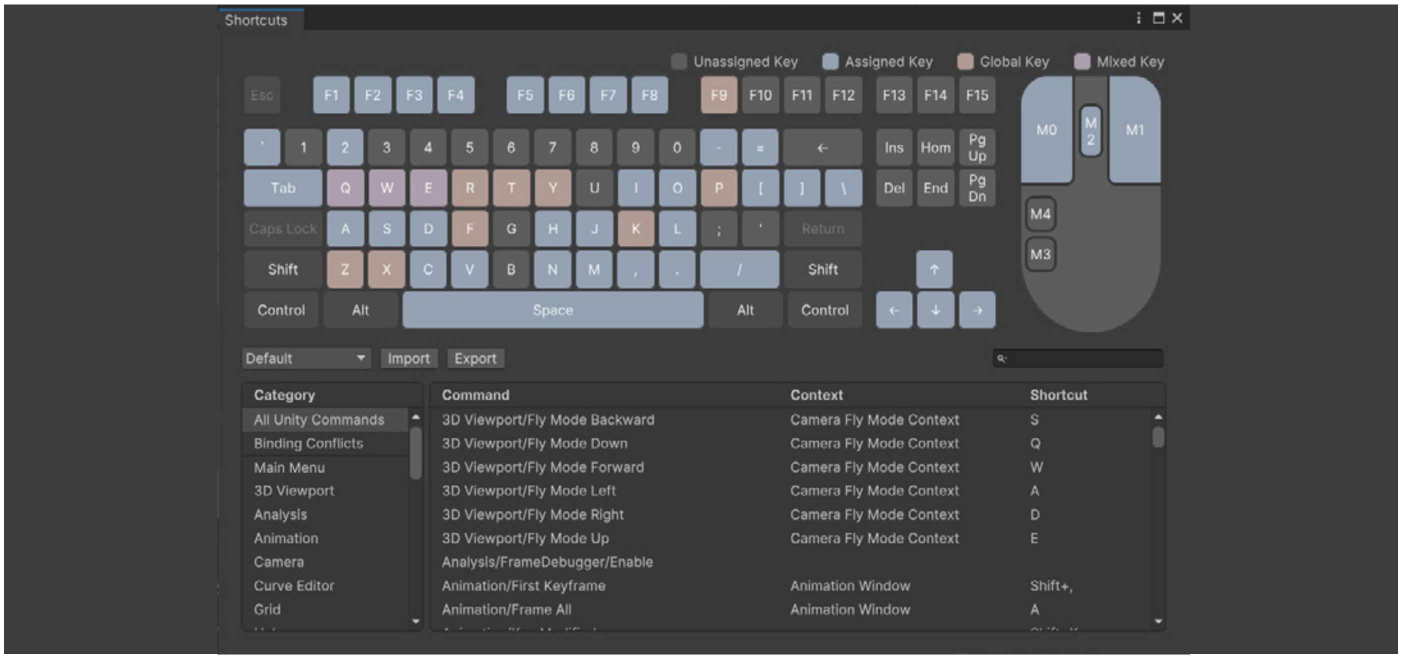
— Redesigned Filters and Sorting controls in the Unity Registry, My Registries, In Project, and My Assets lists

— A Check for Updates option added to the Refresh list in the My Assets list; use this option to check for updates to all packages on your computer, not just the ones that are visible in the My Assets list

— A new Update button to automatically update a Git package to the latest version

Shortcuts Manager

The Shortcuts Manager is an interactive visual interface to help you manage Editor hotkeys. Here, you can assign shortcuts to different contexts and visualize existing bindings for any tools that you use frequently.



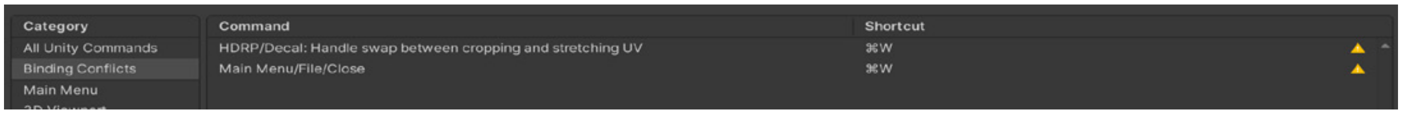
Category
All Unity Commands
Binding Conflicts
Main Menu
3D Viewport
Analysis
Animation
Camera
Curve Editor
Grid

Command	Context	Shortcut
3D Viewport/Fly Mode Backward	Camera Fly Mode Context	S
3D Viewport/Fly Mode Down	Camera Fly Mode Context	Q
3D Viewport/Fly Mode Forward	Camera Fly Mode Context	W
3D Viewport/Fly Mode Left	Camera Fly Mode Context	A
3D Viewport/Fly Mode Right	Camera Fly Mode Context	D
3D Viewport/Fly Mode Up	Camera Fly Mode Context	E
Analysis/FrameDebugger/Enable		
Animation/First Keyframe	Animation Window	Shift+,
Animation/Frame All	Animation Window	A

The Shortcuts Manager

Bind any key or combination of keys, to a Unity Editor command. For example, the R key is bound by default to the Scale tool in the Tools context.

The **Binding Conflicts** Category also identifies if you have a shortcut assigned to two commands that can be executed at the same time. Use the interface to resolve such conflicts. Note: You *can* assign the same shortcut to multiple commands if they are in different contexts and cannot execute at the same time.



Category
All Unity Commands
Binding Conflicts
Main Menu

Command	Shortcut
HDRP/Decal: Handle swap between cropping and stretching UV	⌘W
Main Menu/File/Close	⌘W

Identify Binding Conflicts between shortcuts

Access the Shortcuts Manager from Unity's main menu:

— On Windows and **Linux**, select **Edit > Shortcuts**.

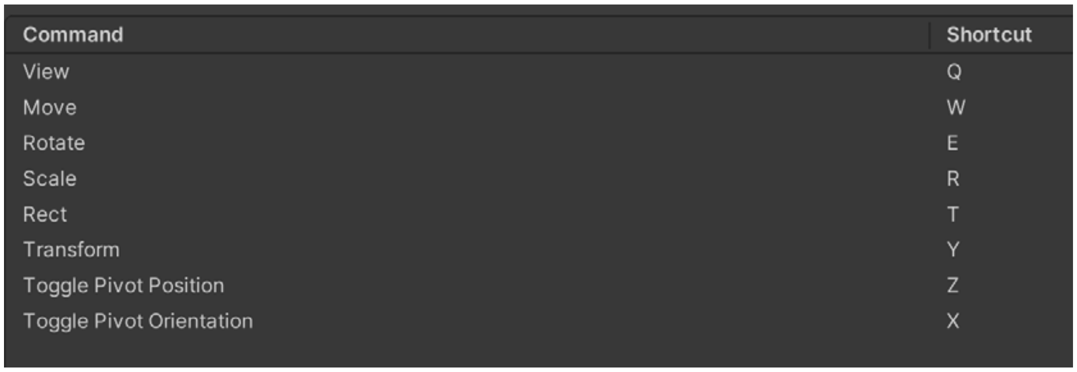
— On macOS, select **Unity > Shortcuts**.

Use the provided API in the UnityEditor.ShortcutManagement namespace to define custom shortcuts in your own scripts and packages.

Common Shortcuts

Here are some common default shortcuts:

Action	Windows	Mac
Frame Selected	**F**	**F**
Duplicate Items	**Ctrl + D**	**Cmd + D**
Delete GameObject	**Shift + Del**	**Cmd + Delete**
View/Move/Rotate/Rect/ Transform	**Q/W/E/R/T**	**Q/W/E/R/T**
Toggle Pivot Mode	**Z**	**Z**
Toggle Pivot Rotation	**X**	**X**
Vertex Snap	**V**	**V**
Snap	**Ctrl + LMB**	**Cmd + LMB**
Toggle Maximize	**Shift + spacebar**	**Shift + spacebar**
Edit Prefab in Context	**P**	**P**



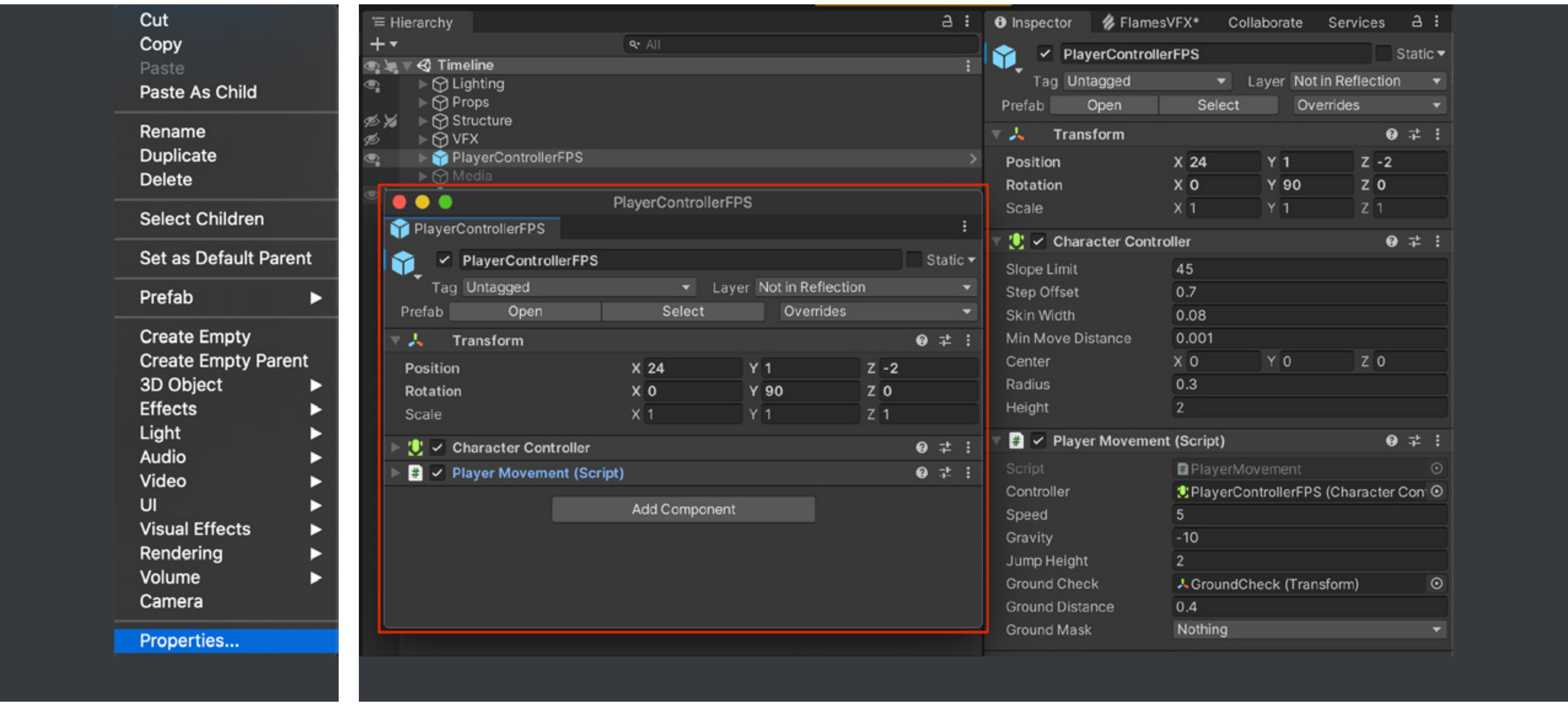
Command	Shortcut
View	Q
Move	W
Rotate	E
Scale	R
Rect	T
Transform	Y
Toggle Pivot Position	Z
Toggle Pivot Orientation	X

Common Editor shortcuts

Focused Inspectors

The Focused Inspector window allows you to inspect the properties for a specific GameObject, component, or asset. It always displays the properties of the item you opened it for, even if you select something else in the Scene.

Right-click on a GameObject or Component, and choose **Properties**. This reveals a floating Inspector window that you can reposition, dock, or resize like any other window.



PlayerControllerFPS
PlayerControllerFPS Static
Tag Untagged Layer Not in Reflection
Prefab Open Select Overrides

Transform

Position	X 24	Y 1	Z -2
Rotation	X 0	Y 0	Z 0
Scale	X 1	Y 1	Z 1

Character Controller
Player Movement (Script)

PlayerControllerFPS Static
Tag Untagged Layer Not in Reflection
Prefab Open Select Overrides

Transform

Position	X 24	Y 1	Z -2
Rotation	X 0	Y 90	Z 0
Scale	X 1	Y 1	Z 1

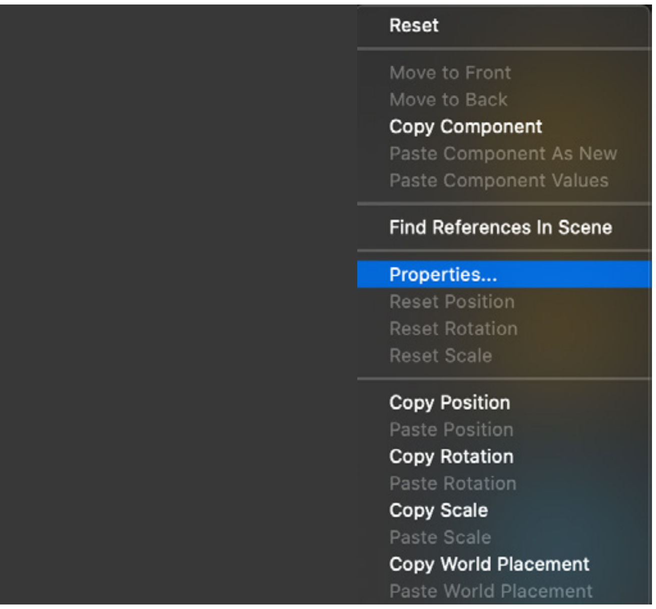
Character Controller

Slope Limit	45
Step Offset	0.7
Skin Width	0.08
Min Move Distance	0.001
Center	X 0 Y 0 Z 0
Radius	0.3
Height	2

Player Movement (Script)

Script	PlayerMovement
Controller	PlayerControllerFPS (Character Con
Speed	5
Gravity	-10
Jump Height	2
Ground Check	GroundCheck (Transform)
Ground Distance	0.4
Ground Mask	Nothing

A Focused Inspector comparing two GameObjects



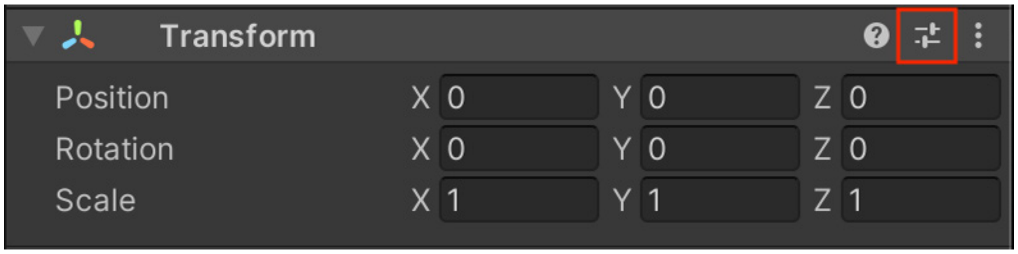
Opening multiple Focused Inspectors at the same time allows you to reference multiple GameObjects while making changes to the Scene.

You can also focus on a specific Component of a GameObject, requiring less screen space.

Presets

Presets enable you to customize the default state of anything in your Inspector. Creating a Preset lets you copy the settings of a component or asset, save it as an asset, then apply the same settings to another item later.

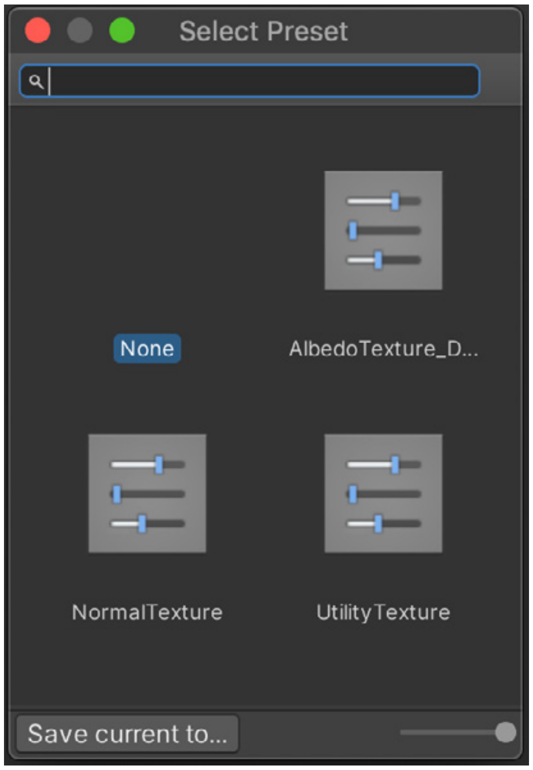
Use Presets to enforce standards or to apply reasonable defaults to new assets. This ensures consistent standards across your team, so commonly overlooked settings don't impact your project's performance.

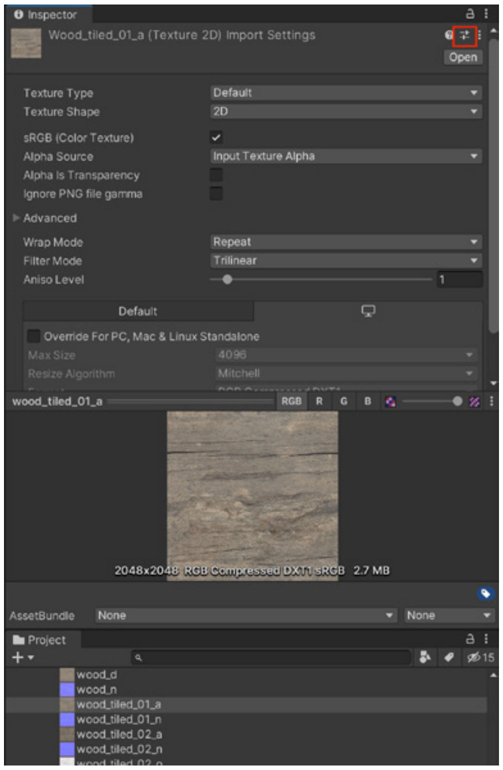

Transform

Position	X 0	Y 0	Z 0
Rotation	X 0	Y 0	Z 0
Scale	X 1	Y 1	Z 1

The Preset icon is highlighted here in red.

Click the Preset icon to the top right of the component. Click **Save current to…** to save the Preset as an asset. Click one of the available Presets to load a set of values.




Inspector

Wood_tiled_01_a (Texture 2D) Import Settings

Texture Type	Default
Texture Shape	2D
sRGB (Color Texture)	✓
Alpha Source	Input Texture Alpha
Alpha Is Transparency	
Ignore PNG file gamma	
Advanced	
Wrap Mode	Repeat
Filter Mode	Trilinear
Aniso Level	1

Default

Override For PC, Mac & Linux Standalone

Max Size	4096
Resize Algorithm	Mitchell

wood_tiled_01_a

2048x2048 RGB Compressed DXT1 sRGB 2.7 MB

AssetBundle None None

Project

wood_d
wood_n
wood_tiled_01_a
wood_tiled_01_n
wood_tiled_02_a
wood_tiled_02_n

In this example, the Presets contain different Import Settings for 2D textures depending on usage (albedo, normal, or utility).

Other handy ways to use Presets:

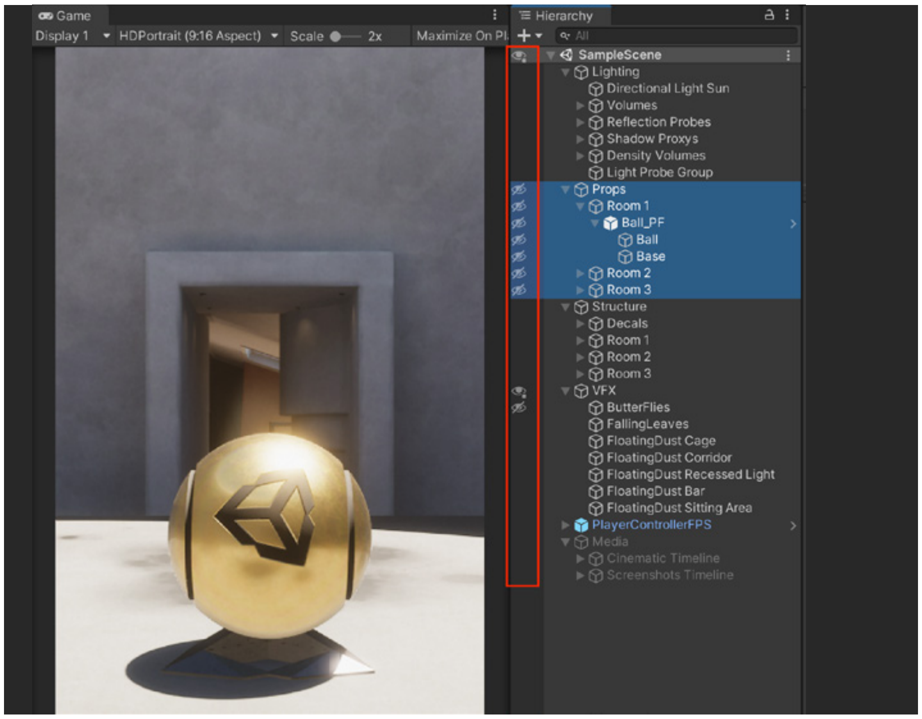
- **Create a GameObject with defaults:** Drag and drop a Preset asset into the Hierarchy in order to create a new GameObject with the corresponding component filled in with Preset values.
- **Associate a specific Type with a Preset:** In the **Preset Manager** (**Project Settings > Preset Manager**), specify one or more Presets per Type. Creating a new component will then default to the specified Preset values.
  - Pro tip: Create multiple Presets per Type, and rely on the Filter to associate the correct Preset by name.
- **Save and load manager settings:** Use Presets for a Manager window, so the settings can be reused; for example, if you plan to reapply the same Tags and Layers or Physics settings, Presets can reduce set up time for your next project.

Scene visibility

As your Scene grows larger, you can temporarily hide specific objects so that you can select and edit your GameObjects with more ease.

Instead of deactivating the GameObjects (which can lead to unintended behavior), toggle the SceneVisibility controls. This allows you to hide and show objects in the Scene view, without changing their in-game visibility.

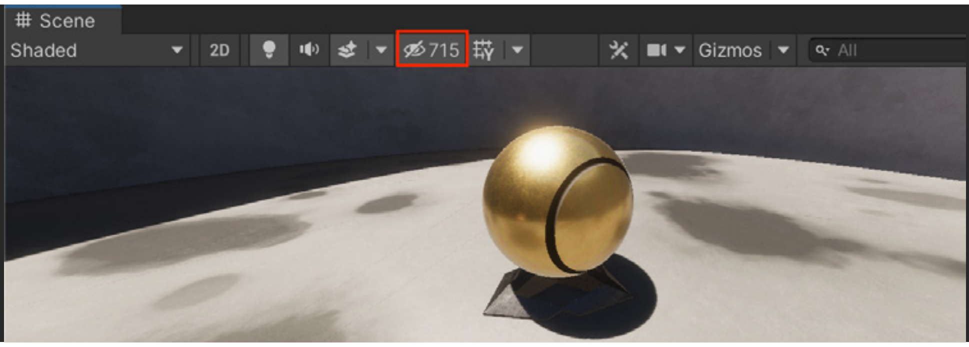
Use the toolbar in the **Hierarchy** window to enable or disable the Scene visibility for GameObjects in the viewport.



Hide objects in the Scene view using SceneVisibility controls.

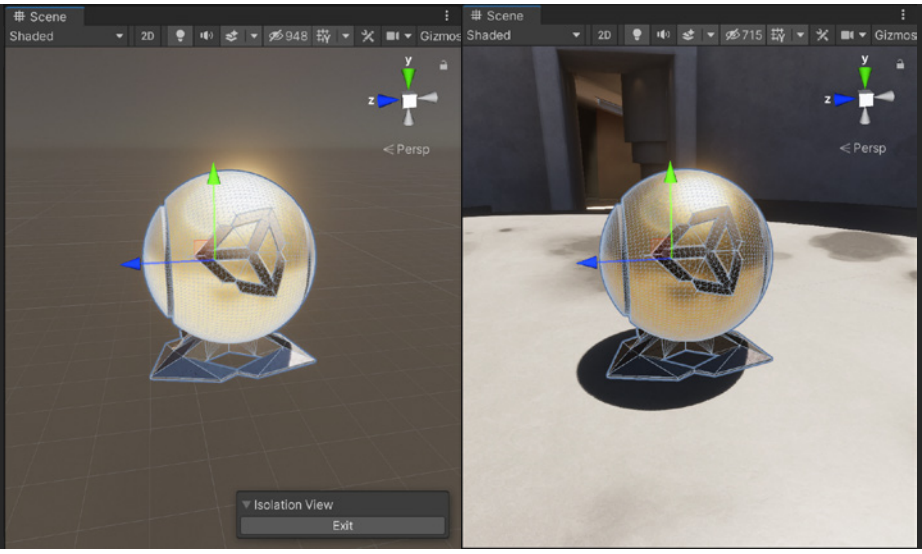
Note that the status icons may change in the Hierarchy, depending on whether parent or child objects become hidden.

Icon	Status
👁■	The GameObject is visible, but some of its children are hidden.
~~👁~~■	The GameObject is hidden, but some of its children are visible.
👁	The GameObject and its children are visible, but they only appear when you hover over the GameObject.
~~👁~~	The GameObject and its children are hidden.



Toggle the Scene view control bar on or off to override the global Scene visibility.

Use **Isolation View** to concentrate on a specific object and its children. Select the GameObject in the Hierarchy window and press **Shift + H** to toggle it on and off. This overrides your other Scene visibility settings until you exit.

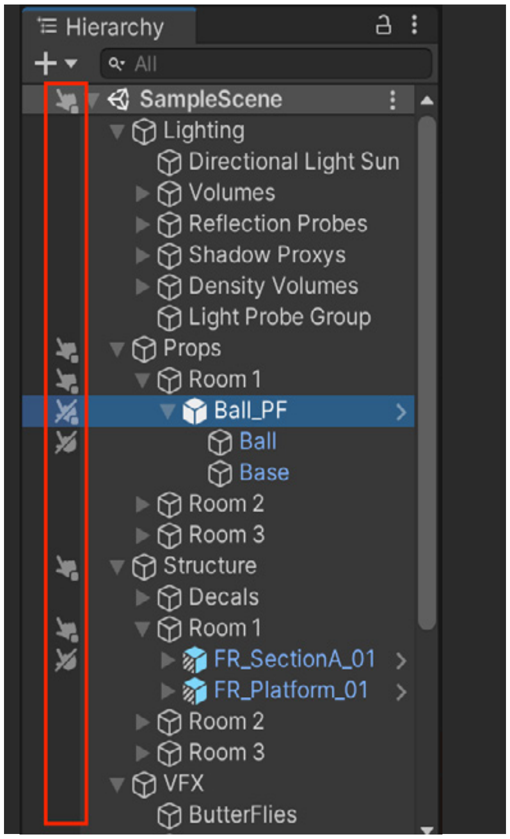


Isolation View allows you to edit a GameObject without distractions.

Remember that you can always use the **Shift + spacebar** shortcut to maximize the viewport and hide the rest of the Editor as well.

Scene picking

You can modify the pickability state of GameObjects, similar to Scene visibility. Use the toolbar to block specific GameObjects from being selected in the Scene view. This is useful to avoid selecting and editing an unintended GameObject in large scenes.



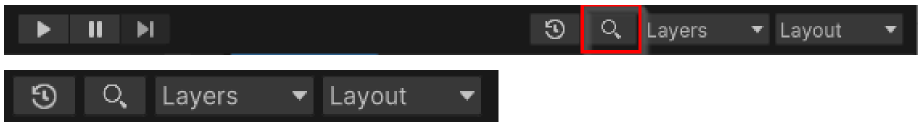
Hierarchy pickability

Because you can toggle pickability for a whole branch or a single object, some GameObjects may be pickable but have children or parents that are not. The following icons differentiate their status.

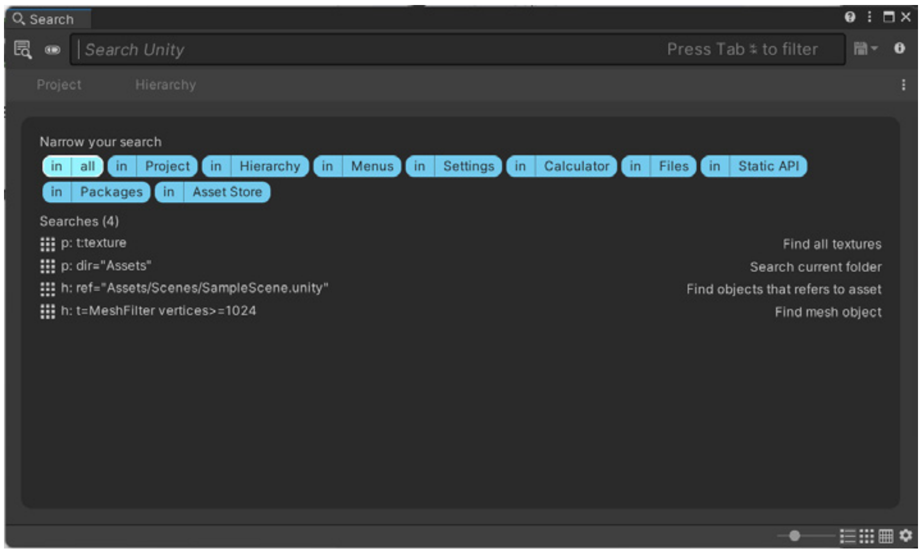
Icon	Status
👆	You can pick the GameObject, but you cannot pick some of its children.
🚫	You cannot pick the GameObject, but you can pick some of its children.
👆	You can pick the GameObject and its children (only appears when you hover over the GameObject).
🚫	You cannot pick the GameObject or its children.

Searching

Search functionality in the Editor has improved in the recent LTS releases, and in 2022 LTS, there are several ways for you to search efficiently in Unity. Besides the search functionality in the Hierarchy and Project views, you can also use the search button icon in the main menu bar or use the Ctrl + K shortcut.

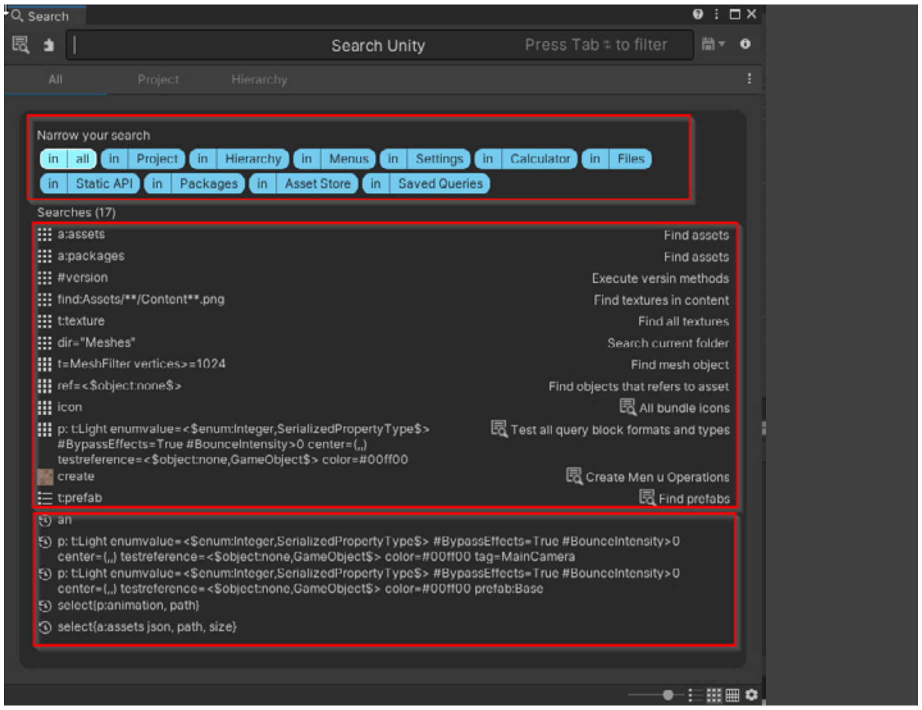


This opens a search window where it's easy to filter your search. The top section of the Landing page allows you to select a search area (search provider) for your search. Clicking on a search area block will filter out the queries and recent searches below. Double-clicking on a search area block will insert the filter token of this area in the search field to help you narrow down your search.



p: t:texture — Find all textures
p: dir="Assets" — Search current folder
h: ref="Assets/Scenes/SampleScene.unity" — Find objects that refers to asset
h: t=MeshFilter vertices>=1024 — Find mesh object

The updated Search window



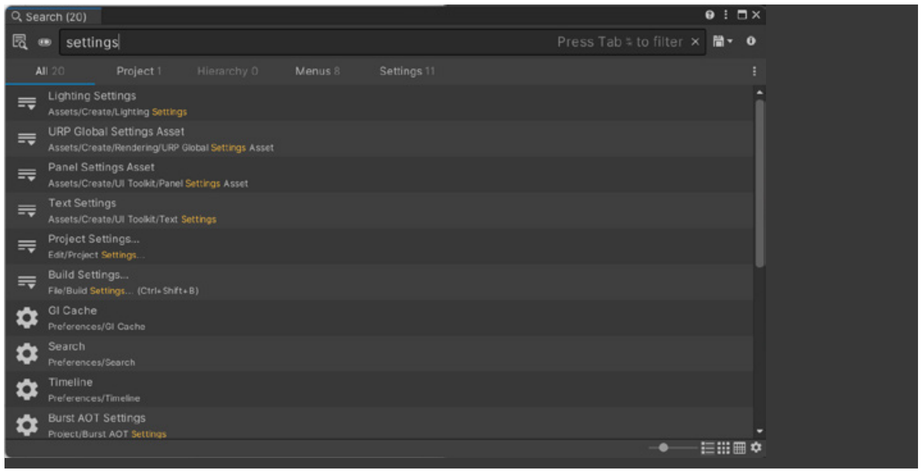
a:assets	Find assets
a:packages	Find assets
#version	Execute versin methods
find:Assets/**/Content**.png	Find textures in content
t:texture	Find all textures
dir="Meshes"	Search current folder
t=MeshFilter vertices>=1024	Find mesh object
ref=<$object:none$>	Find objects that refers to asset
icon	All bundle icons
p: t:Light enumvalue=<$enum:Integer,SerializedPropertyType$> #BypassEffects=True #BounceIntensity>0 center=(,,) testreference=<$object:none,GameObject$> color=#00ff00	Test all query block formats and types
create	Create Men u Operations
t:prefab	Find prefabs

```
an
p: t:Light enumvalue=<$enum:Integer,SerializedPropertyType$> #BypassEffects=True #BounceIntensity>0
center=(,,) testreference=<$object:none,GameObject$> color=#00ff00 tag=MainCamera
p: t:Light enumvalue=<$enum:Integer,SerializedPropertyType$> #BypassEffects=True #BounceIntensity>0
center=(,,) testreference=<$object:none,GameObject$> color=#00ff00 prefab:Base
select{p:animation, path}
select{a:assets json, path, size}
```

The Search window with queries

The middle section shows a list of queries available for the currently selected search area. You can click on any query to execute it. The queries are either SearchTemplates, queries generated dynamically for a given search area when the [SearchTemplate] attribute is used in code, or they can be normal SearchQuery that have been tagged with the Scene Template attribute.

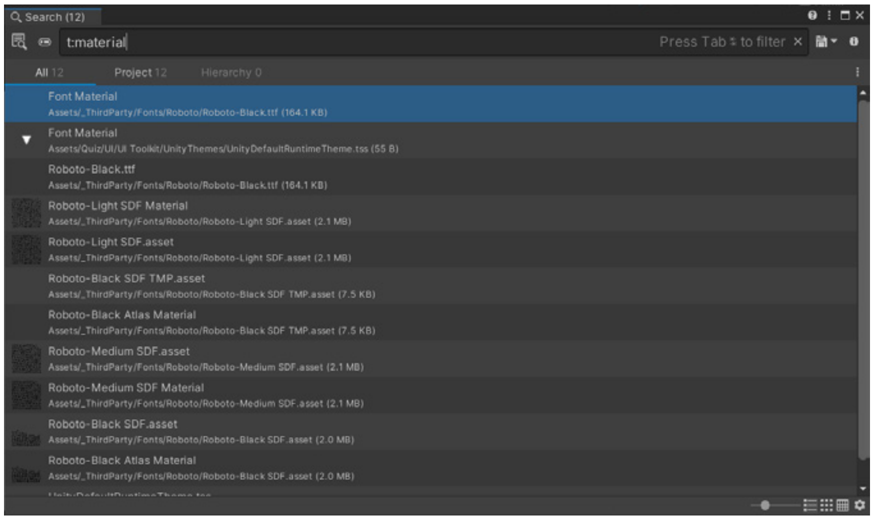
When searching for names, you can also search by type. Use the dropdown to select **Type** or the **t:** shorthand syntax, e.g., t:scene (to search all scenes) or t:texture (to search all textures).



Lighting Settings	Assets/Create/Lighting Settings
URP Global Settings Asset	Assets/Create/Rendering/URP Global Settings Asset
Panel Settings Asset	Assets/Create/UI Toolkit/Panel Settings Asset
Text Settings	Assets/Create/UI Toolkit/Text Settings
Project Settings...	Edit/Project Settings...
Build Settings...	File/Build Settings... (Ctrl+Shift+B)
GI Cache	Preferences/GI Cache
Search	Preferences/Search
Timeline	Preferences/Timeline
Burst AOT Settings	Project/Burst AOT Settings

Search functionality includes support for searching settings and menus.

Additionally, the Search window lets you visualize objects in various ways: Compact list view, big list view or multiple sizes of grid icons. You can also display objects in a table.



t:material

Font Material
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black.ttf (164.1 KB)
Font Material
Assets/Quiz/UI/UI Toolkit/UnityThemes/UnityDefaultRuntimeTheme.tss (55 B)
Roboto-Black.ttf
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black.ttf (164.1 KB)
Roboto-Light SDF Material
Assets/_ThirdParty/Fonts/Roboto/Roboto-Light SDF.asset (2.1 MB)
Roboto-Light SDF.asset
Assets/_ThirdParty/Fonts/Roboto/Roboto-Light SDF.asset (2.1 MB)
Roboto-Black SDF TMP.asset
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black SDF TMP.asset (7.5 KB)
Roboto-Black Atlas Material
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black SDF TMP.asset (7.5 KB)
Roboto-Medium SDF.asset
Assets/_ThirdParty/Fonts/Roboto/Roboto-Medium SDF.asset (2.1 MB)
Roboto-Medium SDF Material
Assets/_ThirdParty/Fonts/Roboto/Roboto-Medium SDF.asset (2.1 MB)
Roboto-Black SDF.asset
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black SDF.asset (2.0 MB)
Roboto-Black Atlas Material
Assets/_ThirdParty/Fonts/Roboto/Roboto-Black SDF.asset (2.0 MB)

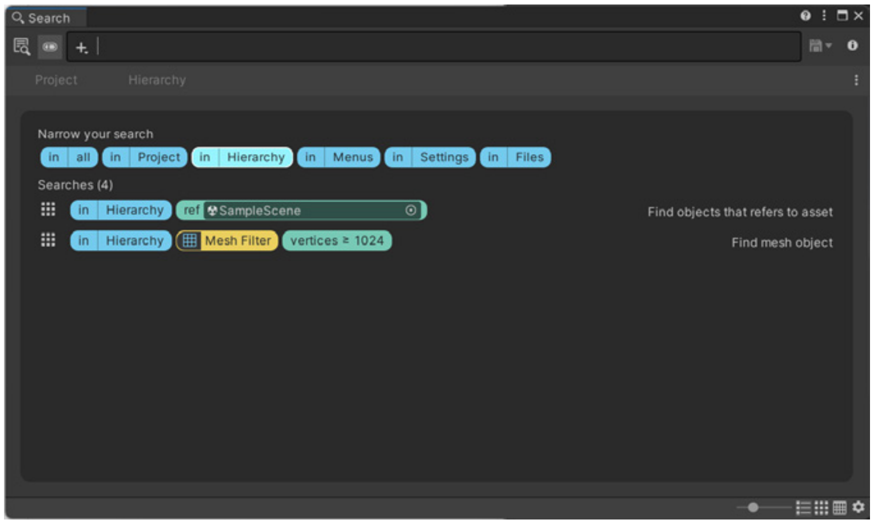
The Search window with queries

This is practical if you want to sort items by names (or description) and especially for extracting properties from SearchItems using a Search Expression and creating a column layout. Additionally, when saving a Search Queries Unity persists all the Search view state, including any column specification. This allows you to create your own "Data Explorer" that is useful to compare multiple property values against one another.

Query Builder

You can type a few characters in the Search window to find objects quickly. But complicated and precise queries are also possible with the rich capabilities of the Search language syntax. However, it can be challenging to remember which filters are available for a specific search area provider or what is the name of a property of a specific type so you can compare it against a threshold value.

The new Query Builder workflow should help you craft complicated queries and explore your project.



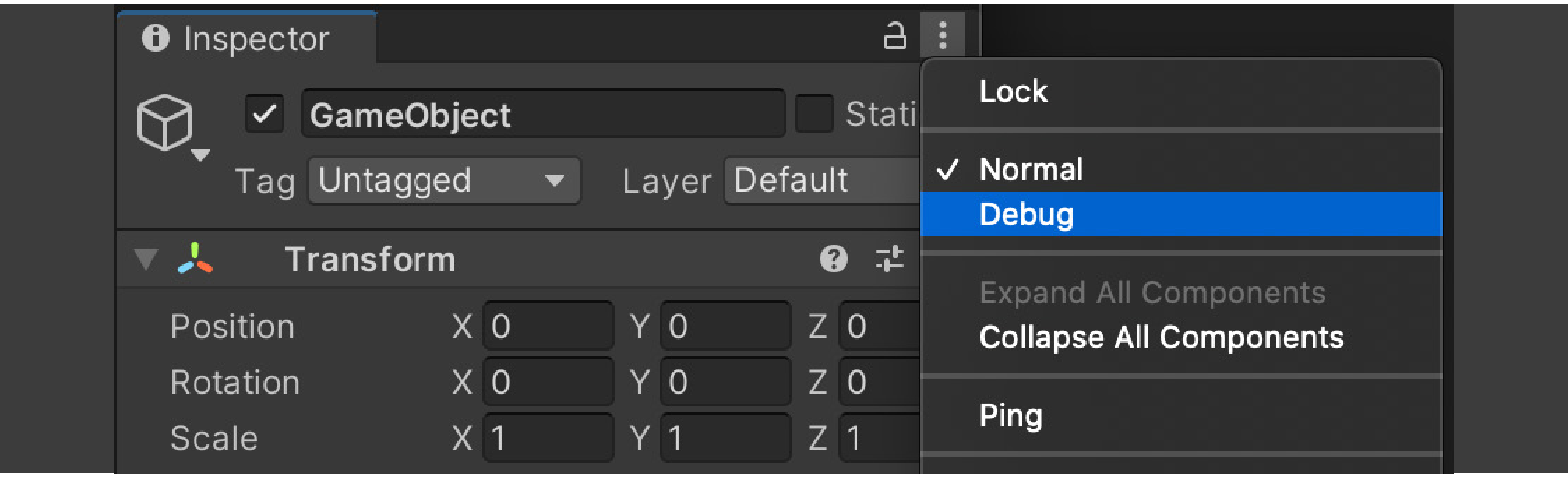
The Query Builder

The Query builder can be activated with the builder toggle (see puzzle button next to the Search Field). Notice how the builder workflow plays well with the new Search Landing page.

Inspector Debug Mode

You can toggle each GameObject's Inspector between Normal and Debug mode. Click the **More Items** (⋮) button to open the context menu and choose the desired mode.

Debug Mode only shows the selected component's properties and their values. It also displays private variables, although you cannot edit them.

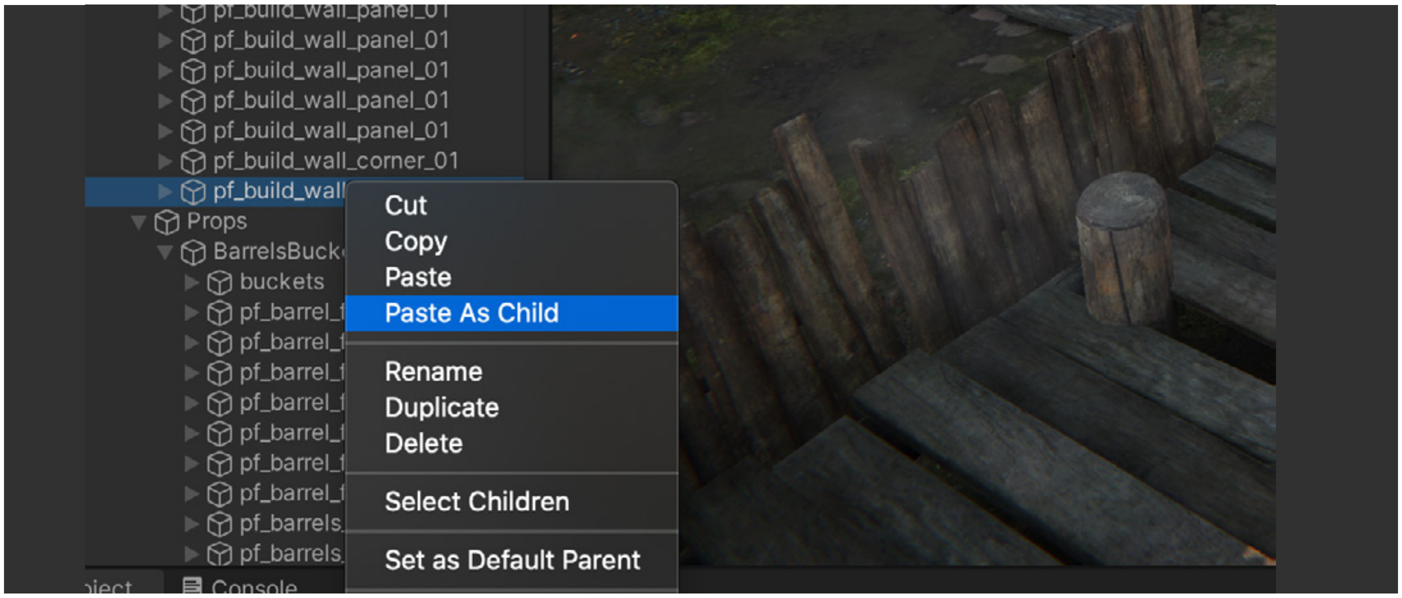


Inspector Debug mode

10 small workflow tips

These 10 small but powerful enhancements will help you further speed things up in the Editor.

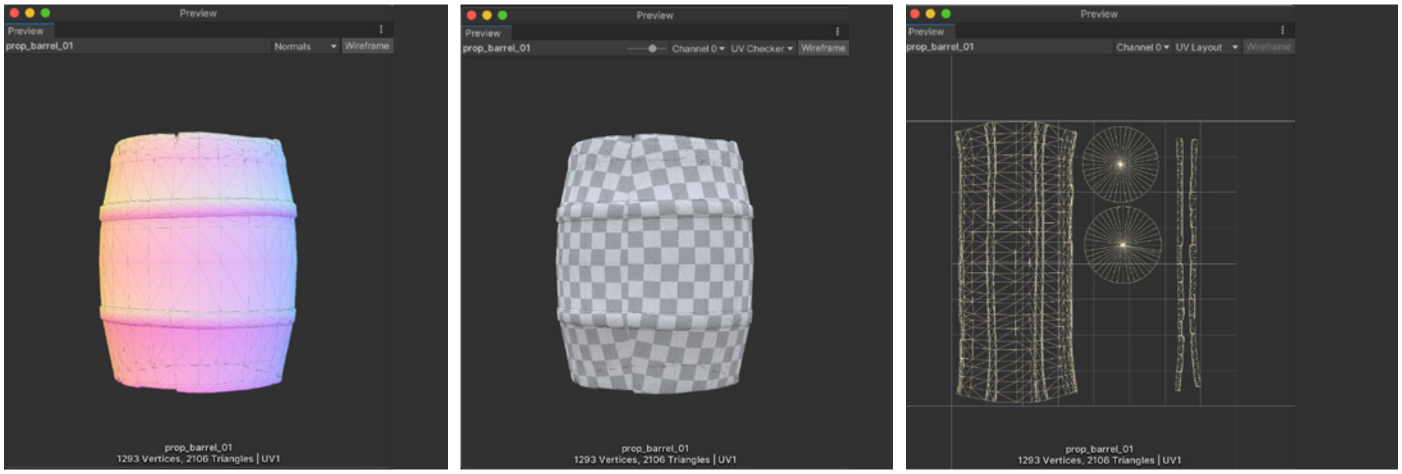
1. Cut and paste GameObjects in the Hierarchy window. You can also **Paste As Child** from the context menu.



Paste As Child

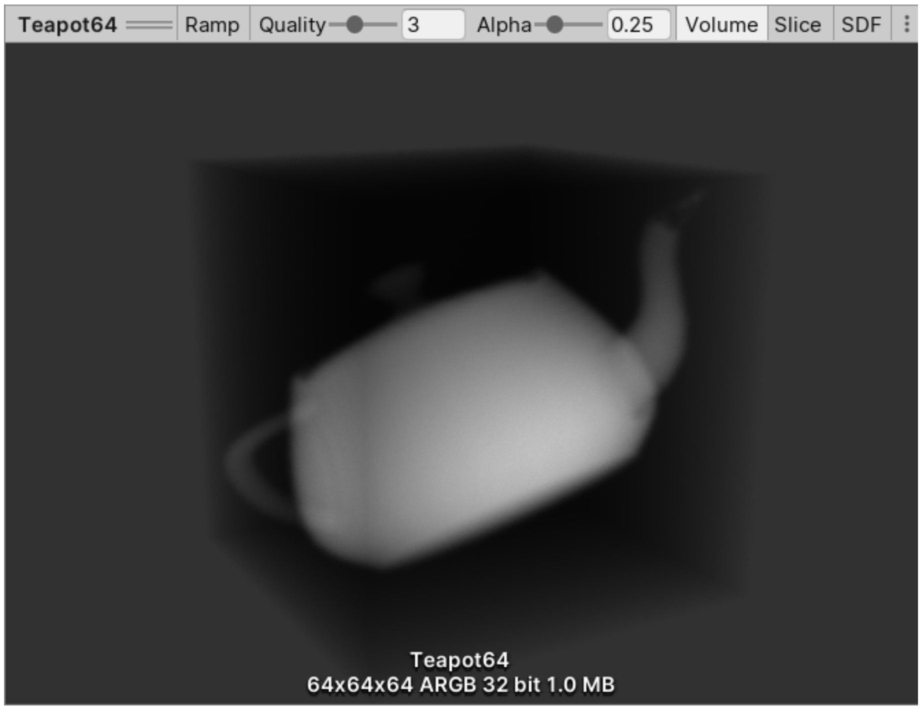
2. Use the **F** shortcut to frame the selected object in Scene View. This now handles more object types and does a better job of framing them. In Play Mode, press **Shift + F** to lock onto a selected GameObject that is moving.

3. Display UVs, normals, tangents, and other Mesh information in the Inspector preview.



The Inspector preview

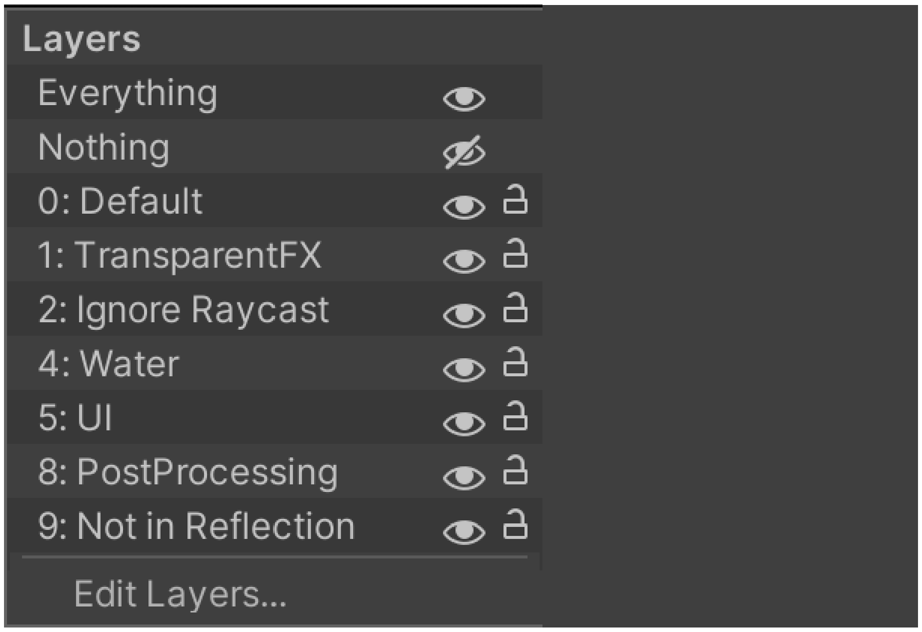
4. See improved Inspector previews for 3D textures, such as volumetric render, 3D texture slices, or a signed distance field.



Teapot64
64x64x64 ARGB 32 bit 1.0 MB

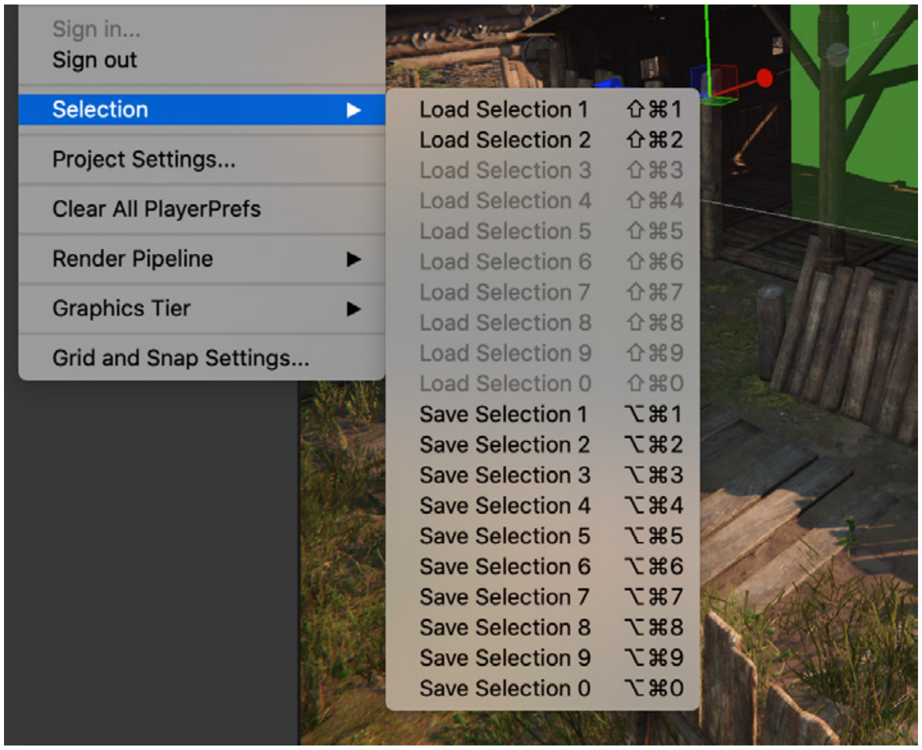
A volumetric render

5. Use the Layers menu to toggle off the visibility of any Layers (such as UI) that may obscure your Scene view. Lock a Layer to avoid changing its state accidentally.



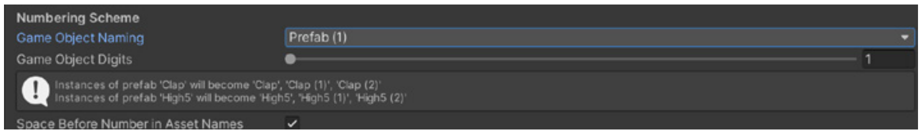
Toggle and edit Layers

6. If you frequently select the same objects in your scene, use the hotkey combos under **Edit > Selection** to quickly save or load a selection set.



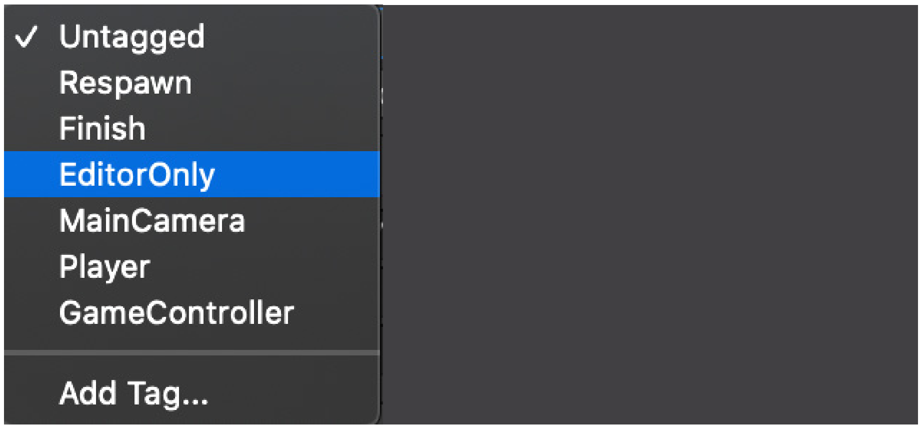
Load and Save Selections

7. Modify the **Numbering Scheme** for duplicate objects in **Project Settings > Editor**.
Define options for the naming here as well as the padding and spacing of the instance number.


Numbering Scheme
Game Object Naming: Prefab (1)
Game Object Digits: 1
Instances of prefab 'Clap' will become 'Clap', 'Clap (1)', 'Clap (2)'
Instances of prefab 'High5' will become 'High5', 'High5 (1)', 'High5 (2)'
Space Before Number in Asset Names: ✓

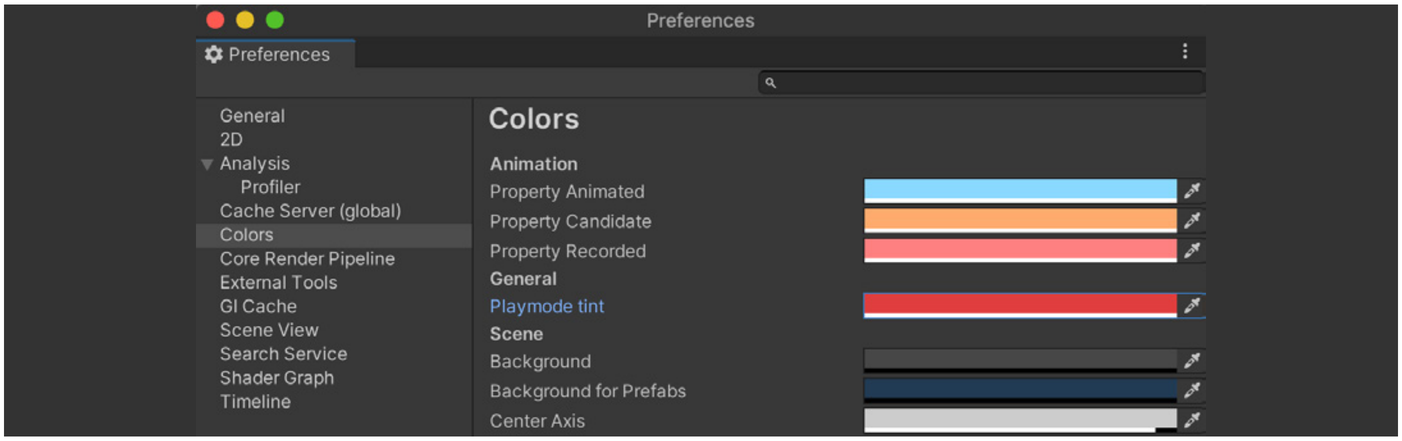
Numbering Scheme

8. Use the **EditorOnly** tag to designate GameObjects that will not appear in a build of the application.



EditorOnly

9. Change colors in the Editor via **Unity > Preferences > Colors** to find certain UI elements or objects more quickly in Editor. Adjust the Playmode tint to remind yourself when Play Mode is active, so you don't lose any changes you intended to save on exit.



Preferences

General
2D
Analysis
Profiler
Cache Server (global)
Colors
Core Render Pipeline
External Tools
GI Cache
Scene View
Search Service
Shader Graph
Timeline

Colors

Animation

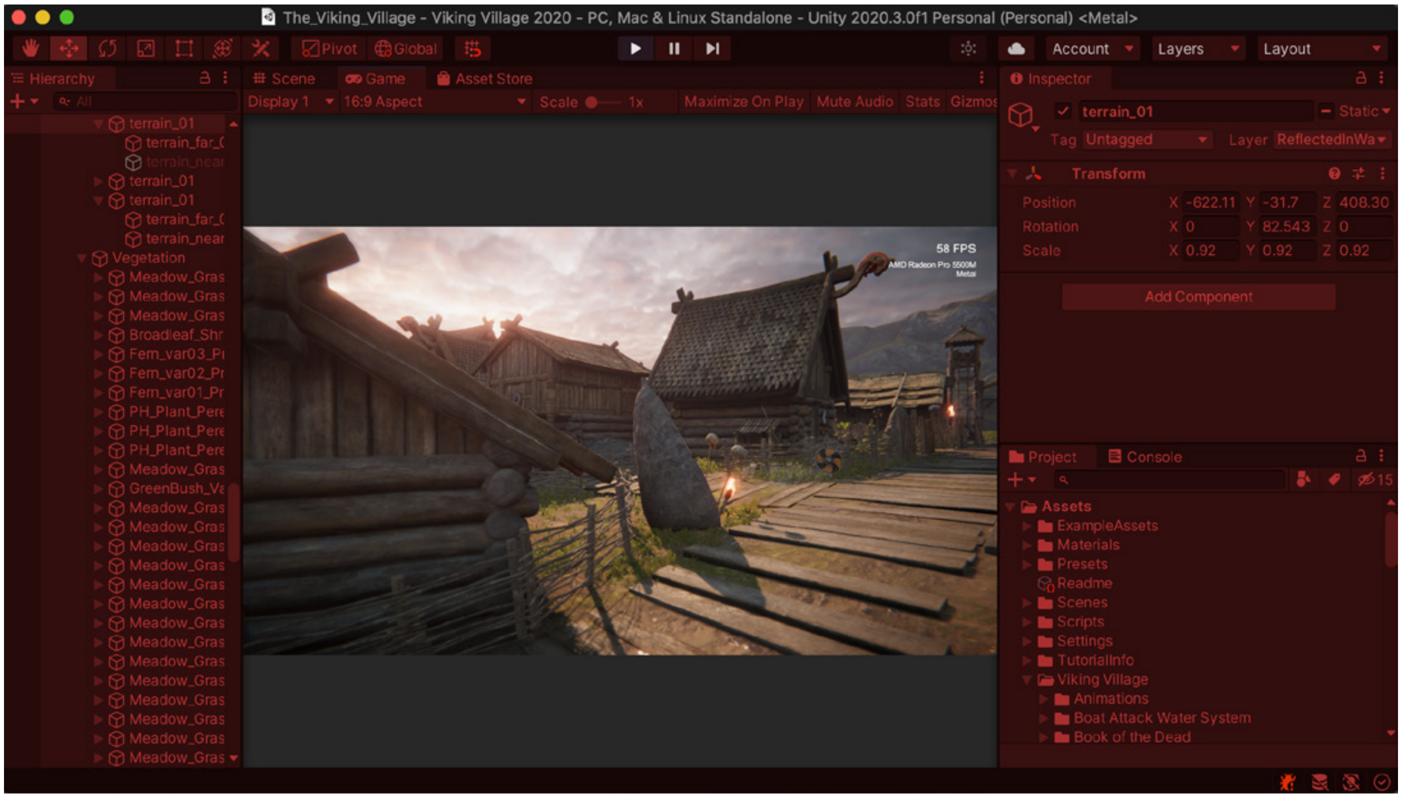
Property Animated	🟦
Property Candidate	🟧
Property Recorded	🟥

General

Playmode tint	🟥

Scene

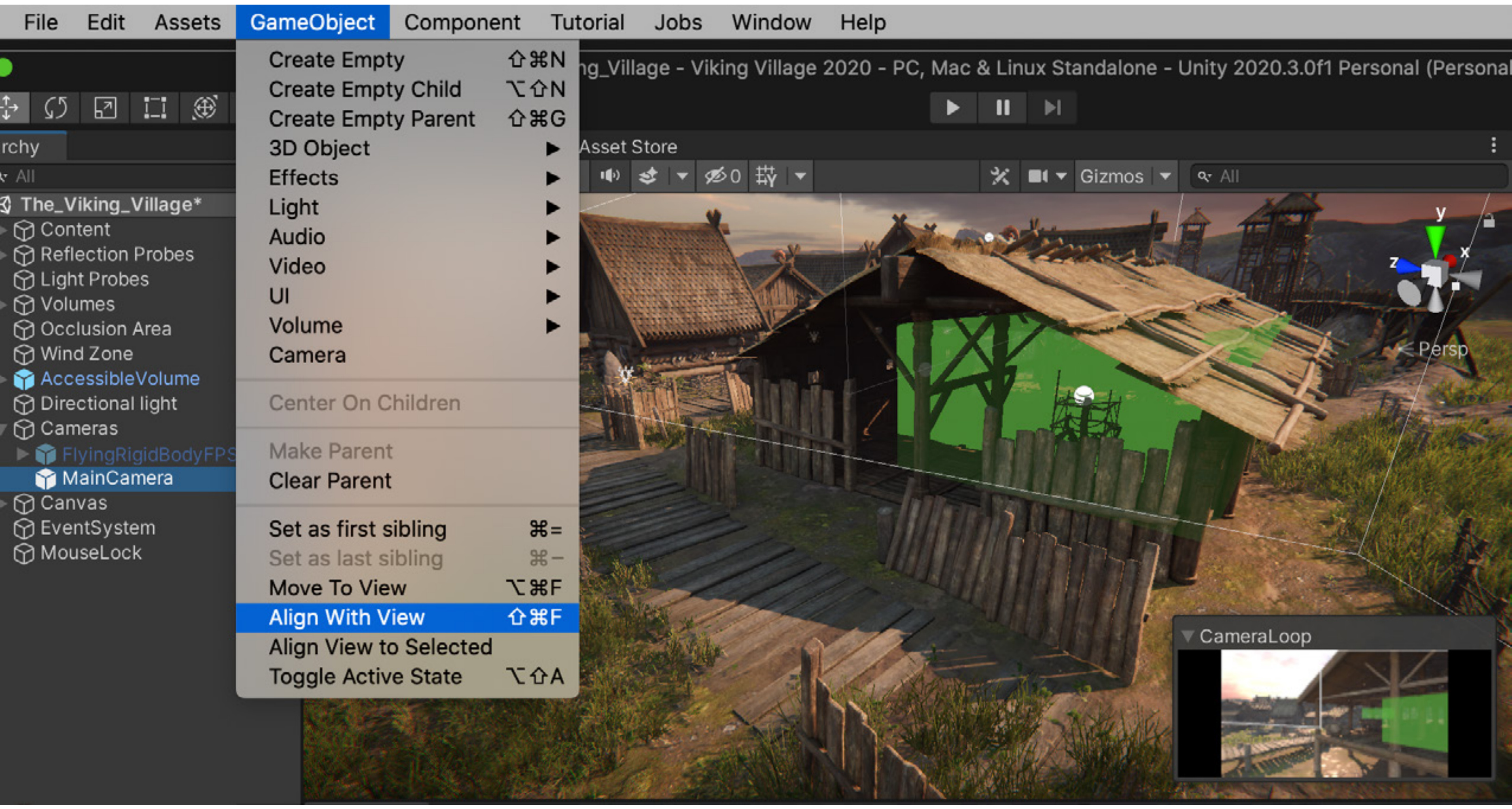
Background	⬛
Background for Prefabs	🟦
Center Axis	⬜



Playmode tint

In the event that you make a change in Play Mode that you want to keep, use the **More Items** (⋮) button. Copy the component or transform values while playing, then paste from the clipboard upon exiting Play Mode. Alternatively, if you have multiple component changes, drag out a temporary Prefab to save your work there.

10. When you set up cameras, use **GameObject > Align With View** to line up your Game camera with the Scene camera. Or, if you're matching the other way around, use **Align View to Selected** to align the Scene camera with another camera in the Hierarchy.



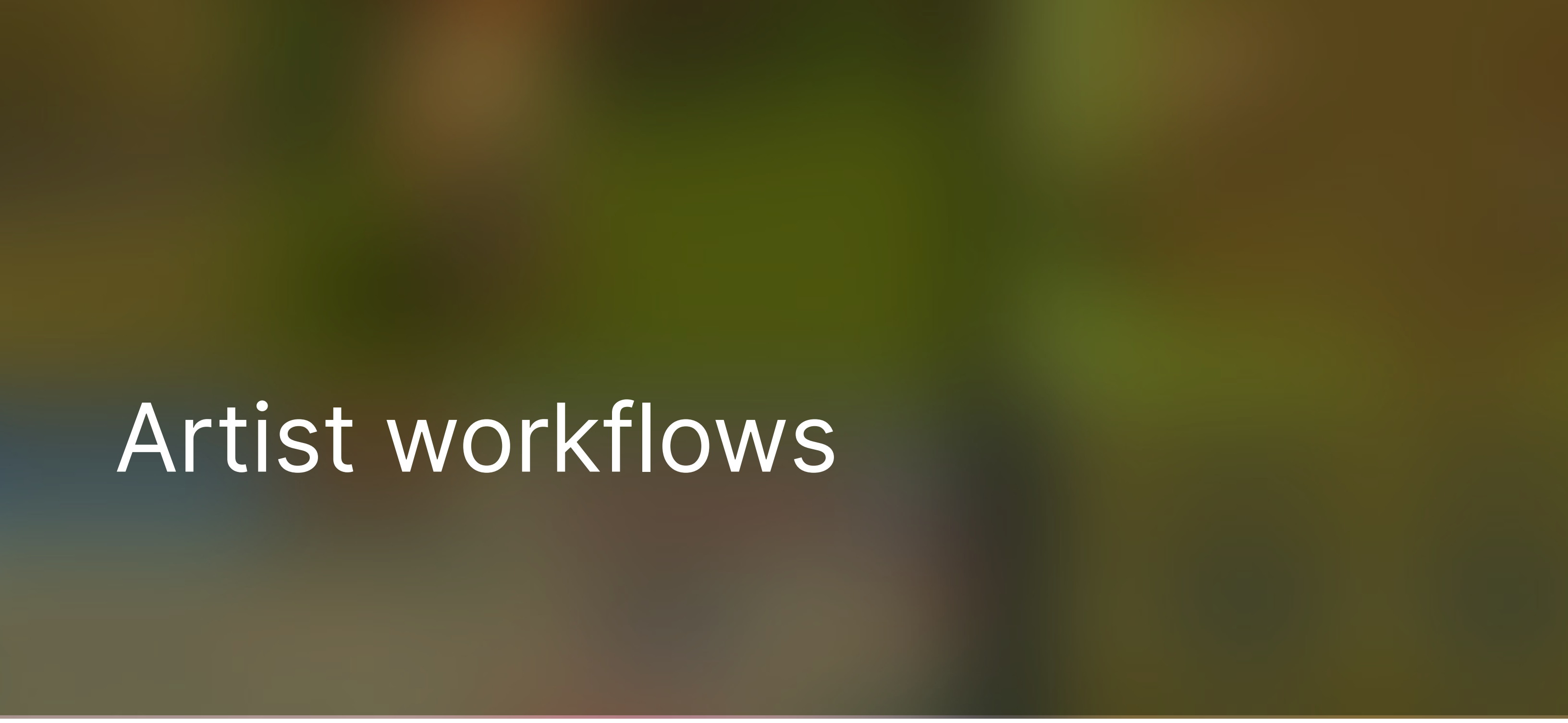
Align With View

More resources

— Advanced Editor scripting hacks to save you time: Part I

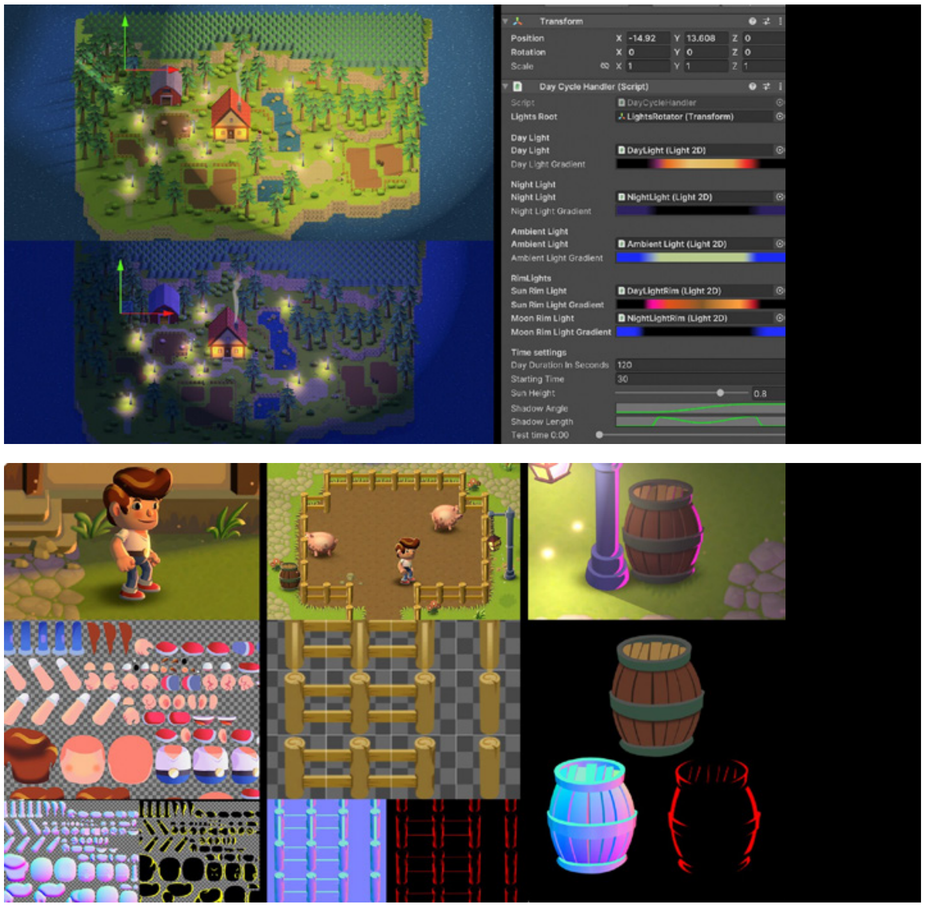
— Advanced Editor scripting hacks to save you time: Part II

— Speed up your productivity with the Unity Hub



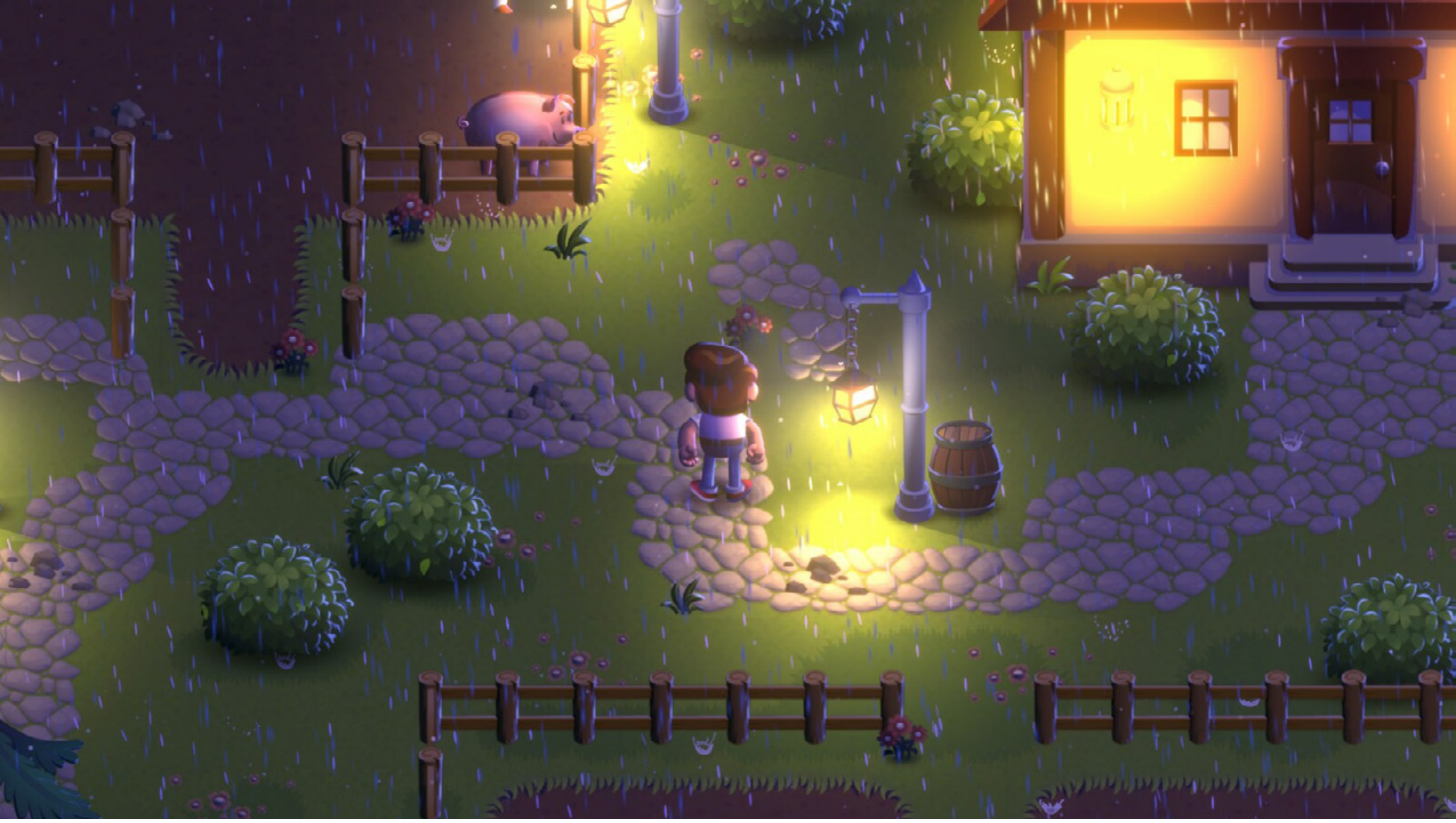
Artist workflows

There are many ways that 2D and 3D artists, animators, and level designers can save time in Unity and work more efficiently with in-context iteration. In Unity 2022 LTS specifically, there are smoother workflows for customizing the Editor with UI Toolkit, advanced new options for visual quality and performance with HDRP and URP, improvements to 2D tools, and more. See the Unity 2022 release notes for a comprehensive list of new features, improvements, and fixes.



```
Transform
Position        X -14.92   Y 13.608   Z 0
Rotation        X 0        Y 0        Z 0
Scale           X 1        Y 1        Z 1
Day Cycle Handler (Script)
Script                      DayCycleHandler
Lights Root                 LightsRotator (Transform)
Day Light
Day Light                   DayLight (Light 2D)
Day Light Gradient
Night Light
Night Light                 NightLight (Light 2D)
Night Light Gradient
Ambient Light
Ambient Light               Ambient Light (Light 2D)
Ambient Light Gradient
RimLights
Sun Rim Light               DayLightRim (Light 2D)
Sun Rim Light Gradient
Moon Rim Light              NightLightRim (Light 2D)
Moon Rim Light Gradient
Time settings
Day Duration In Seconds     120
Starting Time               30
Sun Height                  0.8
Shadow Angle
Shadow Length
Test time 0.00
```

The 2D art for Happy Harvest


Happy Harvest, now available on the Unity Asset Store, harnesses the latest capabilities for creating 2D lights, shadows, and special effects with URP in Unity 2022 LTS.

2D artist tips

Many of the 2D tips and improvements outlined here are used in Happy Harvest, a demo of a 2D top-down farming simulation game that shows what's possible with 2D lights, shadow effects, skeletal animation, sprite libraries, visual effects, and more in Unity 2022 LTS.

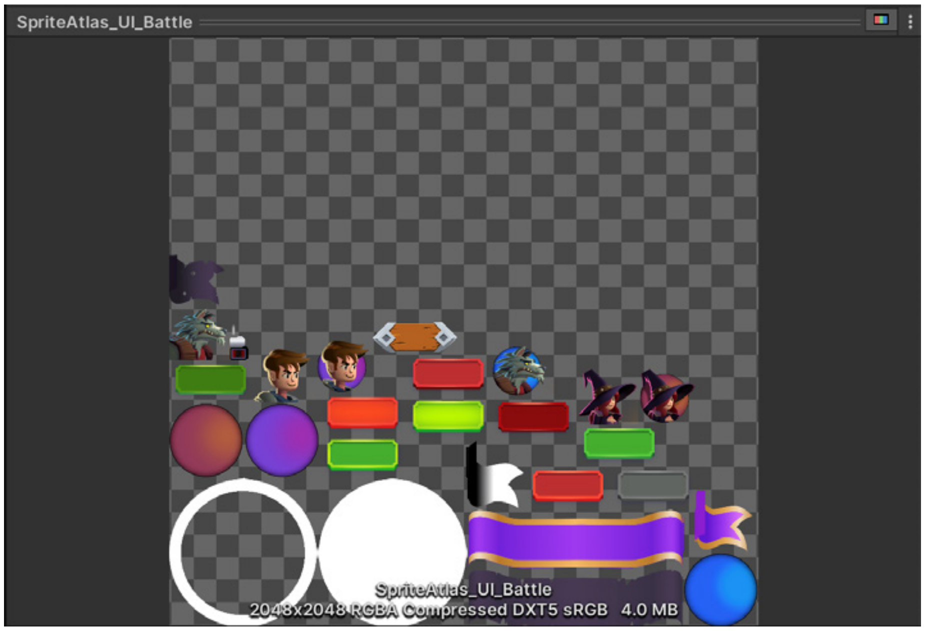
A series of in-depth articles are available to read alongside the demo. These articles explain how to create the 2D visuals in *Happy Harvest* so you can add them to your own projects:

1. 2D light and shadow techniques in the Universal Render Pipeline
2. How to animate 2D characters in Unity 2022 LTS
3. How to create art and gameplay with 2D tilemaps
4. 2D special effects with the VFX Graph and Shader Graph

Finally, you can explore many more 2D art and optimization techniques in the e-book *2D game art, animation, and lighting for artists*.

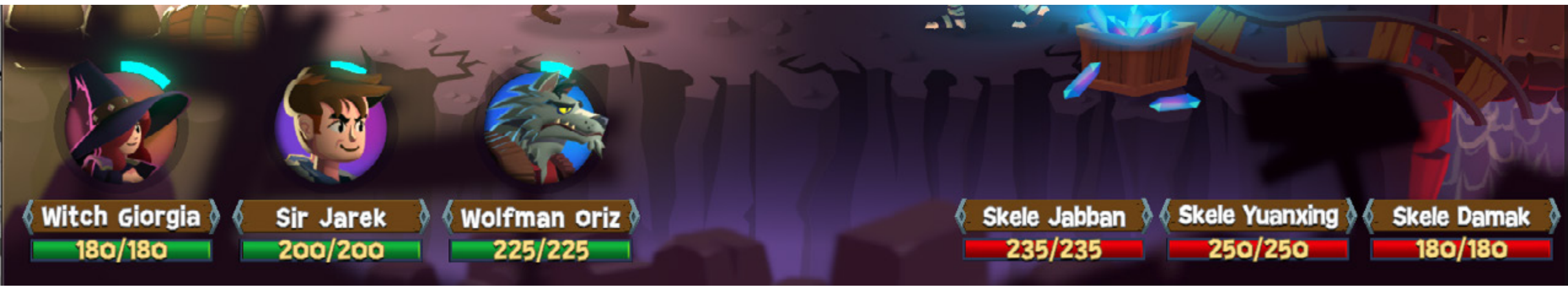
1. A 2D project uses Sprites to create its visuals. These potentially contain many Texture assets and may thus require many draw calls. To optimize resources, use a **Sprite Atlas** (**Asset > Create > Sprite Atlas**) rather than rendering individual Sprites and Textures.

   Sprite Atlas V2 is out of preview in Unity 2022 LTS, fully working in the Editor, allowing users to experience the benefits of atlassing sprites without entering Play mode or making a build. It also supports Unity Accelerator, and, as of 2021.2, it provides full support for folders as packable objects. Sprite Atlas V2 uses the functionalities exposed by AssetDatabase V2 (ADBV2), such as Cache Server support.



A Sprite Atlas packs several Sprites into a single combined Texture.

   Add Sprites into the Objects for Packing list, and enable include in build to include your Sprites with the project. Use the Packing options to determine how closely the Sprites can be laid out in the atlas and whether they can be rotated. Once the Textures are consolidated, Unity can issue a single draw call to access the packed Textures with a smaller performance overhead.

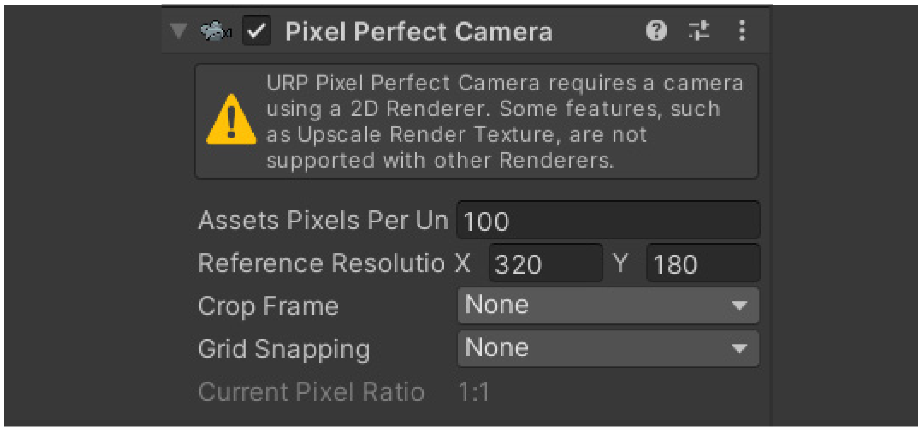


In Unity's UI system, atlasing and the GameObject structure matter for batching.

2. A SpriteAtlas can reduce draw calls if you organize the UI layout correctly. Unity scans the GameObjects' Hierarchy top to bottom in order to batch objects that use the same texture and material. See our guide on Unity UI optimization tips for more best practices.

The SpriteAtlas API provides additional control at runtime. You can also create a Variant Sprite Atlas or prepare the Sprite Atlases for an alternate form of distribution with Late Binding in a script.

3. The 2D Pixel Perfect Package contains a Pixel Perfect Camera that ensures your pixel art remains crisp and clear at different resolutions, so you can avoid manual scaling of your art assets.



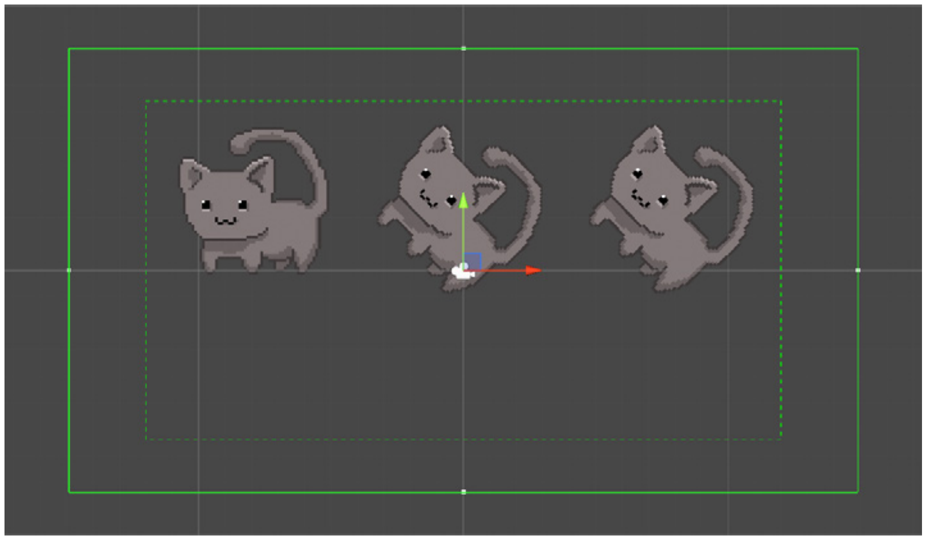
Pixel Perfect Camera

URP Pixel Perfect Camera requires a camera using a 2D Renderer. Some features, such as Upscale Render Texture, are not supported with other Renderers.

Assets Pixels Per Un 100
Reference Resolutio X 320 Y 180
Crop Frame None
Grid Snapping None
Current Pixel Ratio 1:1

Pixel Perfect Camera

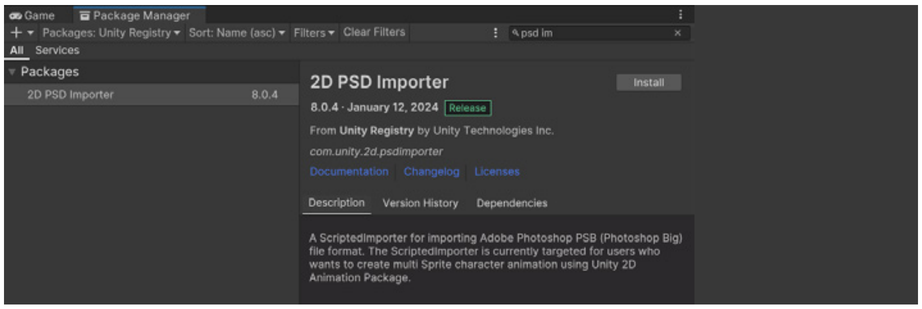
Read how SouthPAW Games created their first pixel art game using Unity's 2D tools in **2D Pixel Perfect for a crisp conquest in *Skul: The Hero Slayer***.



The 2D Pixel Perfect Camera

4. Use the PSD Importer Package if you want to work with Photoshop file assets, both .PSD and .PSB files. Skip exporting separate sprites, and import a **.PSD** or **.PSB** file. This allows you to import multiple sprites from the various layers and generate a Sprite Sheet or 2D Character Rig. See this guide on speeding up your 2D workflows with the PSD Importer.

   In Unity 2022 LTS, you can control which layers to import from a Photoshop file by selecting them from a tab in the PSD Importer Inspector. You can also set padding between sprites in mosaic mode.



2D PSD Importer

8.0.4 · January 12, 2024

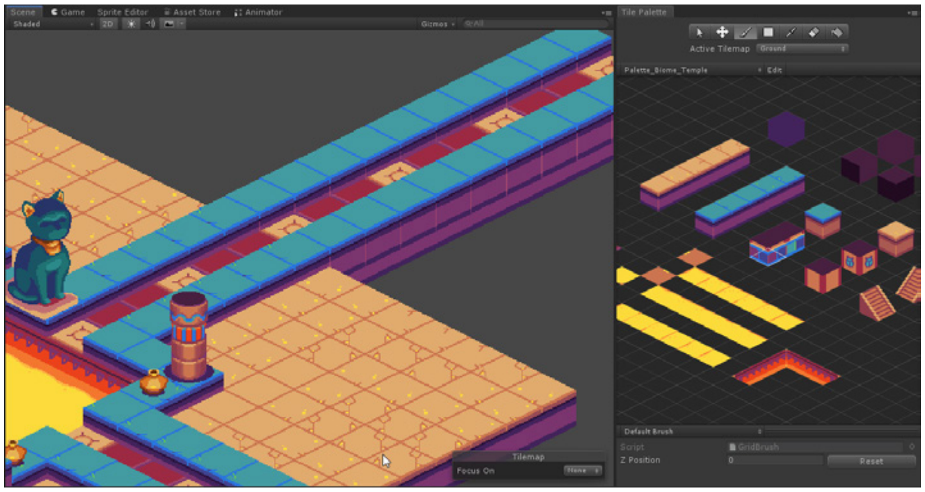
From Unity Registry by Unity Technologies Inc.

com.unity.2d.psdimporter

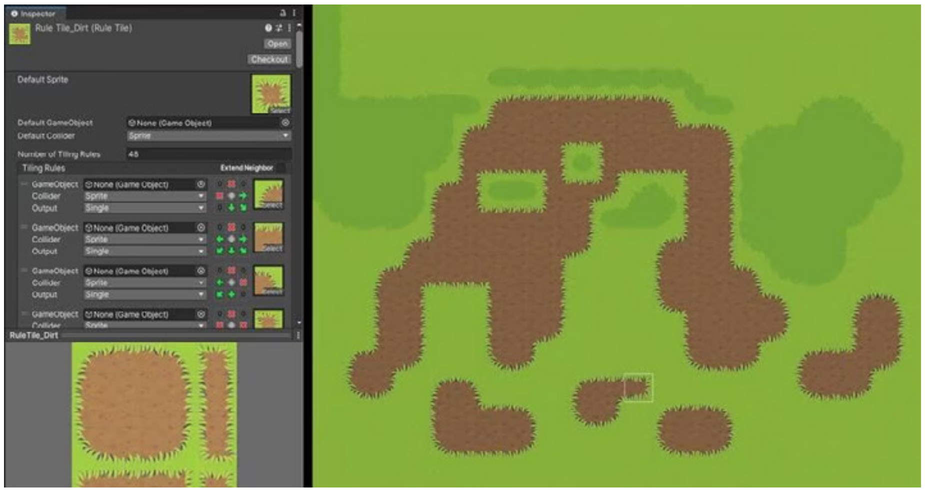
A ScriptedImporter for importing Adobe Photoshop PSB (Photoshop Big) file format. The ScriptedImporter is currently targeted for users who wants to create multi Sprite character animation using Unity 2D Animation Package.

The 2D PSD Importer is available in the Package Manager.

5. Use Tilemaps to create large grid-based worlds, including hexagonal and isometric versions, optimized for size and performance. Get more tips from How to create art and gameplay with 2D tilemaps.

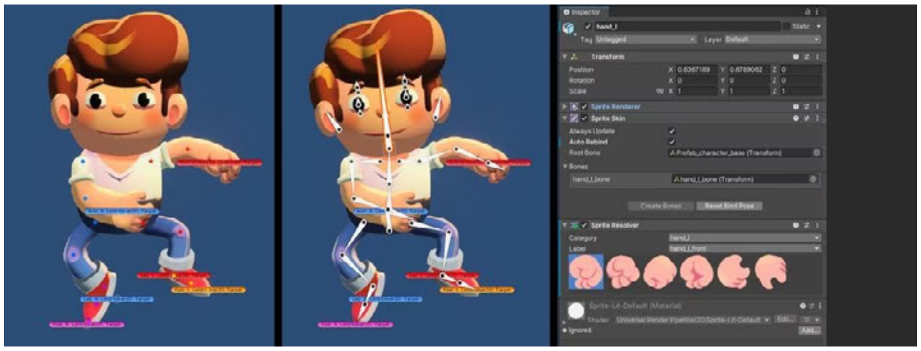


Tilemaps can describe isometric or other grid-like environments.

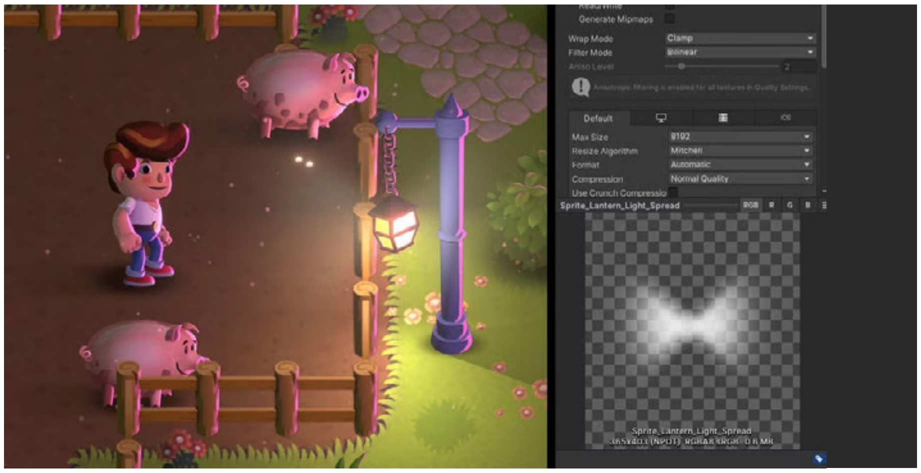


Setting up rule tiles in *Happy Harvest*

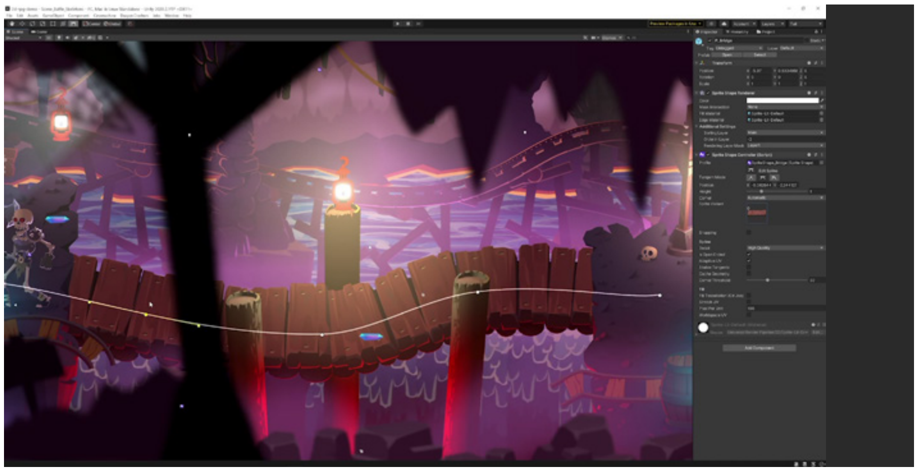
6. Create smooth 2D skeletal animation with rigging, tessellation, and bone creation. 2D Inverse Kinematics (IK) simplifies animation, calculating how your 2D bones can reach their target destination. Learn more in How to animate 2D characters in Unity 2022 LTS.


Animating the main character in *Happy Harvest* with 2D IK Solvers: The left image shows modifying the position of the bones and rotation, while the center and right images show changing the sprite for the hand with Sprite Resolver.

7. Enhance your visuals with 2D Lights. Lights feature easy-to-configure parameters like light colors, intensity, fall-off, and blending effects. Get additional tips on 2D lighting from this article by Martin Reinmann of Odd Bug Studio, and this page on 2D light and shadow techniques in the Universal Render Pipeline.


Using a sprite with a halo around a hanging lamp

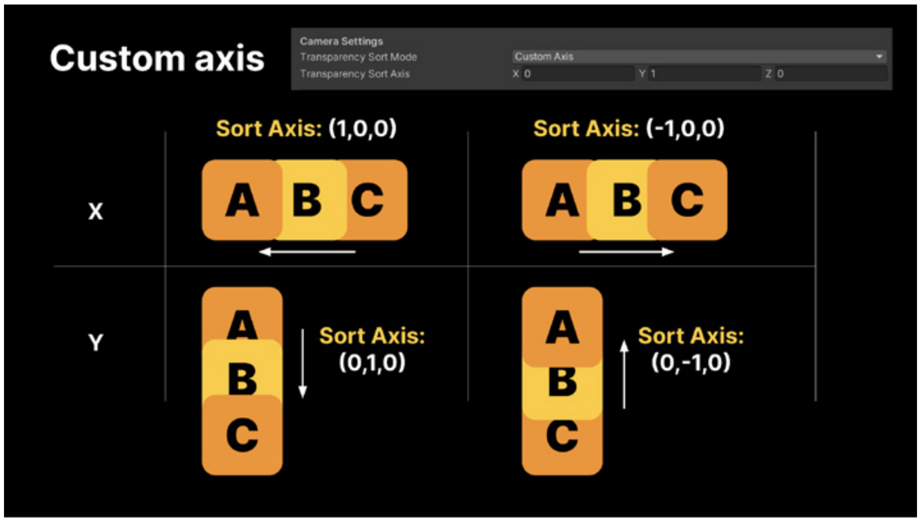
8. 2D Sprite Shape gives you the freedom to create rich free-form 2D environments with a visual and intuitive workflow. It tiles Sprites along a shape's outline, automatically deforming and swapping them based on the outline angle.


One example of how 2D Sprite Shape is used in the latest 2D sample project

Sort your Sprites based on your preferred direction. This can be helpful if you have a number of Sprites within the same layer and sorting order (imagine a card game where the individual cards overlap a bit).

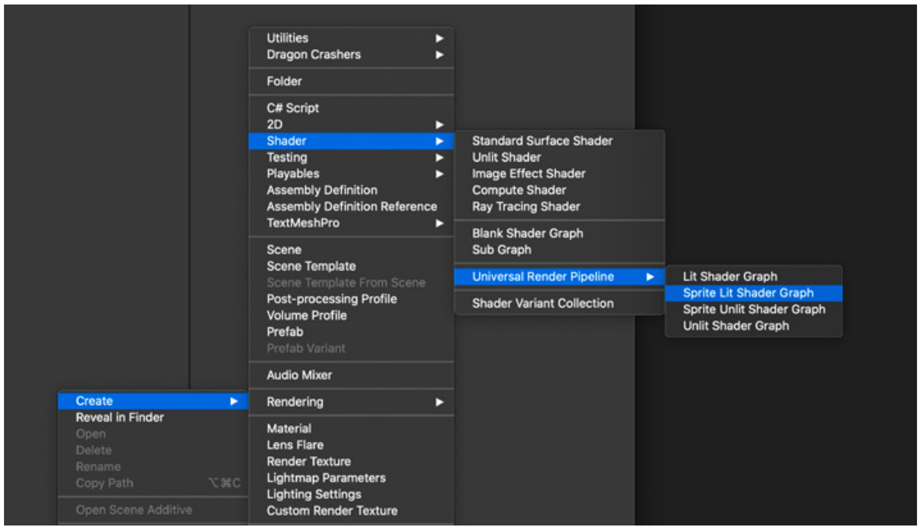
In the built-in render pipeline, look in **Edit > Project Settings > Graphics**. Choose **Custom Axis** for the **Transparency Sort Mode**. For example, use (0, 1, 0) for the **Transparency Sort Axis** to sort along the Y axis from top to bottom.

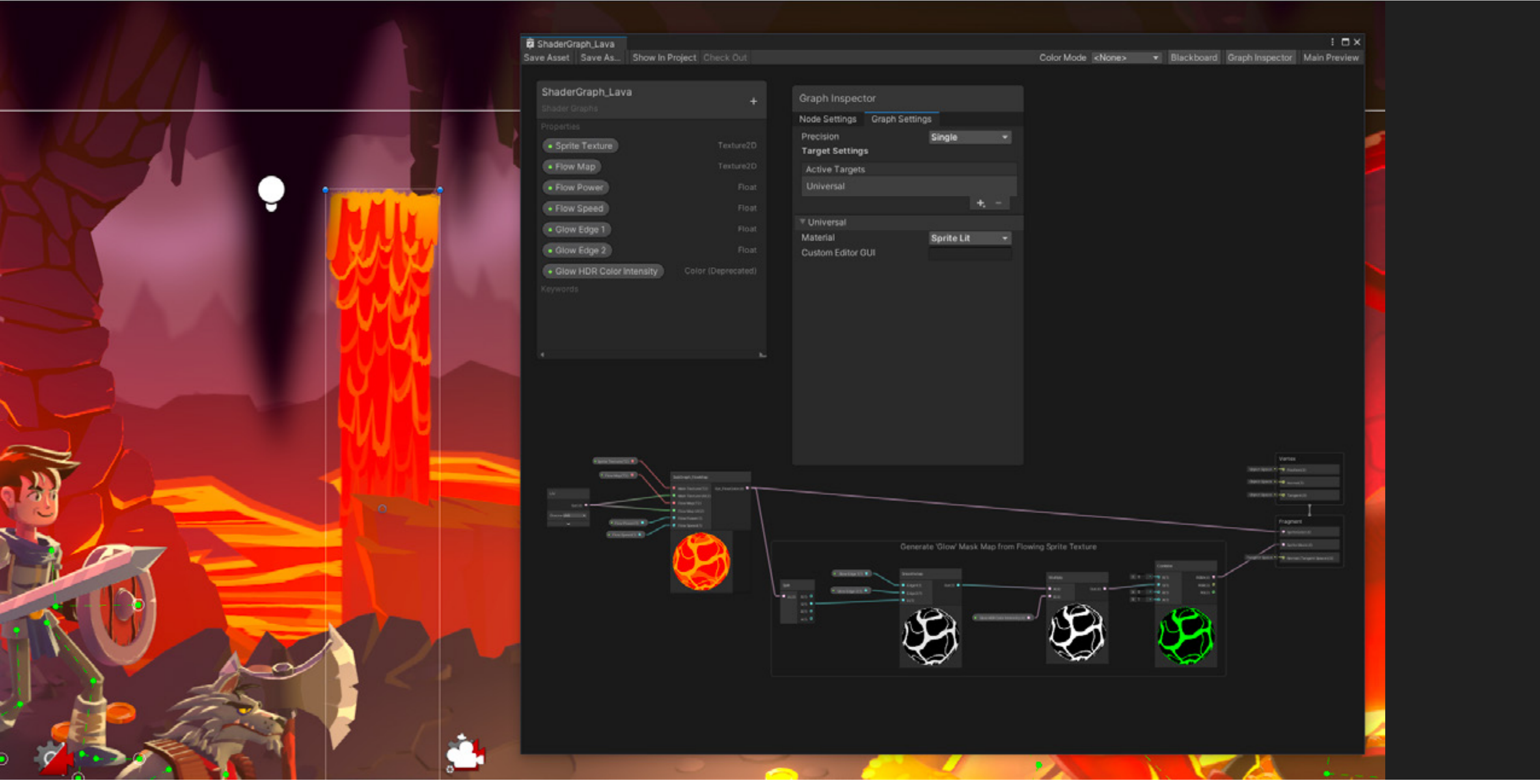
In the Universal Render Pipeline, set the **Camera.transparencySortMode** to **TransparencySortMode.CustomAxis**, then set your axis using **Camera.transparencySortAxis**.


Camera Settings
Transparency Sort Mode: Custom Axis
Transparency Sort Axis: X 0 Y 1 Z 0

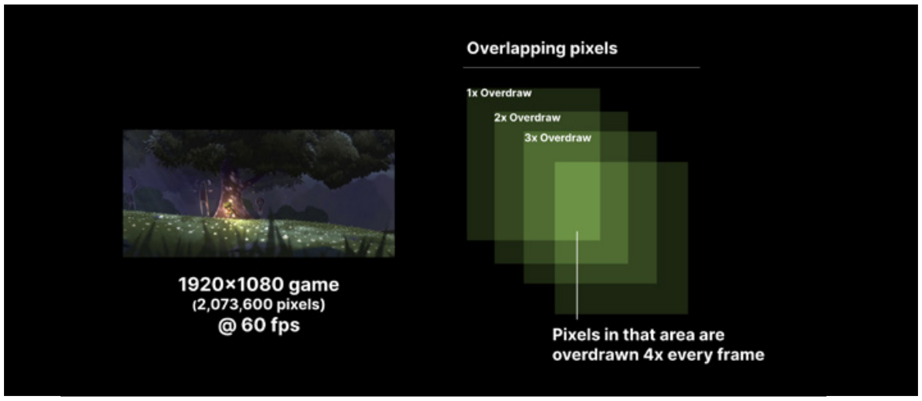
Transparency Sort Mode and Sort Axis

9. Need custom shaders? Shader Graph includes two MasterNodes designed for 2D: **Sprite Lit** and **Sprite Unlit**. Create 2D shaders, and enhance your 2D project visually. In Unity 2022 LTS, VFX Graph supports 2D. Add your 2D-based Shader Graphs in your graph Output and leverage the power of the GPU to render millions of particles.

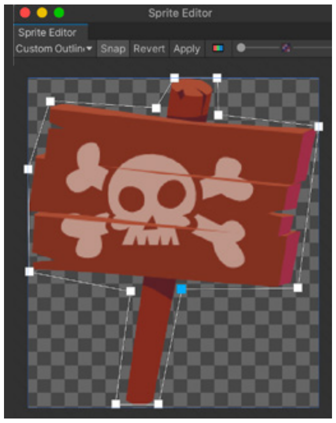



Shader Graph example from *Dragon Crashers*

10. Avoid overdraw to improve performance. Switch the **Mesh Type** to **Tight** in the Import Settings for each Sprite. Merge overlapping graphics in a single Sprite whenever possible, and try to disable Sprites that could be in a background layer with no use in the game. This reduces the overdraw area and potential overlap with neighboring Sprites.



Reduce overdraw between Sprites

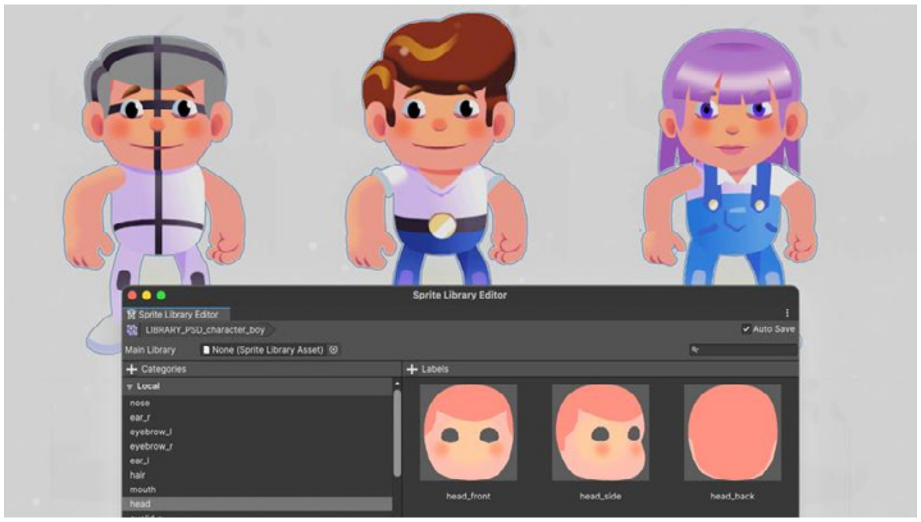


11. You can also consider defining a custom outline around each Sprite using the 2D Sprite Editor to minimize the unused areas. In 2022 LTS the Sprite Library Editor provides a more efficient way to manage Sprite Libraries, with improved performance for larger sets of content.

The Sprite Editor with a custom outline

12. Sprite Swap is a feature that enables you to change a GameObject's rendered Sprite at runtime. This has a number of uses, such as easily creating multiple characters which share a skeleton (requires the PSD Importer package) or reuse existing bone and Mesh data while looking visually different.

    Unity 2022 LTS brings improvements to the Sprite Swap workflows with streamlined Sprite Swap keyframing in the Animation window.



Swapping sprite libraries from the initial dummy character in *Happy Harvest* to a male and female variation that share the same categories and labels.

13. Other improvements for 2D animators in Unity 2022 LTS are Sprite deformation and IK Solvers in Animation preview windows. There is also an added Character Pivot tool in the Skinning Editor. You can use the new asset upgrading tool to upgrade older Sprite Library Assets and Animation Clips to the latest version.

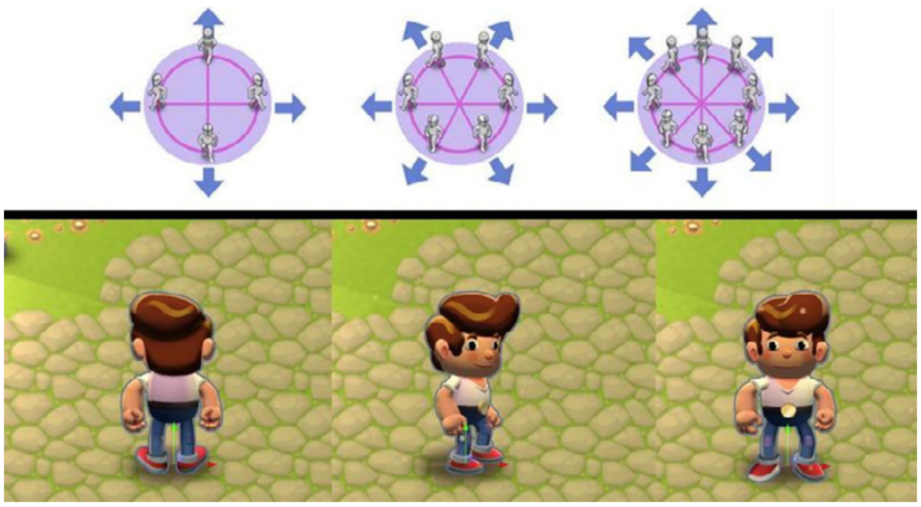
Pro 2D tips from the creators of *Happy Harvest*

— Draw the character in a neutral position with arms and legs straight. If parts of the body are bent, it can cause issues when you're animating.

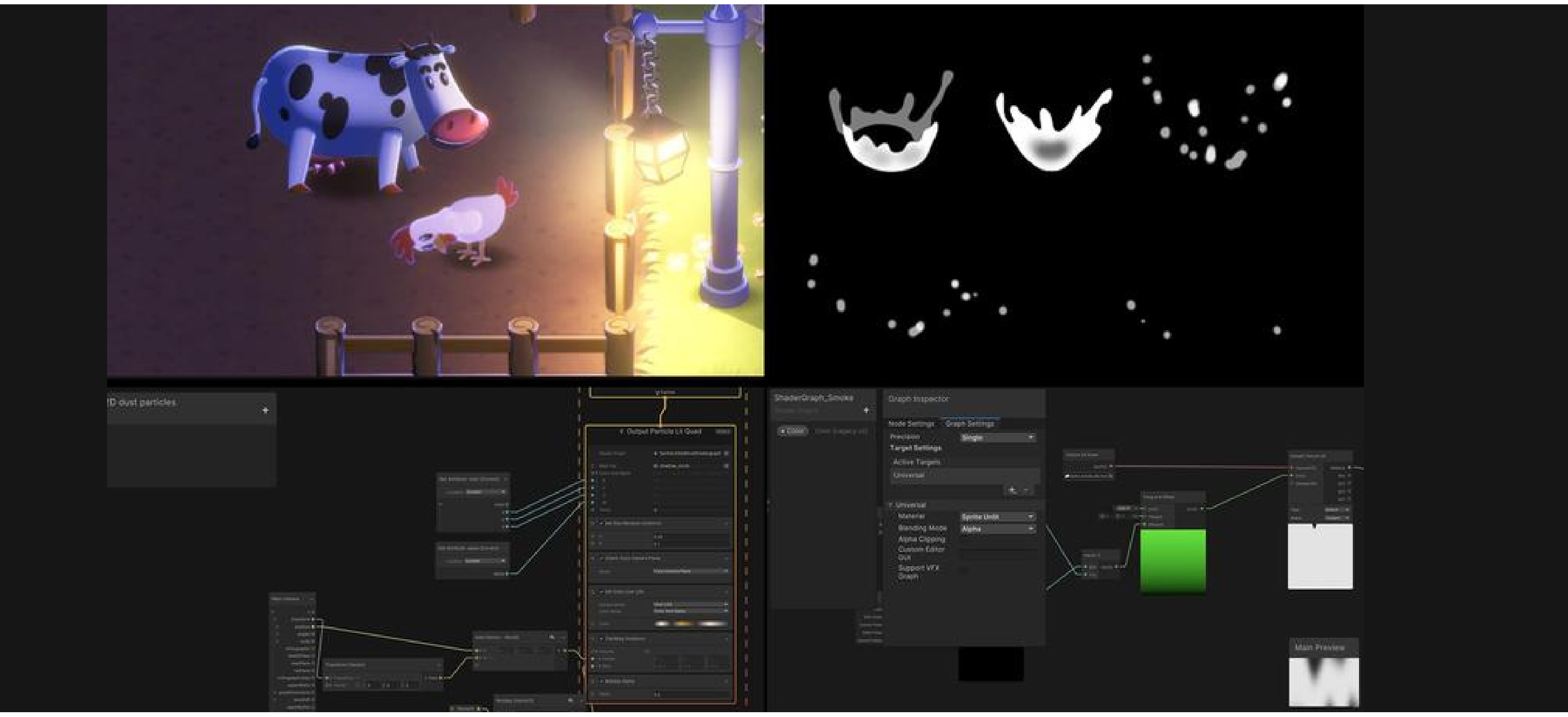
— Make the resolution a little higher than your game's Pixels per Unit (PPU) suggests. A resolution might look good at rest, but rotating and stretching images can cause pixelation.

— If you're using 2D lighting extensively in your game and want to make the most of normal maps, don't paint the light and shadow onto your sprite. Instead, paint nondirectional shadows. This technique is called ambient occlusion. Your sprite will look better, but you'll want to avoid using any directional light like sunlight.

— Body part layers swapped using the Sprite Swap feature should be grouped accordingly. For example, all layers with mouth positions should be placed in a group called "mouth" in the image-editing app.


There are a number of possibilities for character rotation in a 2D top-down or isometric game. The bottom image shows animations of the main character facing three different directions.

- Often, a simple setup with 2D IK will work well for a decorative element. That's what was done for the pig prefab from *Happy Harvest*. Another example of a simple background animation is the swinging movement of the street lamps in *Happy Harvest*, that's achieved with an animation clip that plays in a loop and only changes the rotation of the sprite over time, without the need for rigging.
- Flipbook, or frame-by-frame, animation is a fast method for animating minor background characters with less overhead because it involves fewer frames. It's also well suited to the water splash effect.
- In *Happy Harvest*, the water effect and the breeze moving the bushes and trees are special effects created with the Shader Graph and VFX Graph.



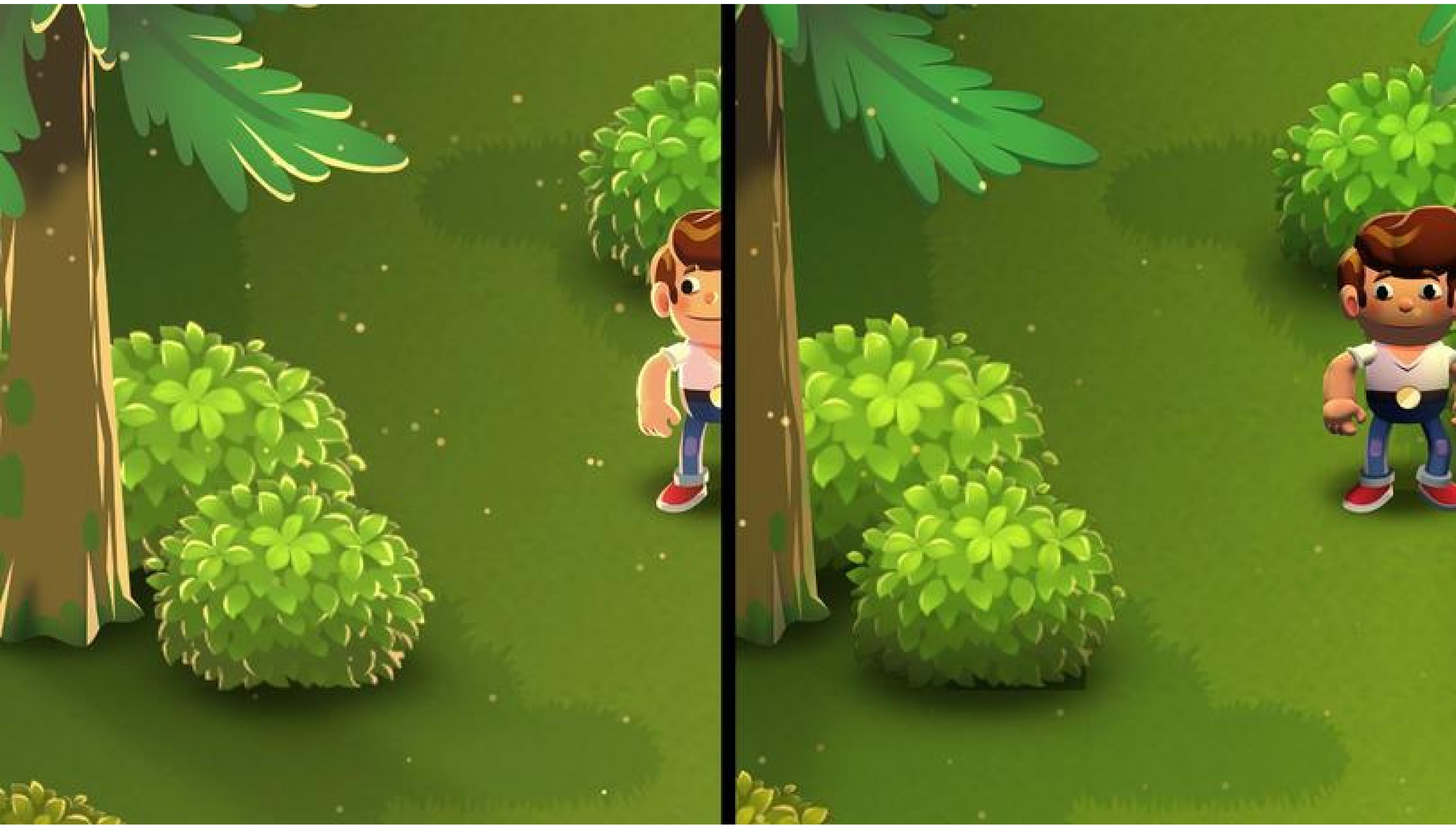
Animating elements with different techniques, including simple animations, frame-by-frame, and effects created with the Shader Graph and VFX Graph

— Secondary Textures: Mask maps can be used to control where lights can affect a sprite. Mask maps help polish your game by enabling you to add details to your visuals. They're also used by the 2D Light Blend Styles.

— Lights and normal maps are used everywhere in *Happy Harvest* to create the illusion of volume. You can use normal maps with Spot, Point, and Freeform lights. Remember that you need to enable normal maps in the light object to use them in the sprites (two quality settings are available: Fast and Accurate).

— By default, 2D lights produce light by adding RGB values to the affected pixels. The higher the RGB values, the lighter the color is. However, if you change the Blend Style to Multiply, those RGB values are subtracted from the affected pixels, resulting in a darker color that simulates a shadow. You can then adjust these simulated shadows, also called negative lighting, via the same controls for lighter 2D lights.

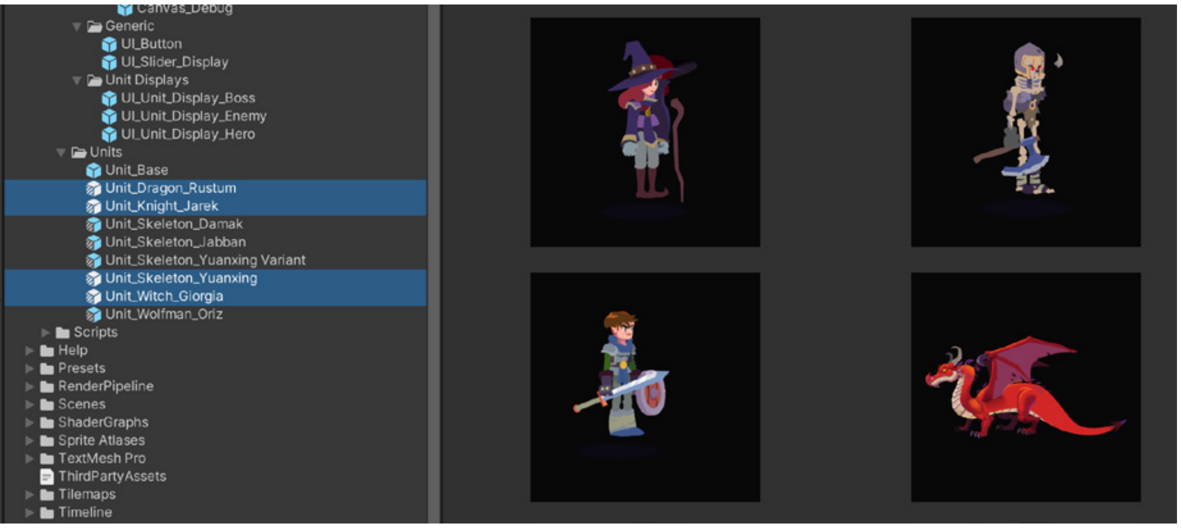
— A quick and easy way to fake shadows is with a blob shadow, a blurred sprite that also uses negative lighting, which you can stretch to represent the ambient occlusion that an object produces on the ground.



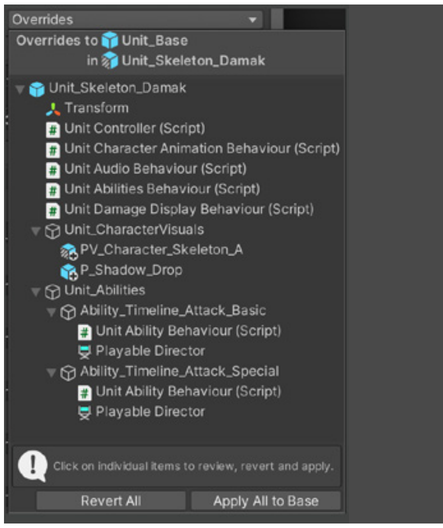
The bushes in *Happy Harvest* appear to have depth thanks to normal maps (enabled by the normal map option in the Light component).

Prefab workflows

Prefabs allow fully configured GameObjects to be saved in the project for reuse. The current workflow with Prefabs lets you build your scenes flexibly and efficiently.



In *Dragon Crashers*, each unit overrides the base unit.

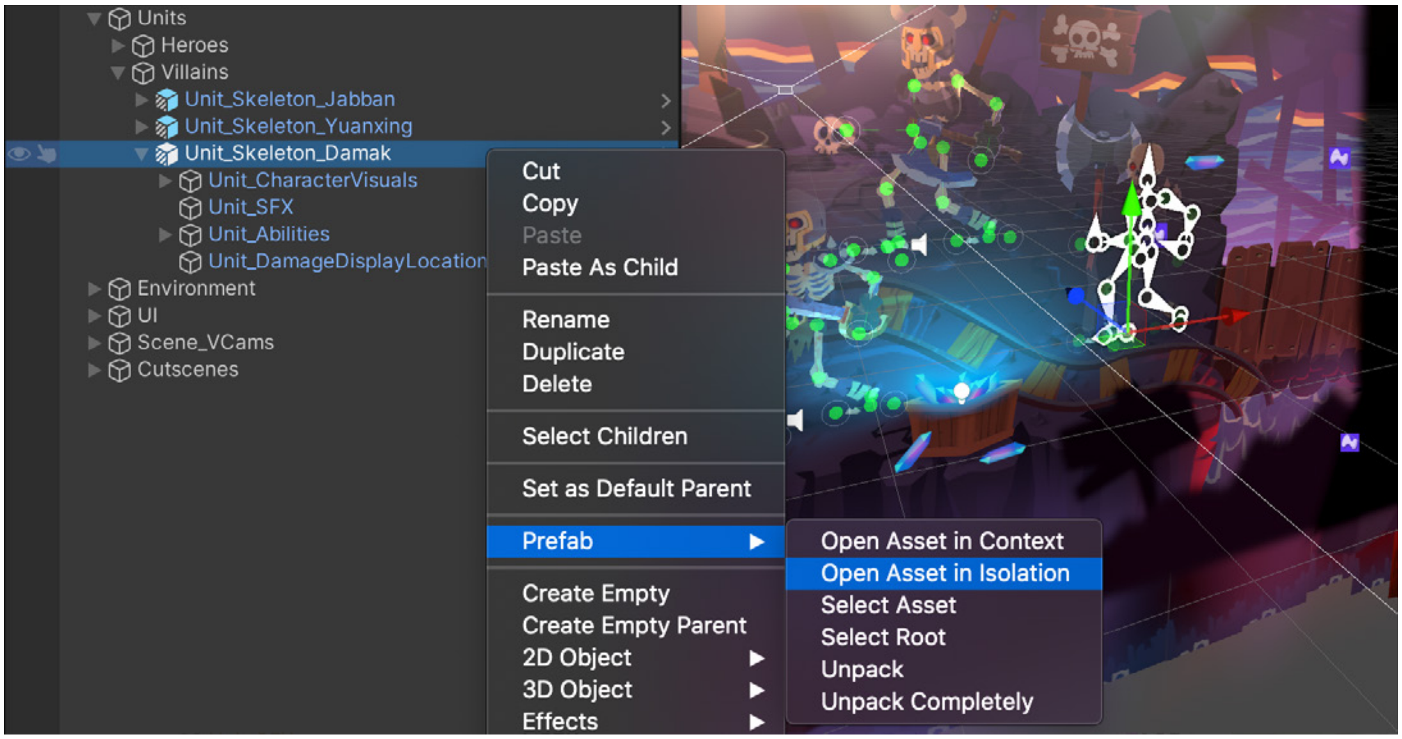


Overrides
Overrides to Unit_Base
in Unit_Skeleton_Damak
Unit_Skeleton_Damak
Transform
Unit Controller (Script)
Unit Character Animation Behaviour (Script)
Unit Audio Behaviour (Script)
Unit Abilities Behaviour (Script)
Unit Damage Display Behaviour (Script)
Unit_CharacterVisuals
PV_Character_Skeleton_A
P_Shadow_Drop
Unit_Abilities
Ability_Timeline_Attack_Basic
Unit Ability Behaviour (Script)
Playable Director
Ability_Timeline_Attack_Special
Unit Ability Behaviour (Script)
Playable Director
Revert All
Apply All to Base

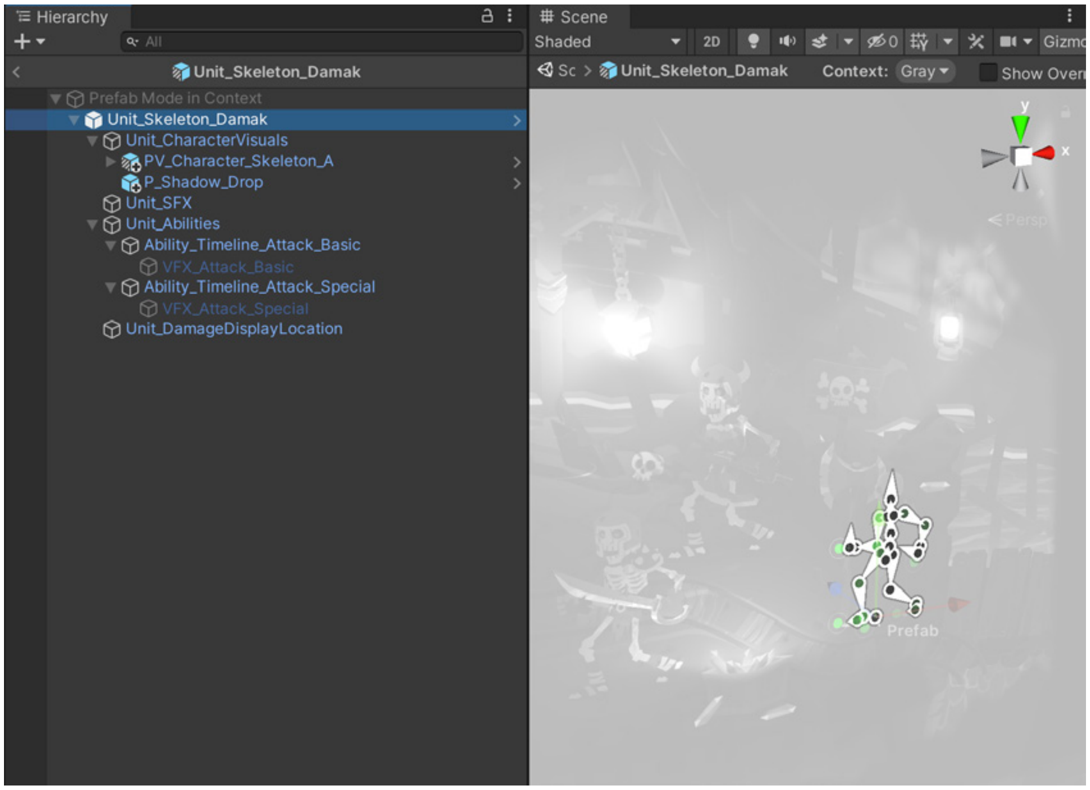
Click on individual items to review, revert and apply.

The Overrides dropdown shows how the Prefab differs from the original.

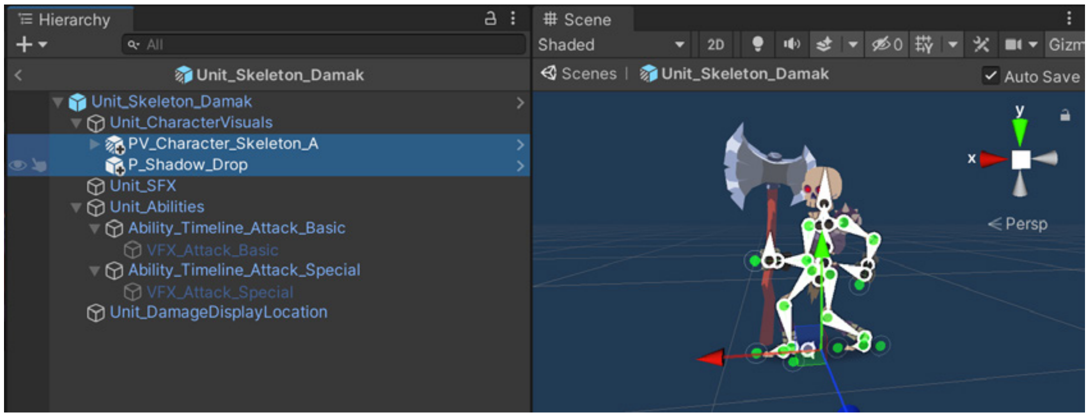
Create your Prefab as an Asset in the Project, then edit it in isolation in **Prefab mode**. Working with the Prefab by itself helps prevent applying unintended overrides. Make your changes with confidence with the background grayed out.



Edit each Prefab, either in Context or in Isolation.



Edit in Context mode to see the Prefab relative to the other objects in the Scene.

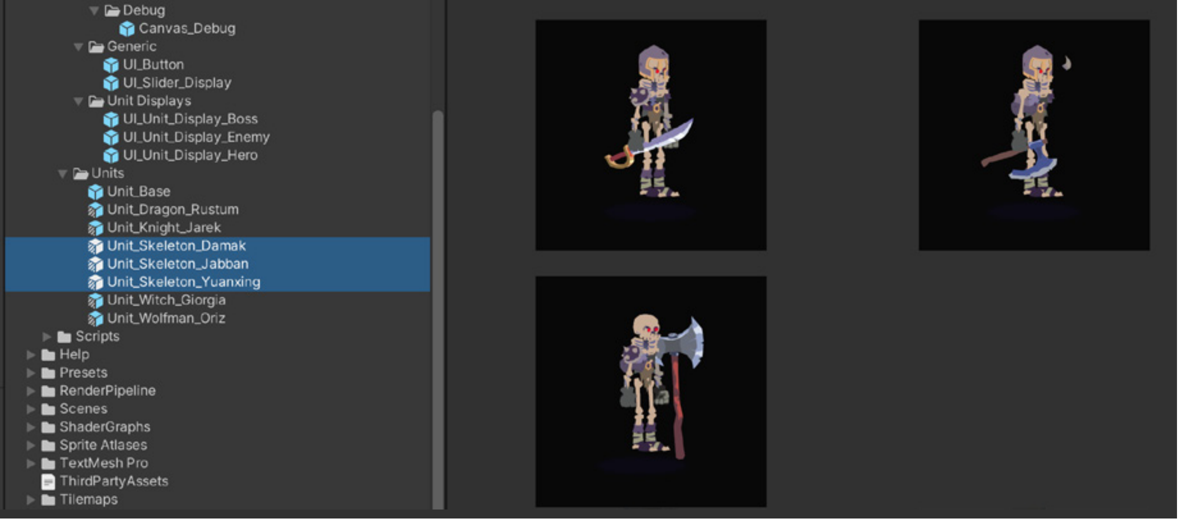


Isolate the Prefab in Prefab mode to avoid unintended overrides. Note how smaller prefabs make up this Nested Prefab.

Nested Prefabs allow you to parent Prefabs to one another. You can now create a larger Prefab, such as a building, composed of smaller Prefabs for the rooms and furniture. This makes it efficient to split development of your assets over a team of multiple artists and developers, who can all work on different parts of the content simultaneously.

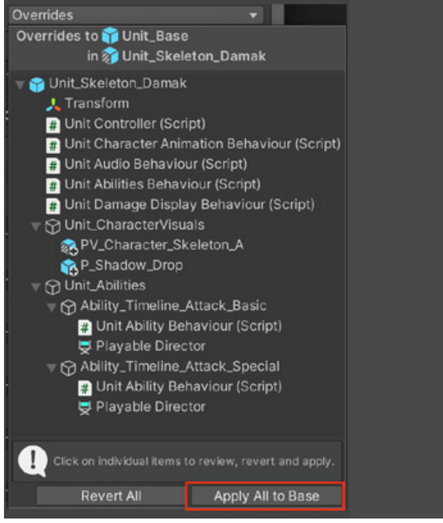
A **Prefab Variant** allows you to derive a Prefab from other Prefabs, much like inheritance in object-oriented programming. To change the Variant, just override certain parts without worry of impacting the original. You can also remove all modifications and revert to the base Prefab at any time.

Alternatively, if you want to change all of your Variants at once, apply changes directly onto the base Prefab itself.



```
Debug
  Canvas_Debug
Generic
  UI_Button
  UI_Slider_Display
Unit Displays
  UI_Unit_Display_Boss
  UI_Unit_Display_Enemy
  UI_Unit_Display_Hero
Units
  Unit_Base
  Unit_Dragon_Rustum
  Unit_Knight_Jarek
  Unit_Skeleton_Damak
  Unit_Skeleton_Jabban
  Unit_Skeleton_Yuanxing
  Unit_Witch_Giorgia
  Unit_Wolfman_Oriz
Scripts
Help
Presets
RenderPipeline
Scenes
ShaderGraphs
Sprite Atlases
TextMesh Pro
ThirdPartyAssets
Tilemaps
```

In *Dragon Crashers*, these Prefab Variants have different weapons and abilities.



```
Overrides
Overrides to Unit_Base
      in Unit_Skeleton_Damak
Unit_Skeleton_Damak
  Transform
  Unit Controller (Script)
  Unit Character Animation Behaviour (Script)
  Unit Audio Behaviour (Script)
  Unit Abilities Behaviour (Script)
  Unit Damage Display Behaviour (Script)
  Unit_CharacterVisuals
    PV_Character_Skeleton_A
    P_Shadow_Drop
  Unit_Abilities
    Ability_Timeline_Attack_Basic
      Unit Ability Behaviour (Script)
      Playable Director
    Ability_Timeline_Attack_Special
      Unit Ability Behaviour (Script)
      Playable Director
Click on individual items to review, revert and apply.
Revert All    Apply All to Base
```

Use **ApplyAll to Base** to propagate changes to the Base object or **Revert All** to undo the overrides.

See Unity documentation for more information about working with Prefabs.

Material Variants

Materials play a crucial role in rendering by determining how an object reflects or emits light. They can make an object look like metal, glass, wood, or even something abstract or magical. A material contains a reference to a shader object. If that shader object defines material properties, then the material can also contain data, such as colors or texture references.

In Unity 2022 LTS, Material Variants allow for the reuse and improved management of materials that share most surface properties.

With Material Variants, you can create templates or material prefabs. Based on a base template, you can create variants that share common properties with the template material and override only the properties that differ. If you change common and non-overridden properties in the template material, the changes automatically reflect in the variant material. You can also lock certain properties on material so they can't be overridden in the variants.

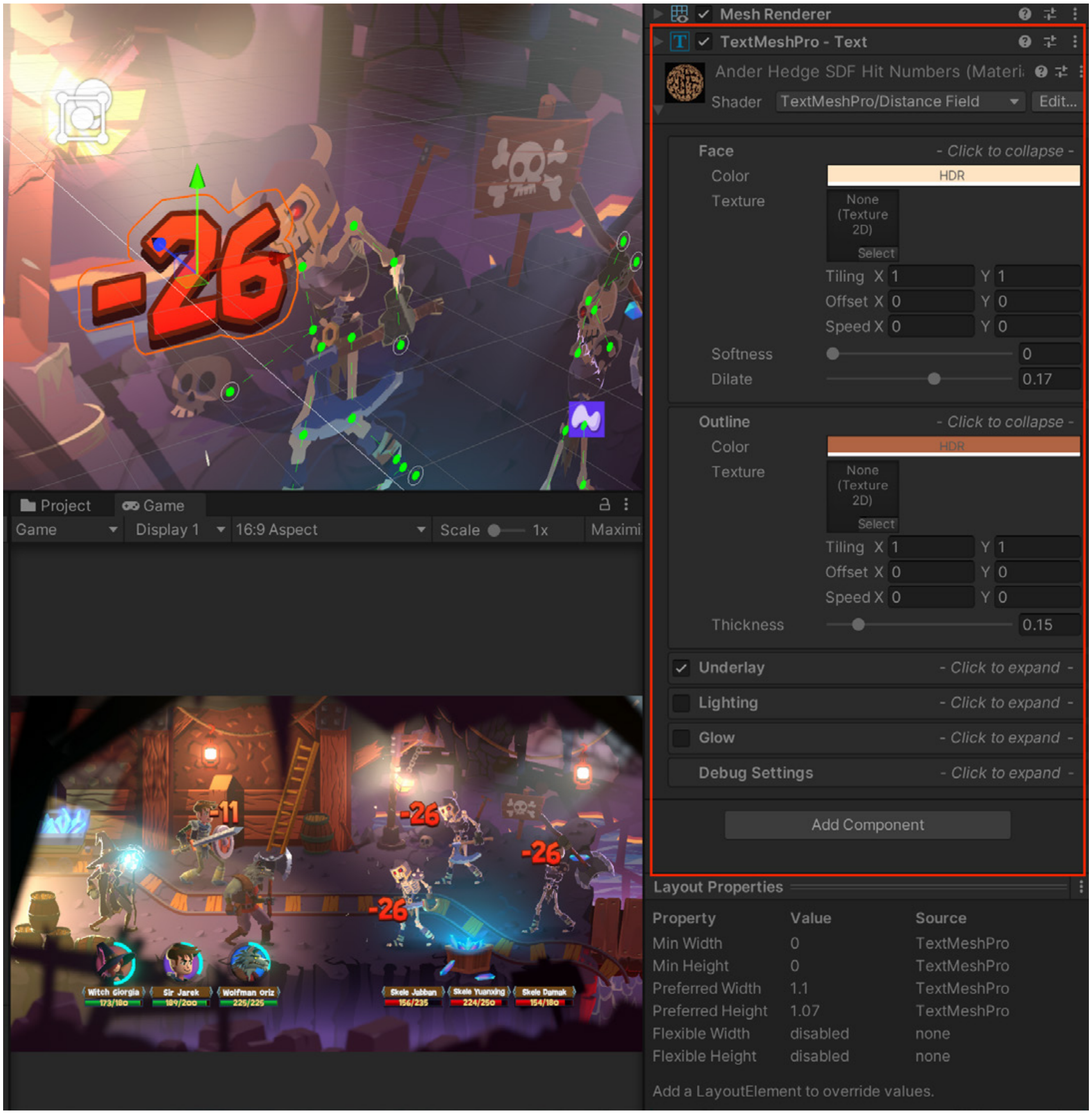
An example of Material Variants; these all share the same base material and only differ in the color property

In a more complex setup, you can create variations of a variant material. The material inheritance hierarchy promotes reusability and improves iteration speed and scalability of material authoring in your project.

TextMeshPro

TextMeshPro replaces Unity's UI Text and the legacy Text Mesh. Installed via the PackageManager, TextMeshPro uses custom shaders and advanced text rendering techniques to deliver flexible text styling and texturing.

Use TextMeshPro to get access to features like character, word, line, and paragraph spacing, kerning, justified text, links, over 30 rich text tags available, support for Multi Font and sprites, custom styles, and more.



Ander Hedge SDF Hit Numbers (Materi

Shader TextMeshPro/Distance Field Edit...

Face - Click to collapse -

Color	HDR			
Texture	None (Texture 2D) Select			
Tiling	X	1	Y	1
Offset	X	0	Y	0
Speed	X	0	Y	0
Softness		0		
Dilate		0.17		

Outline - Click to collapse -

Color	HDR			
Texture	None (Texture 2D) Select			
Tiling	X	1	Y	1
Offset	X	0	Y	0
Speed	X	0	Y	0
Thickness		0.15		

✓ Underlay - Click to expand -

Lighting - Click to expand -

Glow - Click to expand -

Debug Settings - Click to expand -

Layout Properties

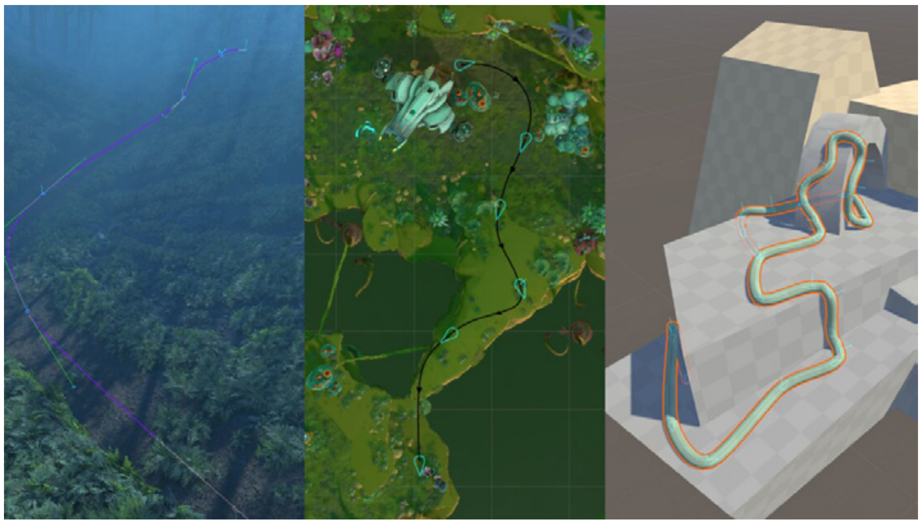
Property	Value	Source
Min Width	0	TextMeshPro
Min Height	0	TextMeshPro
Preferred Width	1.1	TextMeshPro
Preferred Height	1.07	TextMeshPro
Flexible Width	disabled	none
Flexible Height	disabled	none

Add a LayoutElement to override values.

TextMeshPro example from *Dragon Crashers*

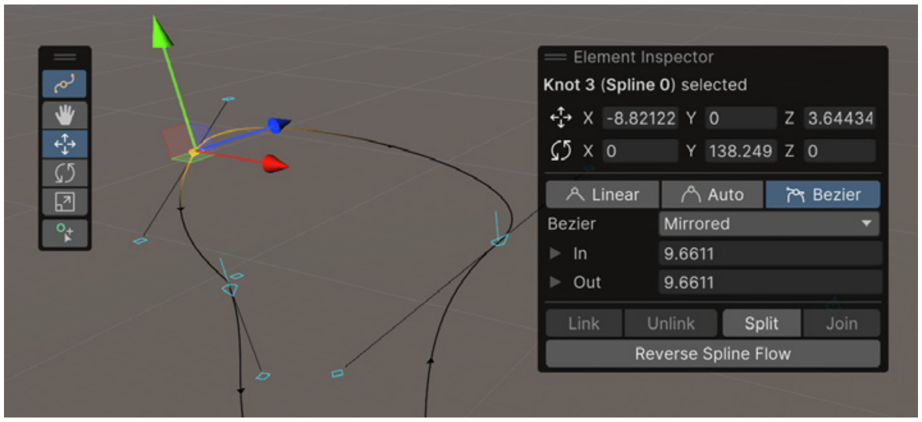
Splines

The Splines package in Unity 2022 LTS enables you to create spline paths in your game for rivers, roads, camera tracks, and other path-like visuals. Depending on the type of environment you're working on, splines can be an important component for your level designs.



Examples of use cases for splines: A road through a forest, an animation path, tubes, or wire meshes, and you can find other samples showcasing all the possibilities in the Splines Package Manager page once it's installed.

Create a new spline via **GameObject > Spline > Draw Splines Tool**. A new GameObject will be created in the Hierarchy with the Spline component attached and the tooling ready to use.



Knot 3 (Spline 0) selected

X -8.82122 Y 0 Z 3.64434

X 0 Y 138.249 Z 0

Bezier Mirrored

In 9.6611

Out 9.6611

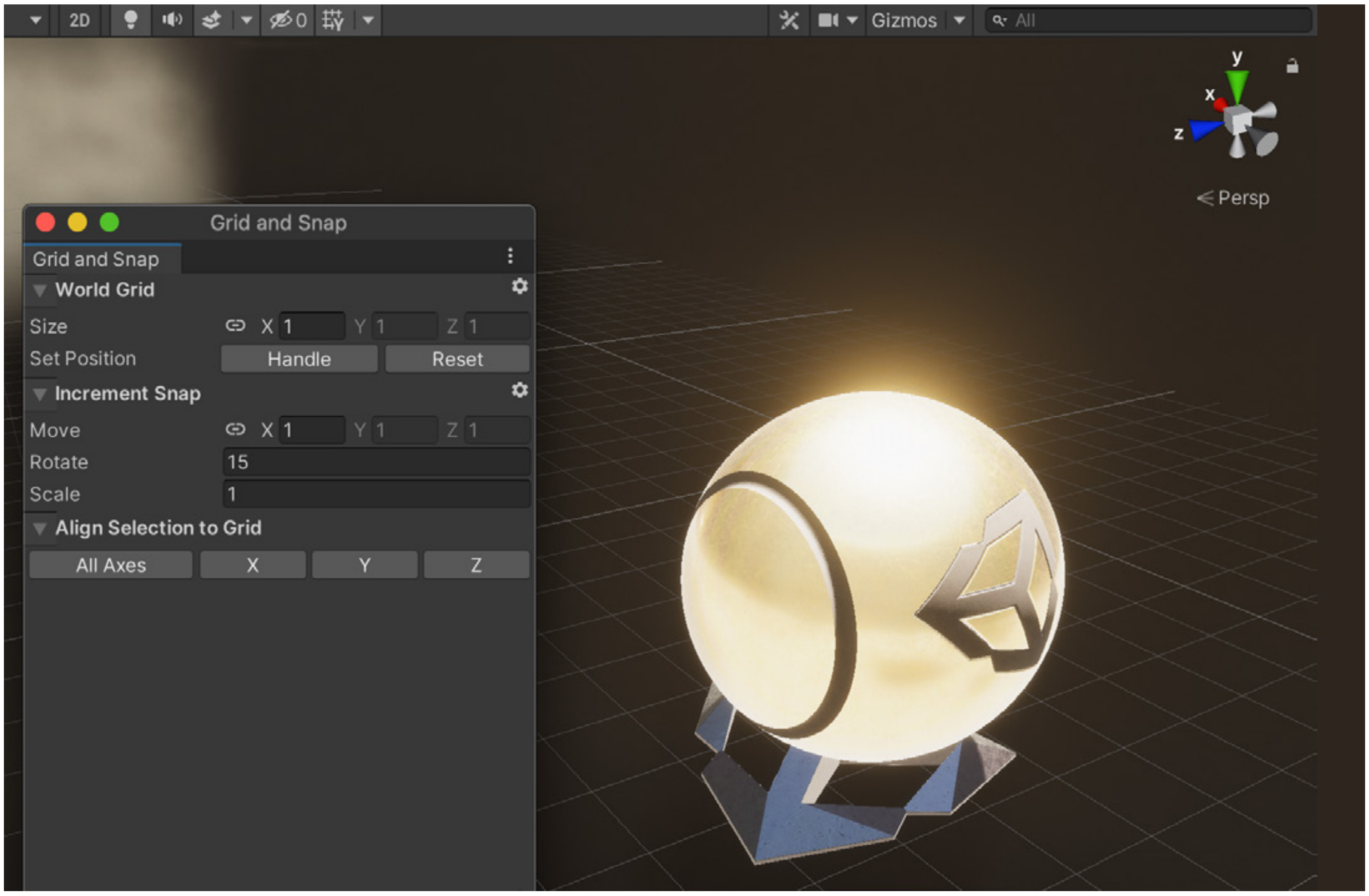
The handles and controls for splines in Unity resemble vector or 3D drawing tools from well-known DCC applications.

Once you've created a spline, both programmers and artists can use it in interesting ways. For example, programmers can read points of the spline and use them in the game logic with the APIs.

Snapping

Working on a grid helps you fit your Prefabs together with less guesswork and greater consistency. Design your level so the pieces connect at scale, making it easier to rearrange and reassemble them.

If you are constructing your Scenes from modular assets, use grid planes to align your GameObjects with each other. Rather than manually typing in round numbers into the Inspector, consider letting the grid snapping tools set your Transforms more quickly and precisely.



World Grid
Size X 1 Y 1 Z 1
Set Position: Handle | Reset

Increment Snap
Move X 1 Y 1 Z 1
Rotate 15
Scale 1

Align Selection to Grid
All Axes | X | Y | Z

The Grid and Snap settings

Unity provides three types of snapping to help you assemble your scenes quickly:

— **World grid snapping:** Make sure the **Move** tool has the handle orientation set to **Global**. Hold **Ctrl (Windows)** or **Cmd (macOS)** to snap an object to the world grid increments set in **Edit > Grid and Snap Settings**.

— **Surface snapping:** Hold **Shift** and **Ctrl** (**Windows**) / **Cmd** (**macOS**) to snap an object to the intersection of any **Collider**.

— **Vertex snapping:** Hold down the **V** key while the Move tool is active. This moves the current GameObject to the vertex position of another mesh. Before moving, hover the mouse over one vertex of the active GameObject to make that vertex act as a pivot. **Shift-V** toggles **Vertex snapping** mode on/off.

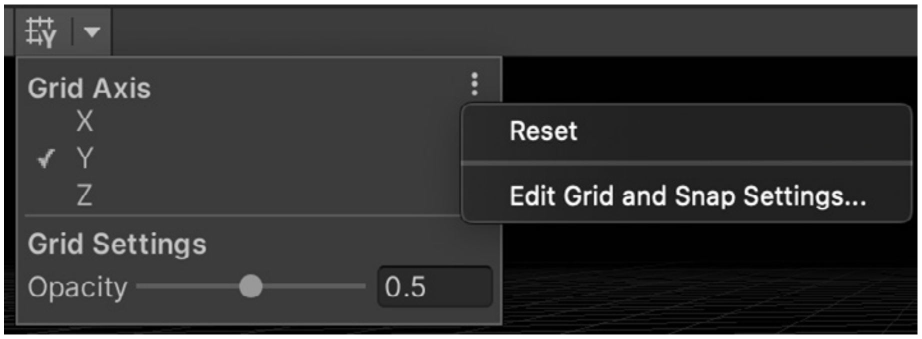
Combine **Vertex and Surface snapping** for quick placement:

— Move the GameObject using **Vertex snapping** with the **V** key or **Shift-V**. Hover the cursor over a vertex as a pivot. Snap to another vertex as usual.

— Hold down the **Shift** and **Ctrl** (**Windows**) / **Cmd** (**macOS**) key combo to drag along the surface of the target Mesh.

— Release the mouse button and **V** key once the object is at the desired location.

Open the **Grid and Snap window** from either **Edit > Grid and Snap Settings** or from the grid visibility drop-down menu.

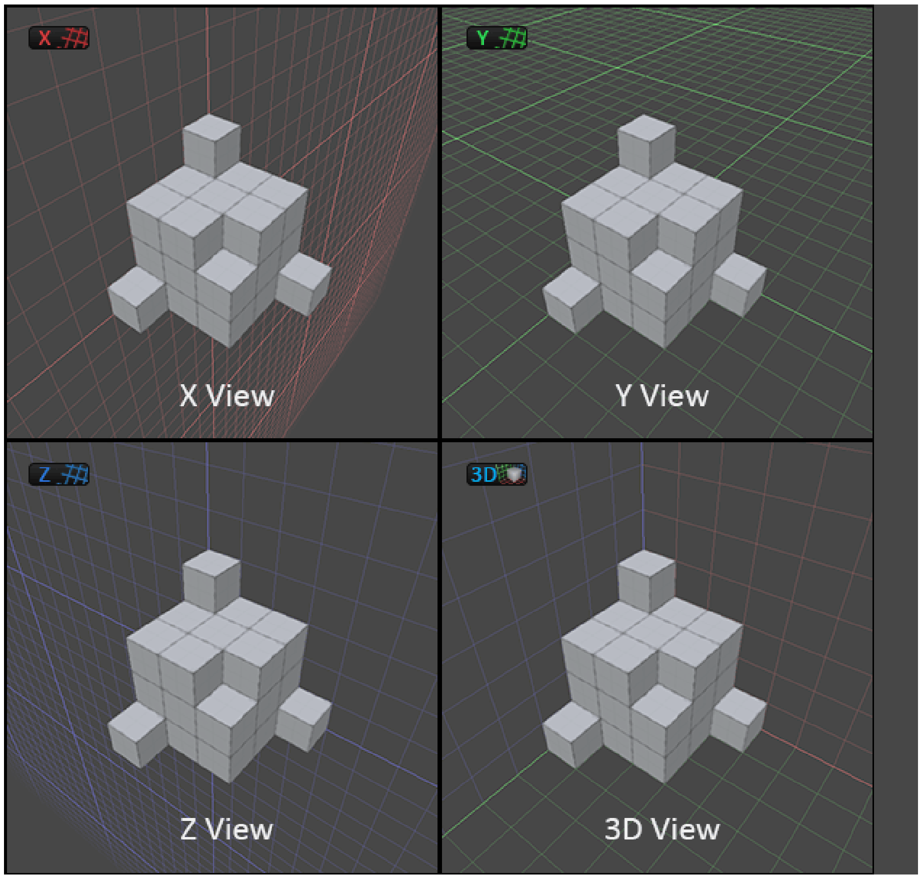


Grid and Snap settings

These grid snapping shortcuts are created by default.

Action	Default Shortcut
Increase Grid Size	Ctrl +] (Windows) or Cmd +] (macOS)
Decrease Grid Size	Ctrl + [(Windows) or Cmd + [(macOS)
Nudge Grid Backward	Shift + [
Nudge Grid Forward	Shift +]
Align Selection to Grid	Ctrl + \ (Windows) or Cmd + \ (macOS)

Need even more control? Consider using the ProGrids package for even finer control of your snapping and grid planes.

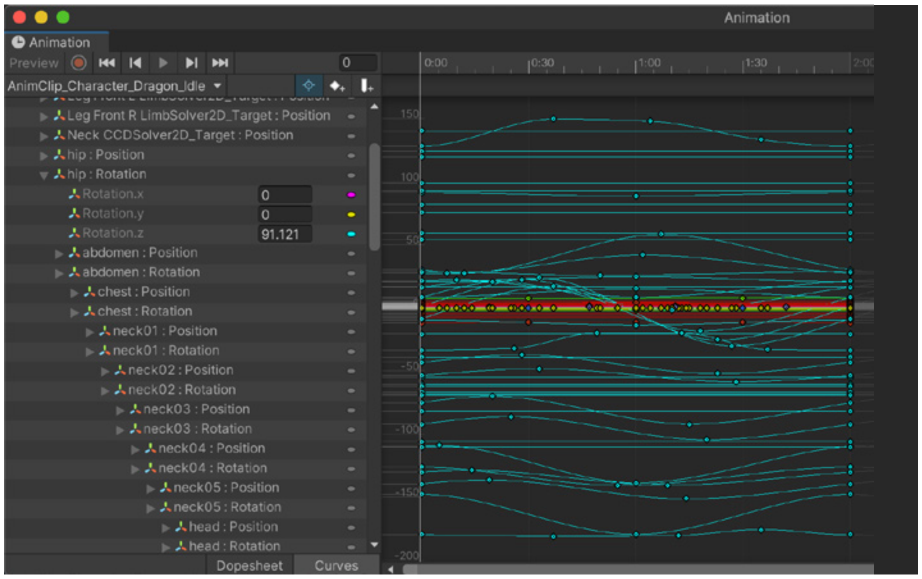


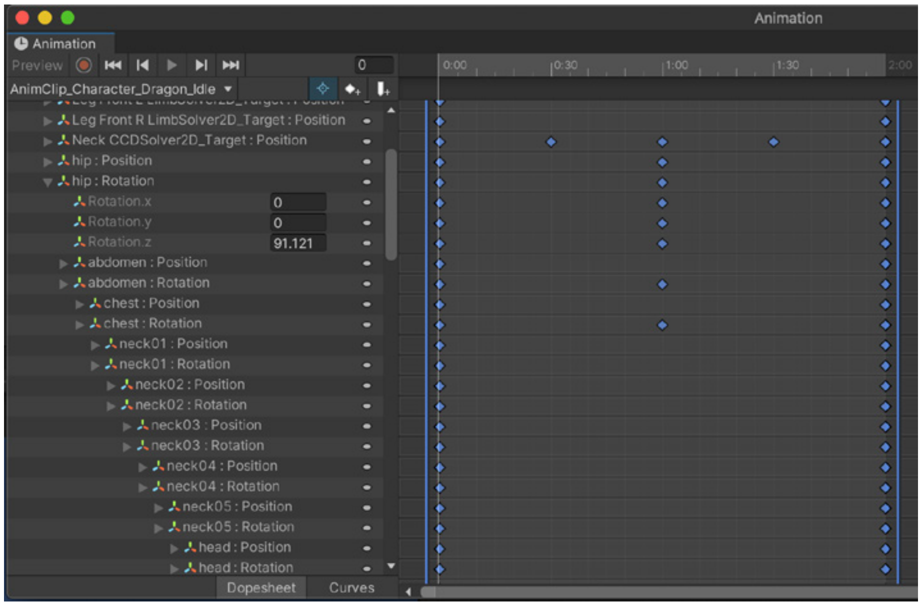
ProGrids

Animation workflow

You can animate just about any property in Unity without writing a single line of code using the **Animation Window** (**Window > Animation > Animation**). In addition to modifying movement, you can even drive parameters defined in your custom scripts.

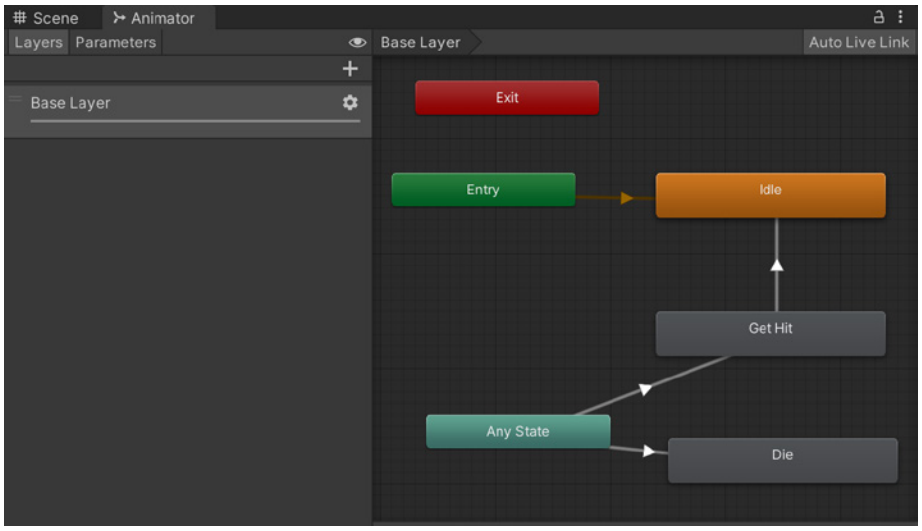
Create Animation Clips here, or work in a third-party DCC package of your choice (Autodesk® Maya®, Blender, etc). Think of each clip as an individual unit of motion.





The Animation window can represent the same animation data as curves or a dopesheet.

Edit the AnimationClip Asset within the window in either **Dopesheet** or **Curve** mode. Use **K** or **C** shortcuts, respectively, to toggle between the two. Use standard shortcuts to frame all keyframes (**A**) or frame selected keyframes (**F**).

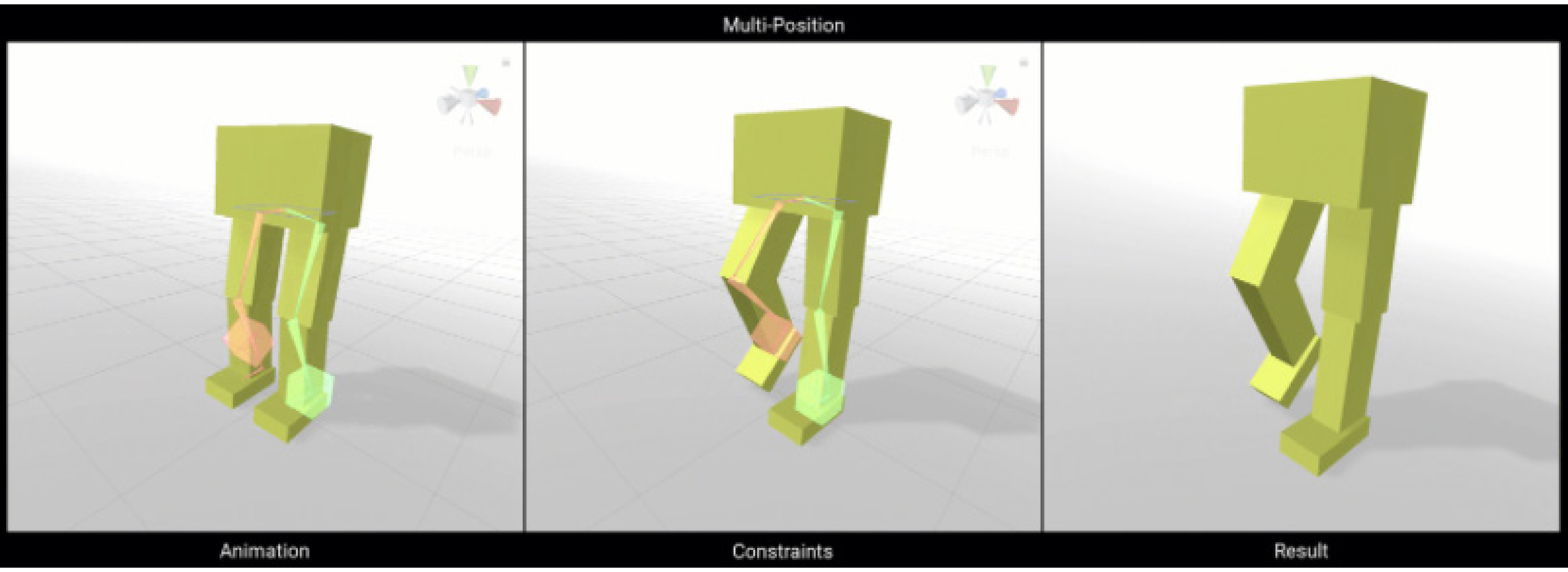


The AnimatorController links the Animation Clips in a visual graph.

Once you have several Animation Clips for your GameObject, the AnimatorController acts as a state machine to create a flowchart-like graph between them.

This allows artists to produce sophisticated animation with greater independence from programmers. If you're using a 2D or 3D rig, you can animate its body parts with different logic. Take advantage of the layering and masking features for greater control. Prototype your motions in a visual programming tool to fine-tune any transitions or interactions between your clips.

Extend this further using the Animation Rigging package. This package provides a library of rig and inverse kinematic constraints that can create procedural motion. Animated skeletons can thus interact with the environment with "runtime rigging," or physics-based constraints can add dynamic secondary motion.



Constraints can modify your animation at runtime.

Optimization tip

While AnimatorControllers offer convenience, be aware of a few caveats:

— Avoid overusing Animators, particularly in conjunction with UI elements. Animators cause the UI Canvas to rebuild each frame, even if no animation is playing. Whenever possible, use the legacy Animation components for UI or simple animations. Also, consider creating tweening functions or using a third-party library (e.g., DOTween).

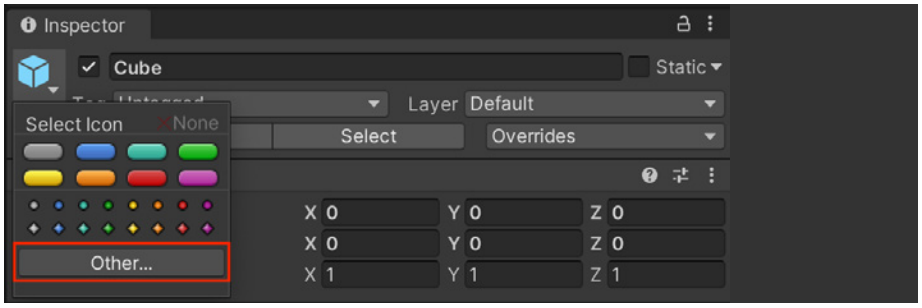
— By default, Unity imports animated models with the Generic Rig, but developers often switch to the Humanoid Rig when animating a character. A Humanoid Rig calculates inverse kinematics and animation retargeting each frame, even when not in use. If you don't need these specific features, save on CPU time and use the Generic Rig.

Refer to the manual pages about AnimationClips and AnimationController for more information about their usage. Read Unity's evolving best practices for more about optimizing your animation components.

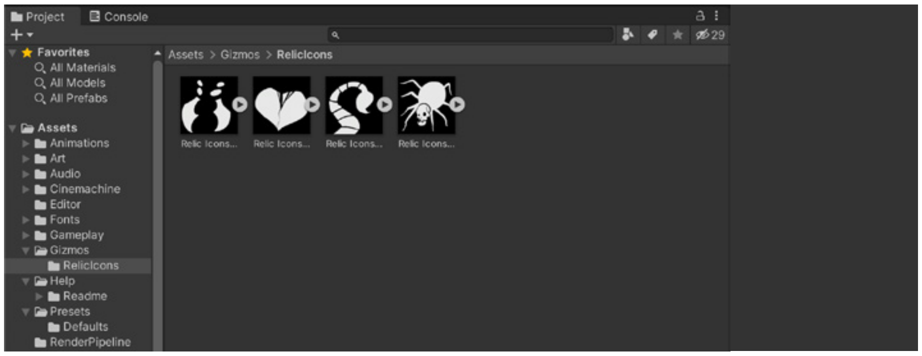
Custom gizmos and icons

Gizmos are small overlay graphics associated with your GameObjects. Use them to navigate the viewport or locate specific objects.

Modify the icons for a GameObject using the **Select Icon** menu. Choose **Other** to define your own icon.

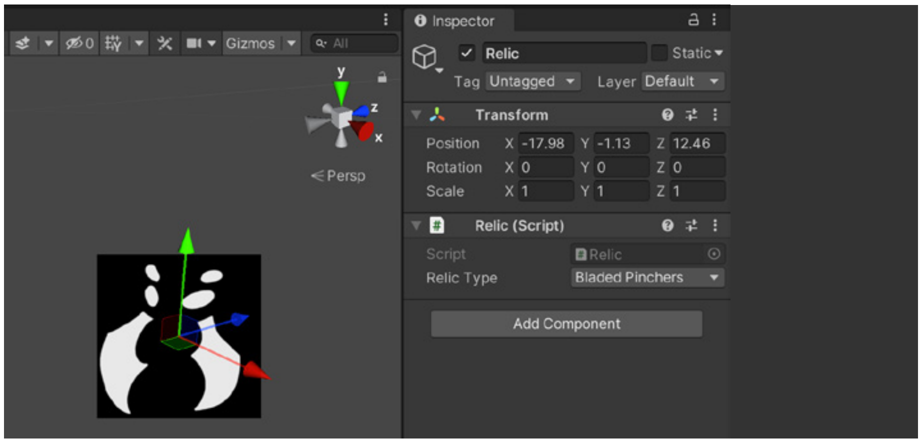


Use the drop-down in the Inspector to switch gizmos.



Select a custom gizmo using the Other... option.

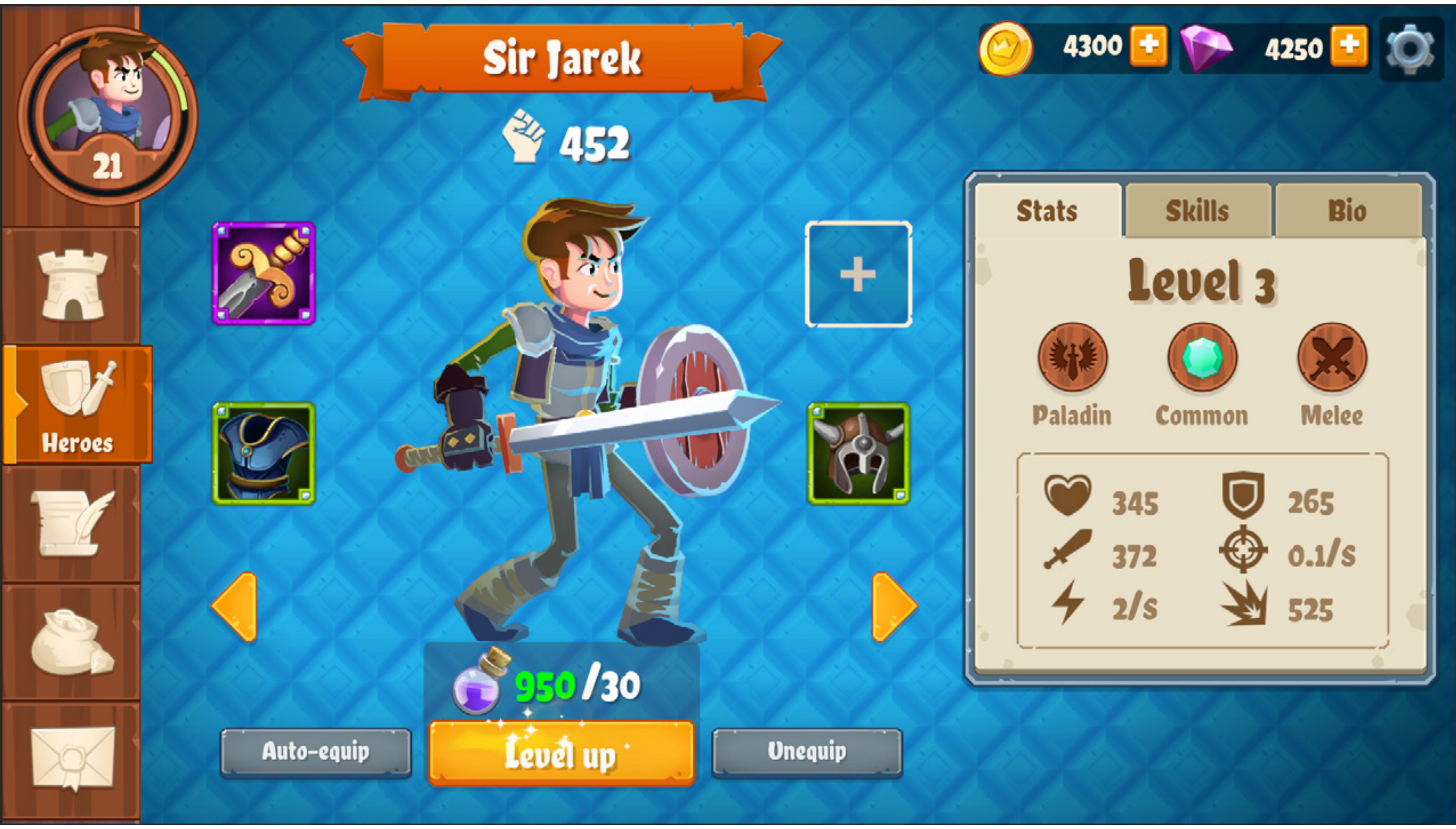
You can also create gizmos with scripts and make them interactive. For example, a gizmo could help you define a volume or area of influence for a custom component.



In this example, a script changes the gizmo based on a selection.

Use the **Gizmos** dialogue in the Scene control bar to toggle specific gizmos or globally enable/disable all of them.

See Creating Custom Gizmos for Development for usage examples. Also, review the APIs for Gizmos and Handles.



A screen shot from the Unity demo UI Toolkit Sample – *Dragon Crashers*, available on the Asset Store

UI Toolkit is tailored for maximum performance and reusability, with workflows and authoring tools inspired by standard web technologies. UI designers and artists will find it familiar if they already have experience designing web pages.

While UI Toolkit is intended to become the recommended system for UI development, it does not include some of the features supported by Unity UI. This makes the latter system a more appropriate choice for certain use cases and legacy projects. See Comparison of UI systems in Unity for more information.

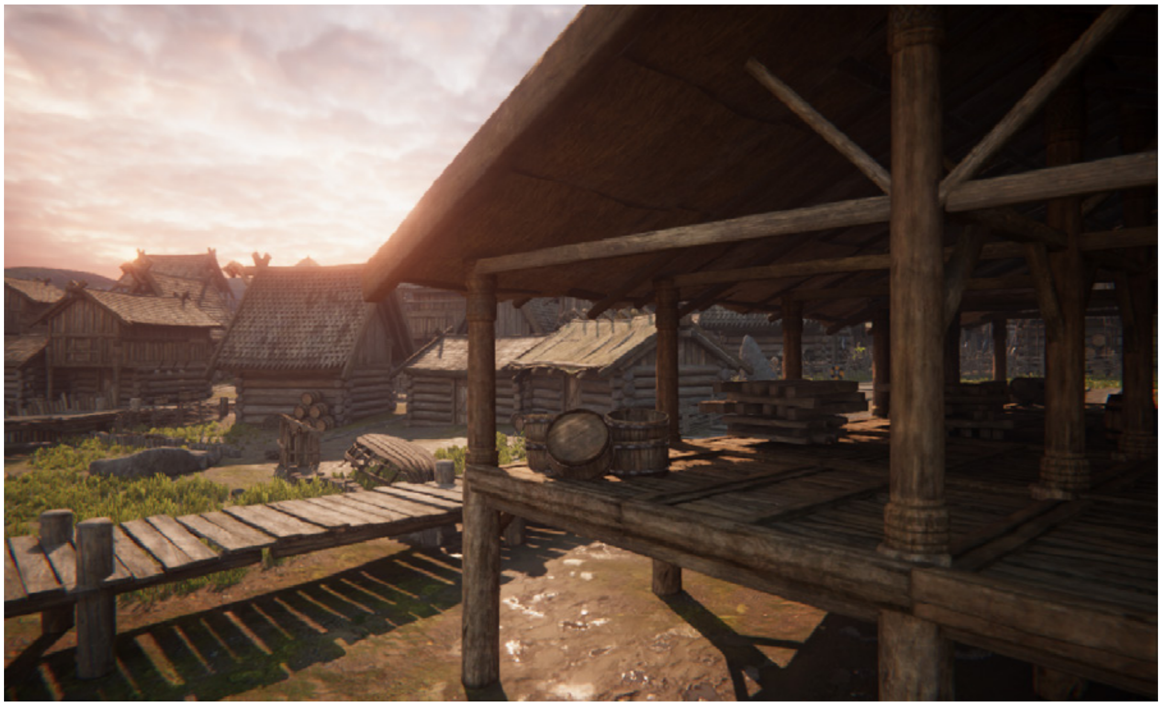
Learn in-depth with the UI Toolkit e-book and sample project

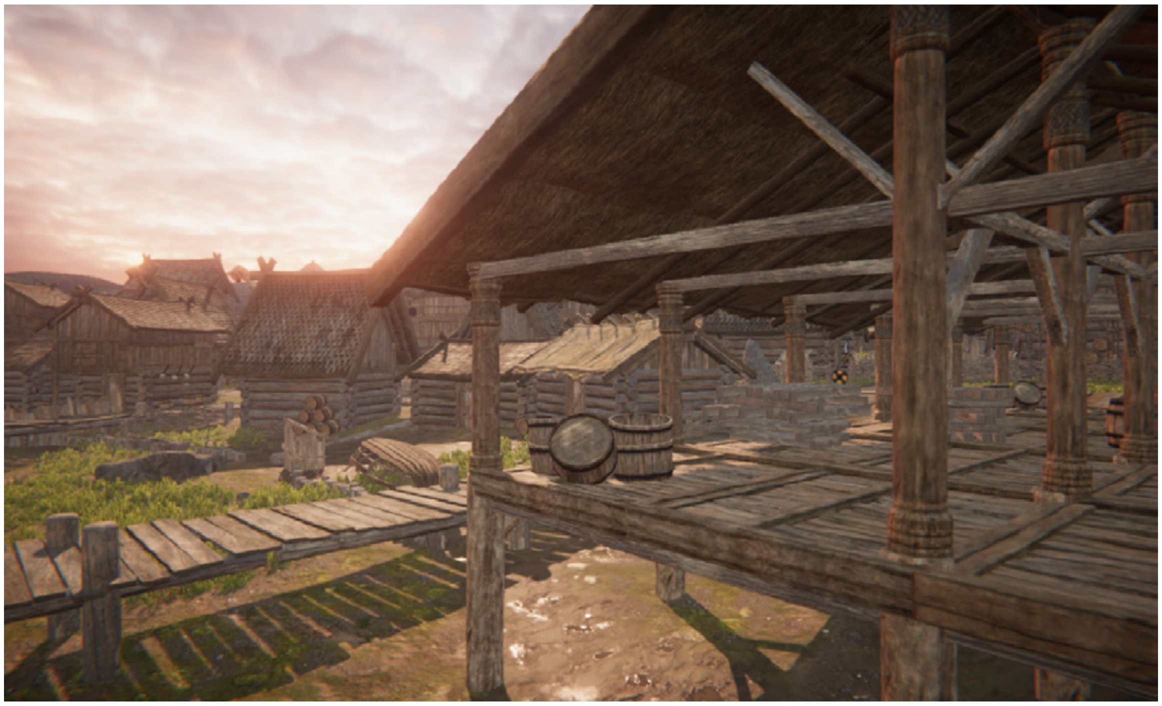
We recommend that you download the e-book *User interface design and implementation in Unity* to get in-depth instruction in how to create UI with UI Toolkit across a wide range of devices.

A sample project accompanies the e-book. *UI Toolkit Sample – Dragon Crashers* is available in the Unity Asset Store. The UI Toolkit sample demonstrates how you can leverage UI Toolkit for your own applications. This demo involves a full-featured interface over a slice of the 2D project *Dragon Crashers,* a mini-RPG, using the Unity 2021 LTS UI Toolkit workflow at runtime.

Progressive Lightmapper

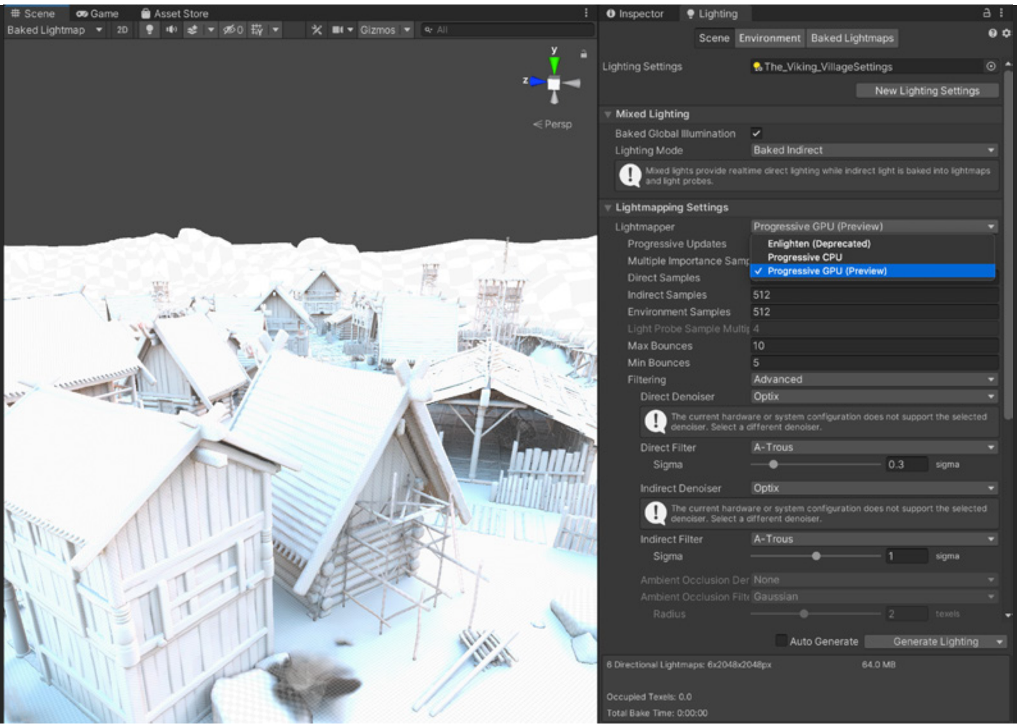
Lightmapping allows you to precalculate both direct and indirect lighting, then store the result in a Texture called a lightmap for later use. Unity offers a number of Global Illumination (GI) techniques to produce high-quality lighting and shadows. Though lightmapped geometry is performant at runtime, baking a lightmap has historically been expensive.


The final scene with lightmaps applied.


The same scene without lightmapping.

The Progressive Lightmapper is a fast path tracer that produces a result quickly, then refines the render over time. You can thus interrupt the process to make changes without waiting for the final bake to complete, allowing you to iterate more rapidly. Here are some tips to speed up your lightmapping:

- Enable **Prioritize View** so the Progressive Lightmapper works on texels currently visible in the Scene view first before changing anything outside of view.
- Reduce unnecessary **Samples** (Direct and Indirect Samples) and **Bounces** (two is usually sufficient; only increase if necessary).
- Optimize the **Lightmap Resolution** and texel count for your lighting needs. The number of texels represents how much work your lightmapper needs to do. Because lightmaps are 2D textures, doubling the lightmap resolution quadruples the amount of work.
- Reduce texels on hidden surfaces, small or thin objects, or anything where lightmapping won't make much impact. Each MeshRenderer contributing to Global Illumination has a **Scale in Lightmap** option to reduce its relative UV size in the lightmap.
- Choose the proper **Lighting Mode**: Baked Indirect, Subtractive, ShadowMask. You don't need to bake shadows if it's not required for your art direction.
- The current Progressive CPU Lightmapper uses your machine's CPU and RAM. The newer **Progressive GPU Lightmapper** (in Preview) uses your GPU and VRAM, potentially speeding up the bake considerably. If your computer meets the hardware and software requirements, this can dramatically accelerate up your lighting workflow (tenfold in some cases).



Lighting Settings: The_Viking_VillageSettings

Mixed Lighting
Baked Global Illumination ✓
Lighting Mode: Baked Indirect
Mixed lights provide realtime direct lighting while indirect light is baked into lightmaps and light probes.

Lightmapping Settings
Lightmapper: Progressive GPU (Preview)
Progressive Updates
Multiple Importance Samp
Direct Samples
✓ Progressive GPU (Preview)
Indirect Samples: 512
Environment Samples: 512
Light Probe Sample Multi: 4
Max Bounces: 10
Min Bounces: 5
Filtering: Advanced
Direct Denoiser: Optix
The current hardware or system configuration does not support the selected denoiser. Select a different denoiser.
Direct Filter: A-Trous
Sigma: 0.3 sigma
Indirect Denoiser: Optix
The current hardware or system configuration does not support the selected denoiser. Select a different denoiser.
Indirect Filter: A-Trous
Sigma: 1 sigma
Ambient Occlusion Der: None
Ambient Occlusion Filt: Gaussian
Radius: 2 texels

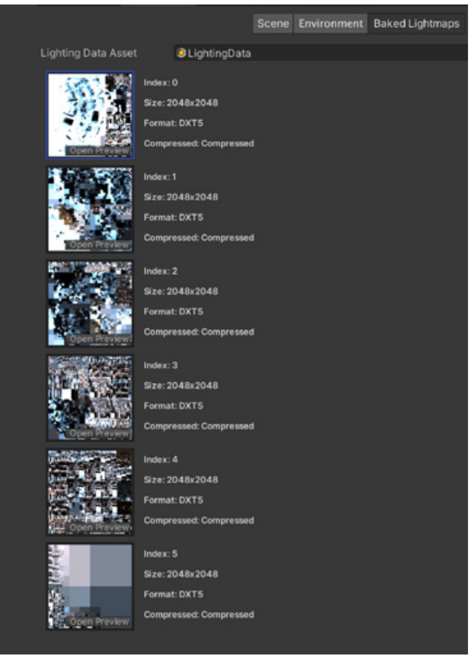
6 Directional Lightmaps: 6x2048x2048px 64.0 MB
Occupied Texels: 0.0
Total Bake Time: 0:00:00

Preview of a baked Lightmap

Light Probes

Global Illumination produces beautiful indirect lighting, but this can be expensive to calculate and store on disk. If you have set dressing or other static meshes that don't absolutely require lightmapping, consider removing them from your lightmap bakes and use Light Probes instead.

In this example, Light Probes could approximate both direct and bounced lighting for the smaller objects, reserving the higher-quality lightmapping where it's more noticeable.



Lighting Data Asset: LightingData

Index: 0
Size: 2048x2048
Format: DXT5
Compressed: Compressed

Index: 1
Size: 2048x2048
Format: DXT5
Compressed: Compressed

Index: 2
Size: 2048x2048
Format: DXT5
Compressed: Compressed

Index: 3
Size: 2048x2048
Format: DXT5
Compressed: Compressed

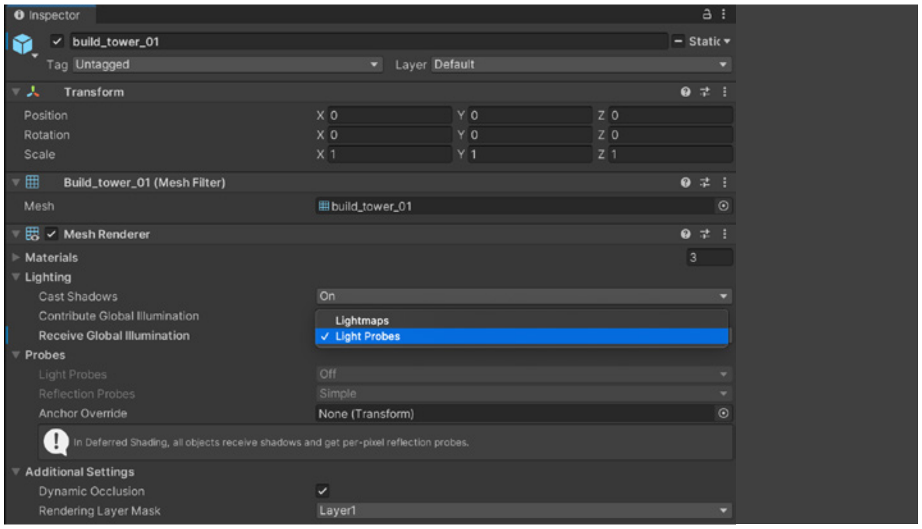
Index: 4
Size: 2048x2048
Format: DXT5
Compressed: Compressed

Index: 5
Size: 2048x2048
Format: DXT5
Compressed: Compressed

Lightmaps applied to the *Viking Village* project

Use Light Probes for smaller details where lightmapping is less noticeable.

Formerly reserved for dynamic objects, Light Probes can apply to static meshes as well. In the MeshRenderer component, locate the **Receive Global Illumination** dropdown and toggle it from **Lightmaps** to **Light Probes**.



build_tower_01
Tag: Untagged
Layer: Default

Position: X 0 Y 0 Z 0
Rotation: X 0 Y 0 Z 0
Scale: X 1 Y 1 Z 1

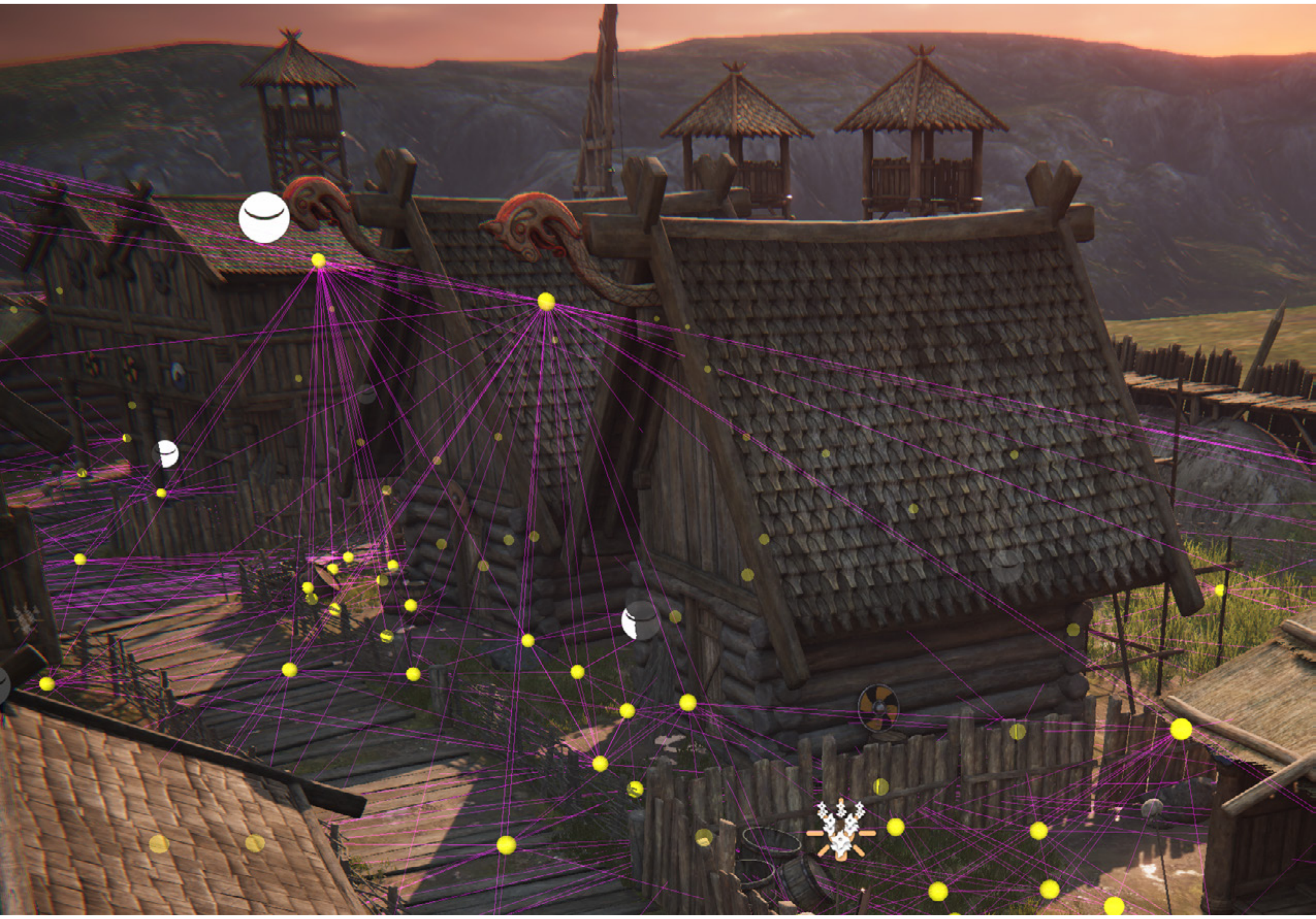
Build_tower_01 (Mesh Filter)
Mesh: build_tower_01

Materials: 3
Cast Shadows: On
Contribute Global Illumination: ✓
Receive Global Illumination: Lightmaps / ✓ Light Probes
Light Probes: Off
Reflection Probes: Simple
Anchor Override: None (Transform)
In Deferred Shading, all objects receive shadows and get per-pixel reflection probes.
Dynamic Occlusion: ✓
Rendering Layer Mask: Layer1

Selecting Light Probes

Light Probe illumination does not require proper UVs, saving you the extra step of unwrapping your meshes. The Spherical Harmonics basis functions used in probe lighting make it fast to calculate relative to lightmapping.

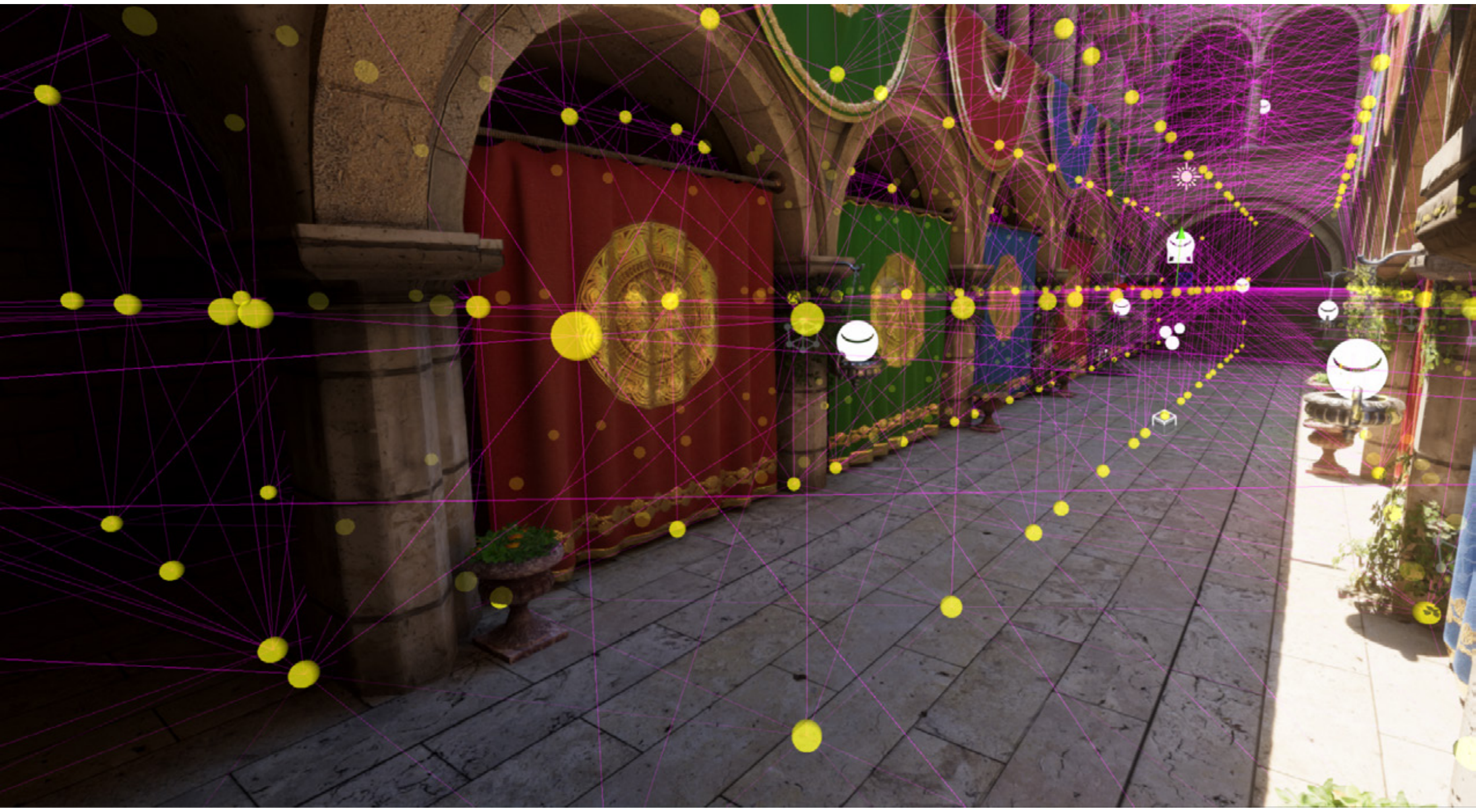
Arrange Light Probes and Light Probe Groups spatially in the scene. Probe lighting typically bakes faster than lightmapping.


A Light Probe Group with Light Probes spread across the level

See Static Lighting with Light Probes for information about selectively lighting scene objects with Light Probes.

For more about lighting workflows in Unity, read Making believable visuals in Unity.

Adaptive probe volumes



Adaptive probe volumes in a scene

Manually placing light probes can be tedious and imprecise. **Adaptive probe volumes (APVs) in Unity 2022 LTS** (named Probe Volumes in the Editor) offer a more accurate solution by automating light probe positions. This results in higher-quality lighting that works per pixel, not per object. APVs are supported in HDRP with URP support coming soon. Learn more in this Unite 2022 talk.

Unity 2022 LTS and HDRP (versions 14 and up) bring improvements to the workflows for APVs, including:

— Adds a system that reduces leaks based on probe validity. This includes the new Probe Touch up Volume that you can use to tune values in specific areas.

— Allows you to bake separate lighting scenarios and blend between them

— Uses a more efficient data layout to optimize asset loading time

Tips for the Universal Render Pipeline

URP is designed to be efficient for you to learn, customize, and scale to all Unity-supported platforms. Our top goal is that URP is the leading renderer for mobile, XR, and untethered hardware.

URP is the successor to our Built-in Render Pipeline. It will provide all the functionality you are familiar with, but with better performance, greater customizability, and more productive workflows.

In-depth technical resources for URP

- *The Universal Render Pipeline for advanced Unity users*: This e-book was created by a highly experienced Unity developer in collaboration with senior graphics engineers at Unity. Topics covered include:
  - How to set up URP for a new project or convert an existing Built-in Render Pipeline-based project to URP
  - A comparison of URP and Built-in Render Pipeline Quality settings
  - Lighting in URP, namely lighting a new scene, managing shadows, Light Modes, Light Layers, Light Probes, and more
  - A comparison of URP and Built-in Render Pipeline shaders
  - Callback differences between the two rendering pipelines
  - Shader Graph, Visual Effects Graph, 2D features, and integrating post-processing effects with URP
- *Recipes for popular visual effects using the Universal Render Pipeline*: This handy cookbook provides 12 recipes for popular visual effects that can be applied to a wide range of games, art styles, and platforms.

Let’s look at some helpful tips for using URP in Unity 2022 LTS.

1. URP provides a Universal Renderer that supports Forward, Forward+ and Deferred rendering paths, as well as a 2D Renderer.

   URP provides equal, if not better performance than the Built-in Render Pipeline for comparable Quality settings in the majority of cases. For example, it evaluates real-time lighting more efficiently. In Forward rendering it evaluates all lighting in a single pass. Forward+ rendering, available in 2022 LTS and later, improves upon standard Forward rendering by culling lights spatially rather than per object. This increases the overall number of lights that can be utilized in rendering a frame.

   In Deferred rendering, it supports the Native RenderPass API, allowing G-buffer and lighting passes to be combined into a single render pass.

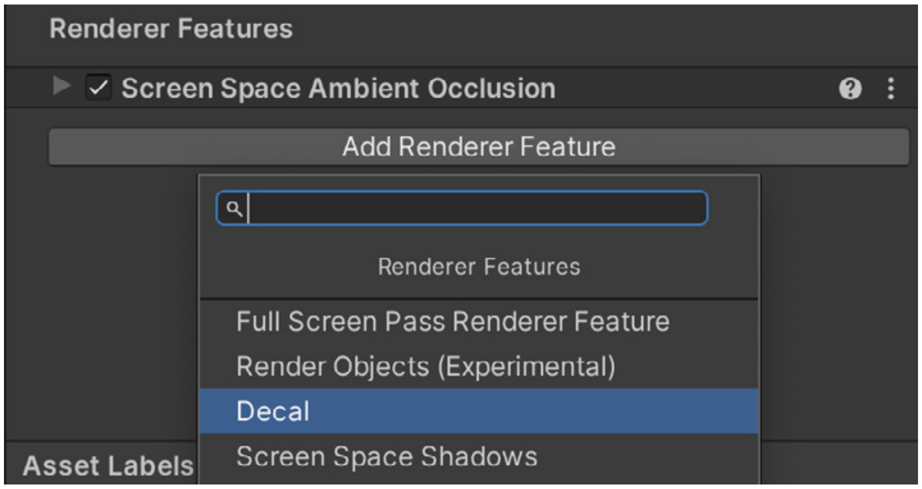
   URP is also compatible with the latest artist-friendly tools, such as Shader Graph, VFX Graph, and the Rendering Debugger.

2. The Rendering Layers feature lets you configure certain Lights to affect only specific GameObjects. With the Custom Shadow Layers property, you can configure certain GameObjects to cast shadows only from specific Lights (even if those Lights do not affect the GameObjects).

   Rendering Layers work not only with Lights, but also with Decals.

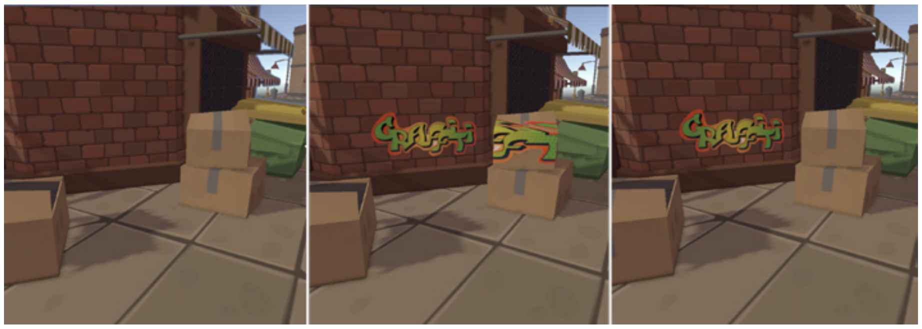
Highlighting an object using Rendering Layers

3. Decal Projectors are a great way of adding detail to a mesh. Use them for elements such as bullet holes, footsteps, signage, cracks, and more. Because they use a projection framework they conform to an uneven or curved surface. To use a Decal Projector with URP, you need to locate your Renderer Data asset and add the **Decal Renderer Feature**.


Renderer Features
Screen Space Ambient Occlusion
Add Renderer Feature
Renderer Features
Full Screen Pass Renderer Feature
Render Objects (Experimental)
Decal
Screen Space Shadows
Asset Labels
Adding the Decal Renderer Feature

   For most purposes, you can accept the default settings (learn more about these here).

Now your scene is ready for Decals. Create a Decal by right-clicking in the Hierarchy view and select **Rendering > URP Decal Projector.** By default, the projector uses the material Decal, which will project a white square onto a surface. Use the usual tools to position and orientate the projector. Adjust the **Width**, **Height** and **Projection Depth** in the Inspector. To customize the decal create a material using the **Shader Graph > Decal** shader. This shader has three inputs: Base Map, Normal Map, and Normal Blend. Once the material is prepared, assign it to the Decal Projector.



From left to right: No decal in the image, the decal hitting all objects, and the decal applied to the wall only, using Rendering Layers

4. Even if you follow the correct steps to convert a Built-in Render Pipeline project to URP (you can find the steps in the e-book *Introduction to the Universal Render Pipeline for advanced Unity creators*), you might find that your scenes are suddenly colored magenta. This is because the shaders used by the materials in a Built-in Render Pipeline project are not supported in URP. Fortunately, there is a method to restore your scenes to their original quality.

   Go to **Window > Rendering > Render Pipeline Converter**. Choose **Convert Built-n to 2D (URP)** for a 2D project, or **Built-In to URP** for a 3D project. Assuming that your project is 3D, you'll need to select the appropriate converters:

   — **Rendering Settings:** Select this to create multiple Render Pipeline setting assets that will match Built-in Render Pipeline Quality settings as closely as possible. This lets you test different Quality Levels more efficiently. See the section in the URP e-book on comparing Built-in Render Pipeline and URP Quality options for more details.

   — **Material Upgrade**: Use this to convert materials from the Built-in Render Pipeline to URP.

   — **Animation Clip Converter:** This converts animation clips. It runs once the Material Upgrade converter finishes.

   — **Read-only Material Converter:** This converts the prebuilt, read-only Materials included in a Unity project. It indexes the project and creates the temporary .index file. Note that it can take significant time. Add in a quick tips list for the SRPs as I suggested in the draft (under the lighting section).

Once you select one or more of the above converters, either click **Initialize Converters** or **Initialize And Convert** (the latter option is included in the Render Pipeline Converter window in Unity 2022 LTS). Whichever option you choose, the project will be scanned, and those assets that need converting will be added to each of the converter panels. If you choose **Initialize Converters**, you can limit the conversions by deselecting the items using the checkbox provided for each one. At this stage, click **Convert Assets** to start the conversion process. If you choose **Initialize And Convert**, the conversion starts automatically after the converters are initialized. Once it's complete, you might be asked to reopen the scene that's active in the Editor.

Unity 2022 LTS provides improvements of the Render Pipeline Converter, including:

- Certain dialogs now show the number of selected elements and the total number of elements.
- You can click each converter to see more information about the elements it converts.
- Material converter section improvements:
    - Items in the list are sorted alphabetically now.
    - The converter handles Materials in packages better.
    - The converter ignores Shader Graph shaders.
- Performance improvement:
    - Indexing is significantly faster, improving the performance of converters that use an .index file.

5. If you convert a project from the Built-in Render Pipeline to URP, you might notice differences in the lighting. This is because the Built-in Render Pipeline uses a gamma lighting model by default and URP uses a linear model. As such, any light with an intensity value differing from 1.0 will need to be adjusted.

There are also differences in where to find the Settings controls in-Editor, as well as how to handle the challenge of widely differing hardware specs. The rest of this section covers some tricks you can use to achieve balance between graphic fidelity and performance.

You'll set properties in the three places listed here. The first and second locations are essentially the same for both render pipelines, while the third location applies to URP only:

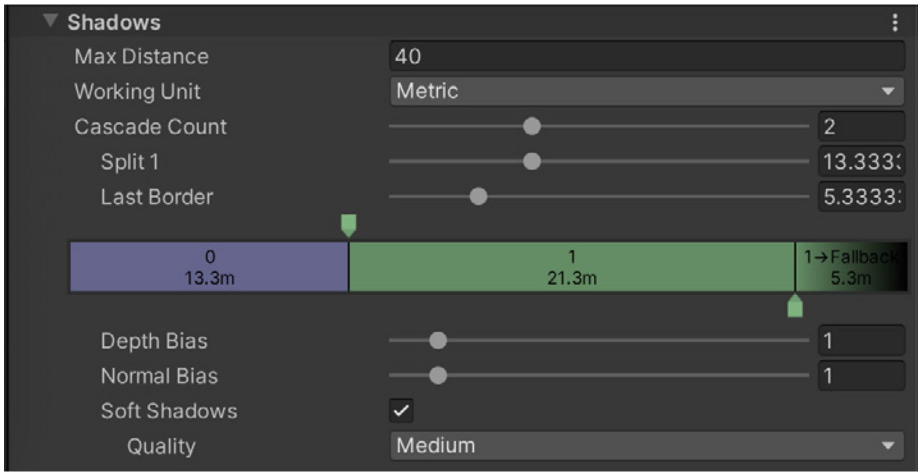
- **Window > Rendering > Lighting:** This panel allows you to set lightmapping and environment settings, as well as view real-time and baked lightmaps. It is unchanged from the Built-in Render Pipeline to URP.

— **Light Inspector:** There are significant differences between the Built-in Render Pipeline and URP Inspectors. See the Light Inspector section in the URP e-book for details.

— **URP Asset Inspector:** This is the principal place where you will set shadows. Lighting in URP relies heavily on the settings chosen in this panel.

Quality settings are handled via **Edit > Project Settings > Quality** in the Built-in Render Pipeline. In URP, this depends on the URP Asset settings which can be swapped using the **Quality** panel (See the Quality settings section in the URP e-book).

6. Shadow settings are no longer available via **Project Settings > Quality**. You need a Renderer Data object and a Render Pipeline Asset when using URP. There is a section on setting up a project for URP in the URP e-book that covers how to view your scene via the Render Pipeline Asset, which you can use to define the fidelity of your shadows.



Shadows
Max Distance 40
Working Unit Metric
Cascade Count 2
Split 1 13.333
Last Border 5.3333
Depth Bias 1
Normal Bias 1
Soft Shadows ✓
Quality Medium

The URP Asset

The Lighting and Shadow groups in the URP Asset are key to setting up shadows in your scene. First, set the **Main Light Shadow** to **Disabled** or **Per Pixel**, then go to the checkbox to enable **Cast Shadows**. The last setting is the resolution of the shadow map.

Another important setting for the Main Light Shadow is Max Distance. This is set in scene units. The Max Distance property needs to relate directly to what the user can see, as well as the units used in the scene. Aim for the minimum distance that gives acceptable shadows (see note below). If the player only sees shadows from dynamic objects 60 units from the Camera, then set Max Distance to 60.

7. A great feature of SRPs is that you can add code at just about any stage of the rendering process using a C# script. Scripts can be injected at stages such as:

   — Rendering shadows
   — Rendering prepasses
   — Rendering G-buffer
   — Rendering Deferred lights
   — Rendering opaques
   — Rendering Skybox
   — Rendering transparents
   — Rendering post-processing

   You can inject scripts in the rendering process via the **Add Renderer Feature** option in the Inspector for the **Universal Renderer Data Asset**. Remember, when using URP, there is a Universal Renderer Data object and a URP Asset. The URP Asset has a Renderer List with at least one Universal Renderer Data object assigned. It is the asset you assign in **Project Settings > Graphics > Scriptable Render Pipeline Settings**.

   If you are experimenting with multiple setting assets for different scenes, then attaching the following script to your Main Camera can be useful. Set the **Pipeline Asset** in the Inspector. Then it will switch the asset when the new scene is loaded.

```
using UnityEngine;
using UnityEngine.Rendering;
using UnityEngine.Rendering.Universal;
 [ExecuteAlways]
public class AutoLoadPipelineAsset : MonoBehaviour
{
    public UniversalRenderPipelineAsset pipelineAsset;
    void OnEnable()
    {
        if (pipelineAsset)
        {
        GraphicsSettings.renderPipelineAsset =
            pipelineAsset;
        }
    }
}
```

Script to switch Universal Render Pipeline Asset on scene load

Tips for the High Definition Render Pipeline

With HDRP's cutting-edge real-time 3D graphics, you can take players to visually stunning environments that push the boundaries of game design. HDRP extends Unity's existing lighting system with a variety of features to make rendering your scene more closely resemble real-world lighting, including:

— Physical light units and advanced lighting

— Skyscapes

— Terrains

— Water system

— Fog

— Volume system

— Post-processing

— Advanced shadows

— Advanced reflections

— Extensibility

Unity 2022 LTS and above includes the HDRP package with the installation to ensure that you're always running on the latest verified graphics code. When you install the most recent Unity release, it also installs the corresponding version of HDRP. Tying the HDRP graphics packages to a specific Unity release helps ensure compatibility. However, you can also switch to a custom version of HDRP by overriding the manifest file.

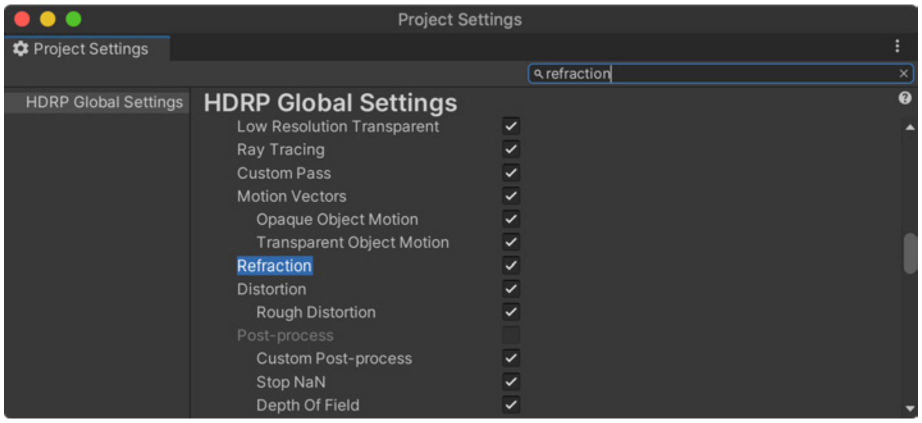
The e-book *Definitive guide to lighting in the High Definition Render Pipeline in Unity* provides hundreds of pages detailing what HDRP systems do, how to understand their capabilities so you can use them in the best way possible for your project, and step-by-step instructions for implementing and tweaking them.

1. The **HDRP Global Settings** section (or **HDRP Default Settings** prior to version 12) determines the baseline configuration of the project. You can override these settings in the scene by placing local or global Volume components, depending on the camera position (see Volumes below).

   Global Settings save in their own separate Pipeline Asset defined at the top field. Set up the default rendering and post-processing options here.

   As you develop your project, you might need to return to the **Global** settings to toggle a specific feature on or off. Some features will not render unless the corresponding checkbox in **HDRP Global Settings** is enabled. Make sure you only enable features you require because they might negatively impact the rendering performance and memory usage. Also, certain settings will appear in the **Volume Profiles**, while other features appear in the **Frame Settings**, depending on usage.

While familiarizing yourself with HDRP's feature set, make use of the top right Search field in the Project Settings. This will only show you the relevant panels with the search terms highlighted.


Project Settings

Project Settings

refraction

HDRP Global Settings

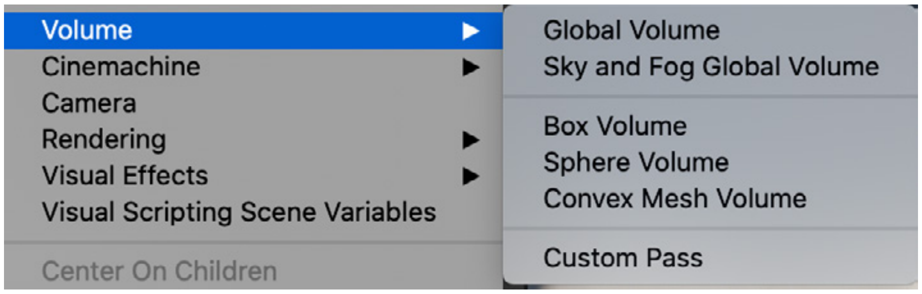
HDRP Global Settings

Low Resolution Transparent	✓
Ray Tracing	✓
Custom Pass	✓
Motion Vectors	✓
Opaque Object Motion	✓
Transparent Object Motion	✓
Refraction	✓
Distortion	✓
Rough Distortion	✓
Post-process	
Custom Post-process	✓
Stop NaN	✓
Depth Of Field	✓

Search for HDRP features

Enabling a feature in the HDRP Global Settings does not guarantee it can be rendered at any time by any camera. You must ensure that the Render Pipeline Asset whose Quality level is selected under **Projects Settings > Quality** supports that feature as well. For instance, to ensure cameras can render Volumetric Clouds, you must toggle them under **HDRP Global Settings > Frame Settings > Camera > Lighting** and in the active Render Pipeline Asset, under **Lighting > Volumetrics**.

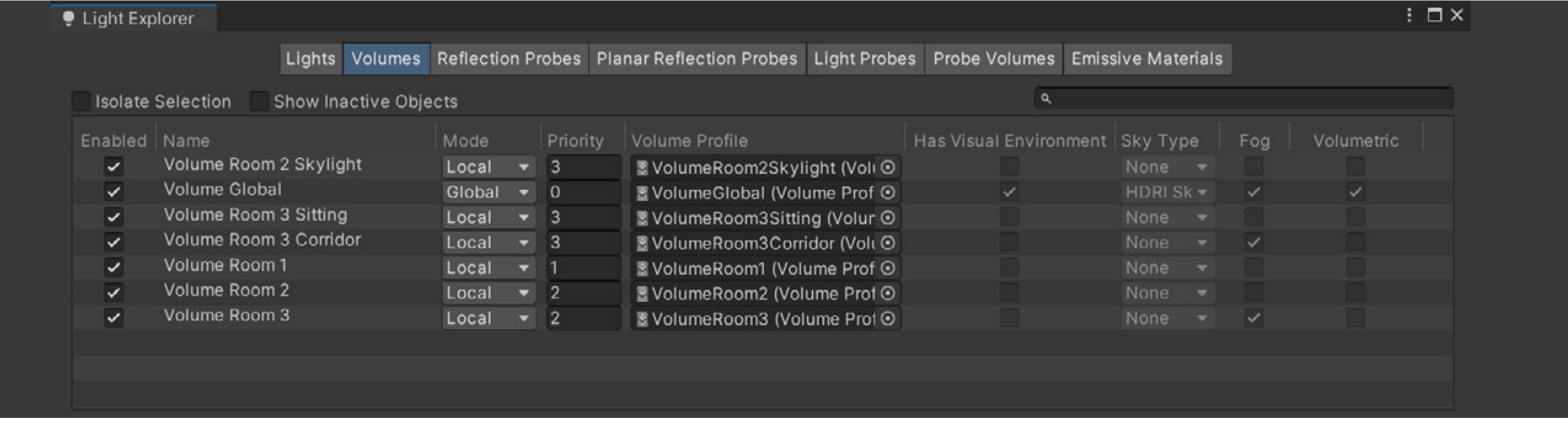
2. HDRP uses a **Volume framework**. This system allows you to split up your Scene and enable certain settings or features based on camera position. A volume is just a placeholder object with a Volume component. You can create one through the **GameObject > Volume** menu by selecting a preset. Otherwise, simply make a GameObject with the correct components manually.



Creating a Volume object using presets

A Volume component itself contains no actual data. Instead, it references a **Volume Profile**, a ScriptableObject Asset on disk that contains HDRP settings to render the scene.

The Light Explorer (**Window > Rendering > Light Explorer > Volumes**) can help you locate the volumes in the loaded scenes. Use this interface to make quick adjustments.


Light Explorer

Lights | Volumes | Reflection Probes | Planar Reflection Probes | Light Probes | Probe Volumes | Emissive Materials

Isolate Selection   Show Inactive Objects

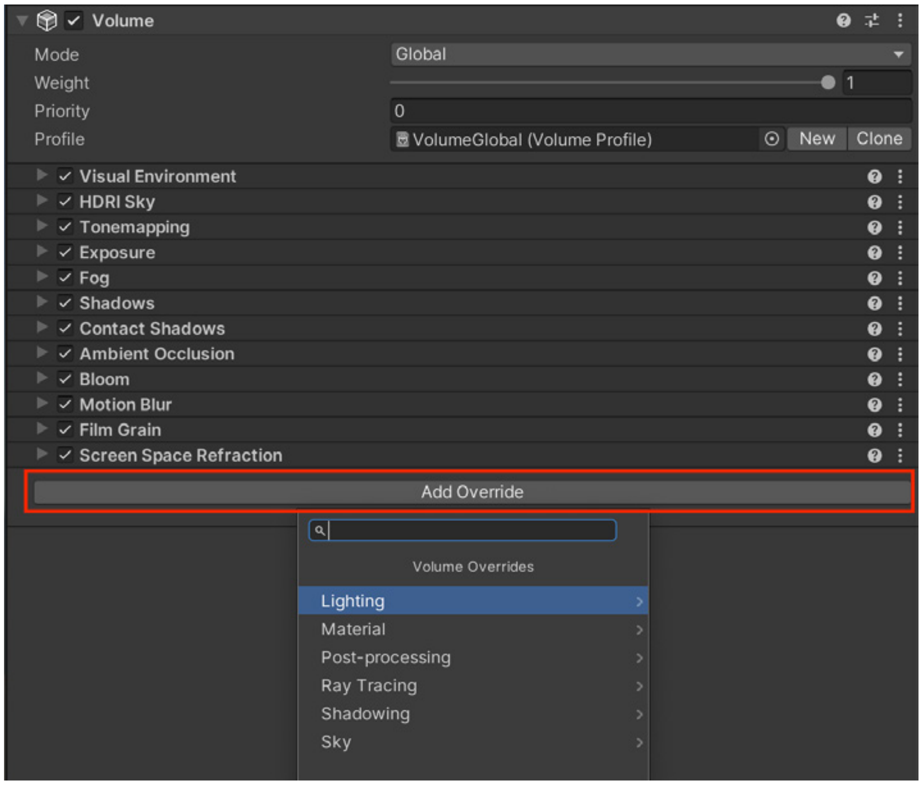
Enabled	Name	Mode	Priority	Volume Profile	Has Visual Environment	Sky Type	Fog	Volumetric
✓	Volume Room 2 Skylight	Local	3	VolumeRoom2Skylight (Volu		None		
✓	Volume Global	Global	0	VolumeGlobal (Volume Prof	✓	HDRI Sk	✓	✓
✓	Volume Room 3 Sitting	Local	3	VolumeRoom3Sitting (Volur		None		
✓	Volume Room 3 Corridor	Local	3	VolumeRoom3Corridor (Volu		None	✓	
✓	Volume Room 1	Local	1	VolumeRoom1 (Volume Prof		None		
✓	Volume Room 2	Local	2	VolumeRoom2 (Volume Prof		None		
✓	Volume Room 3	Local	2	VolumeRoom3 (Volume Prof		None	✓	

The Light Explorer can list all the Volumes in the open Scene(s).

3. Each Volume Profile begins with a set of default properties. To edit their values, use Volume Overrides and customize the individual settings. For example, Volumes Overrides could modify the Volume's Fog, Post-processing, or Exposure.

   Adding overrides is a key workflow in HDRP. If you understand the concept of inheritance from programming, Volume Overrides will seem familiar to you.

   The higher-level Volume settings serve as the defaults for lower-level Volumes. Here, the HDRP Default Settings pass down to the global Volume. This, in turn, serves as the "base" for the local Volumes.


Volume

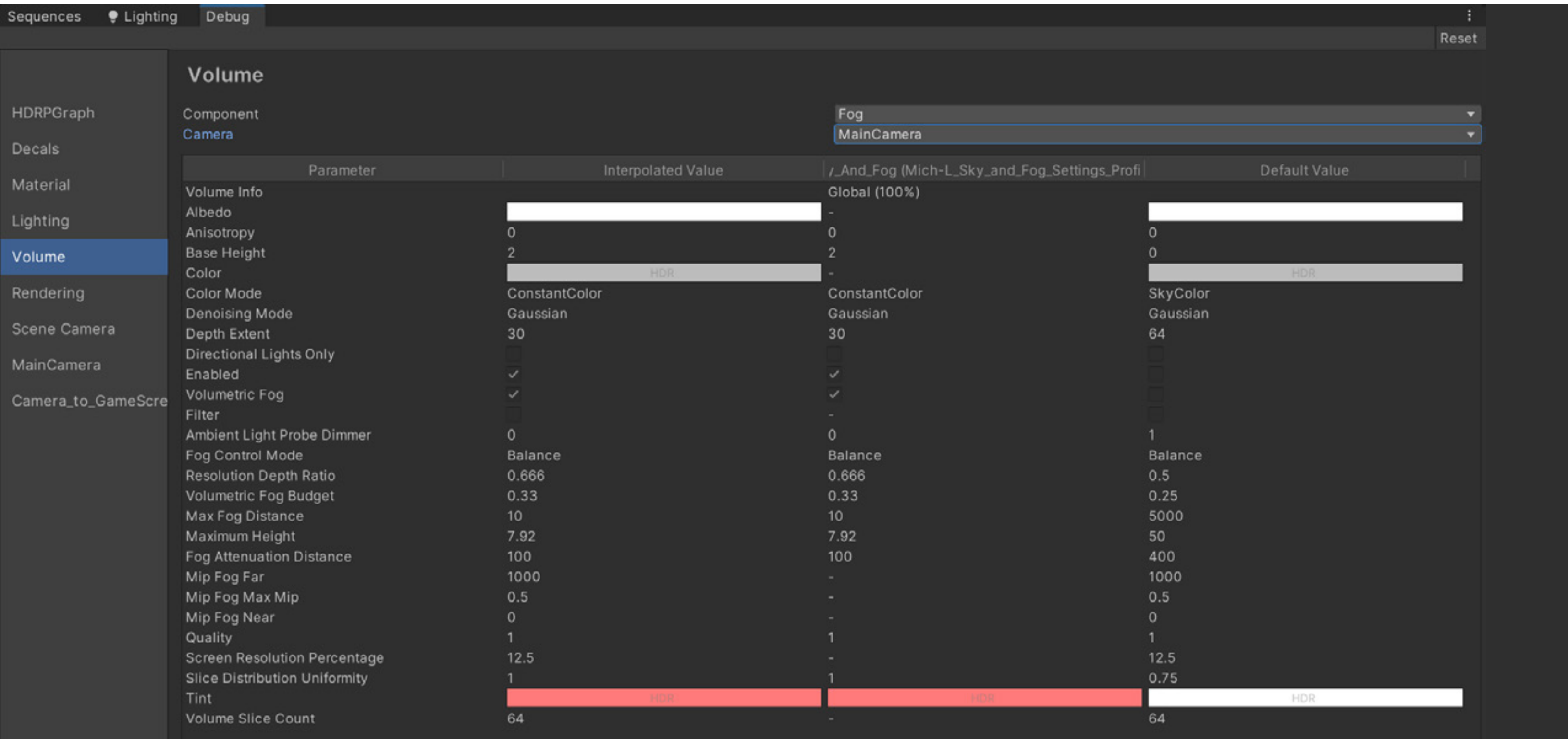
Mode: Global
Weight: 1
Priority: 0
Profile: VolumeGlobal (Volume Profile)   New   Clone

✓ Visual Environment
✓ HDRI Sky
✓ Tonemapping
✓ Exposure
✓ Fog
✓ Shadows
✓ Contact Shadows
✓ Ambient Occlusion
✓ Bloom
✓ Motion Blur
✓ Film Grain
✓ Screen Space Refraction

Add HDRP features using Volume Overrides.

The Global Volume overrides the HDRP Default Settings. The Local Volumes, in turn, override the Global Volume. Use the **Priority**, **Weight**, and **Blend Distance** (outlined below) to resolve any conflicts from overlapping Volumes.

To debug the current values of a given Volume component, you can use the Volume tab in the Rendering Debugger.



Volume

Component: Fog
Camera: MainCamera

Parameter	Interpolated Value	,_And_Fog (Mich-L_Sky_and_Fog_Settings_Profi	Default Value
Volume Info		Global (100%)	
Albedo	⬜	-	⬜
Anisotropy	0	0	0
Base Height	2	2	0
Color	HDR	-	HDR
Color Mode	ConstantColor	ConstantColor	SkyColor
Denoising Mode	Gaussian	Gaussian	Gaussian
Depth Extent	30	30	64
Directional Lights Only	☐	☐	☐
Enabled	✓	✓	☐
Volumetric Fog	✓	✓	☐
Filter	☐	-	☐
Ambient Light Probe Dimmer	0	0	1
Fog Control Mode	Balance	Balance	Balance
Resolution Depth Ratio	0.666	0.666	0.5
Volumetric Fog Budget	0.33	0.33	0.25
Max Fog Distance	10	10	5000
Maximum Height	7.92	7.92	50
Fog Attenuation Distance	100	100	400
Mip Fog Far	1000	-	1000
Mip Fog Max Mip	0.5	-	0.5
Mip Fog Near	0	-	0
Quality	1	1	1
Screen Resolution Percentage	12.5	-	12.5
Slice Distribution Uniformity	1	1	0.75
Tint	🟥 HDR	🟥 HDR	⬜ HDR
Volume Slice Count	64	-	64

Debugging a Volume

You can find a complete Volume Overrides List in the HDRP documentation.

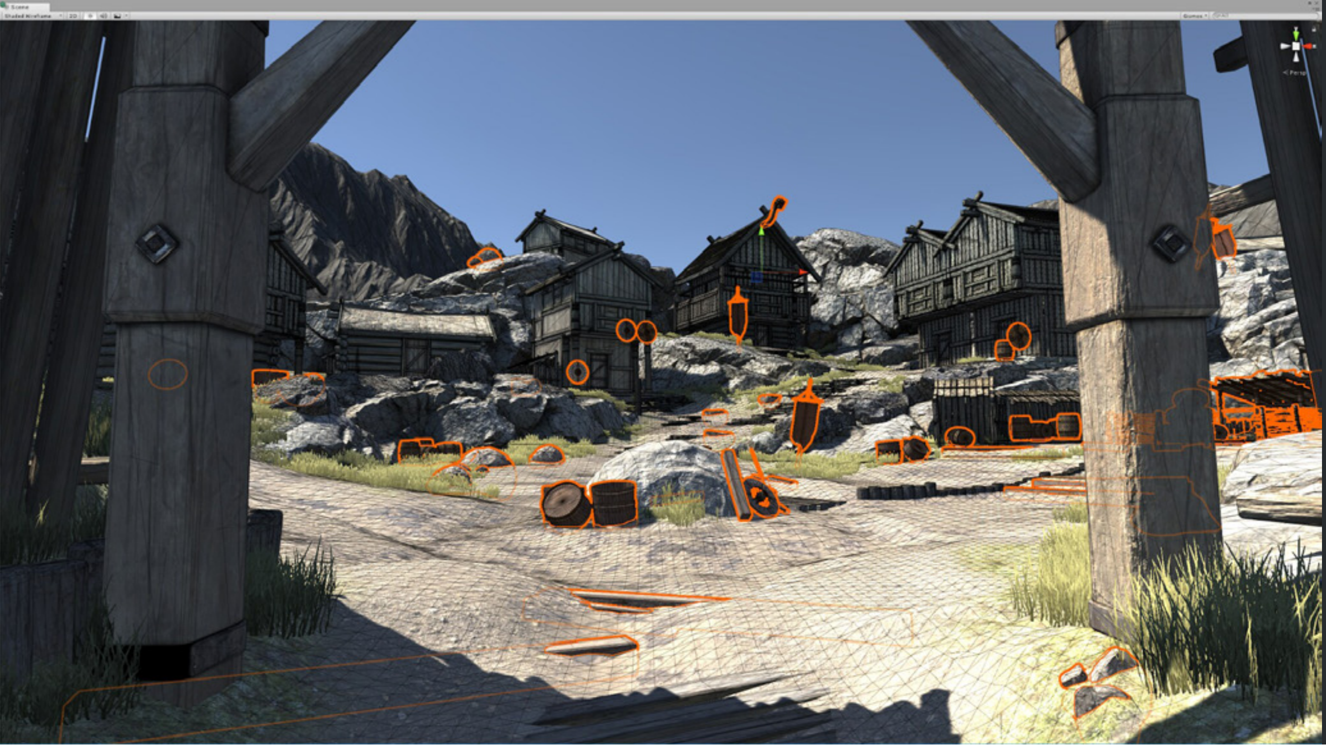
4. Baked global illumination (GI) pre-computes light interactions within a scene and stores the results as textures called lightmaps. When developing for mobile platforms, this is often a common strategy for adding realistic lighting to the game environment. When baking lighting, the intensive computations are performed offline, just once.

   Optimizing Baked GI is a strategic balance of visual quality with computational efficiency and memory management.

   Here's a general list of tips for lightmapping:

— **Lightmap Resolution:** Higher resolutions capture more detail but increase memory usage. Prioritize larger resolutions for hero objects, and reduce the resolutions for elements in the background.

— **Don't waste texels.** Small or thin objects, like pebbles or wires, can disproportionately use lightmap resources. Disable **Contribute Global Illumination** in either the Static menu or MeshRenderer to exclude those objects from GI calculations unless they significantly influence scene lighting (e.g., are brightly colored or have emissive materials).



Don't waste texels on small or thin objects.

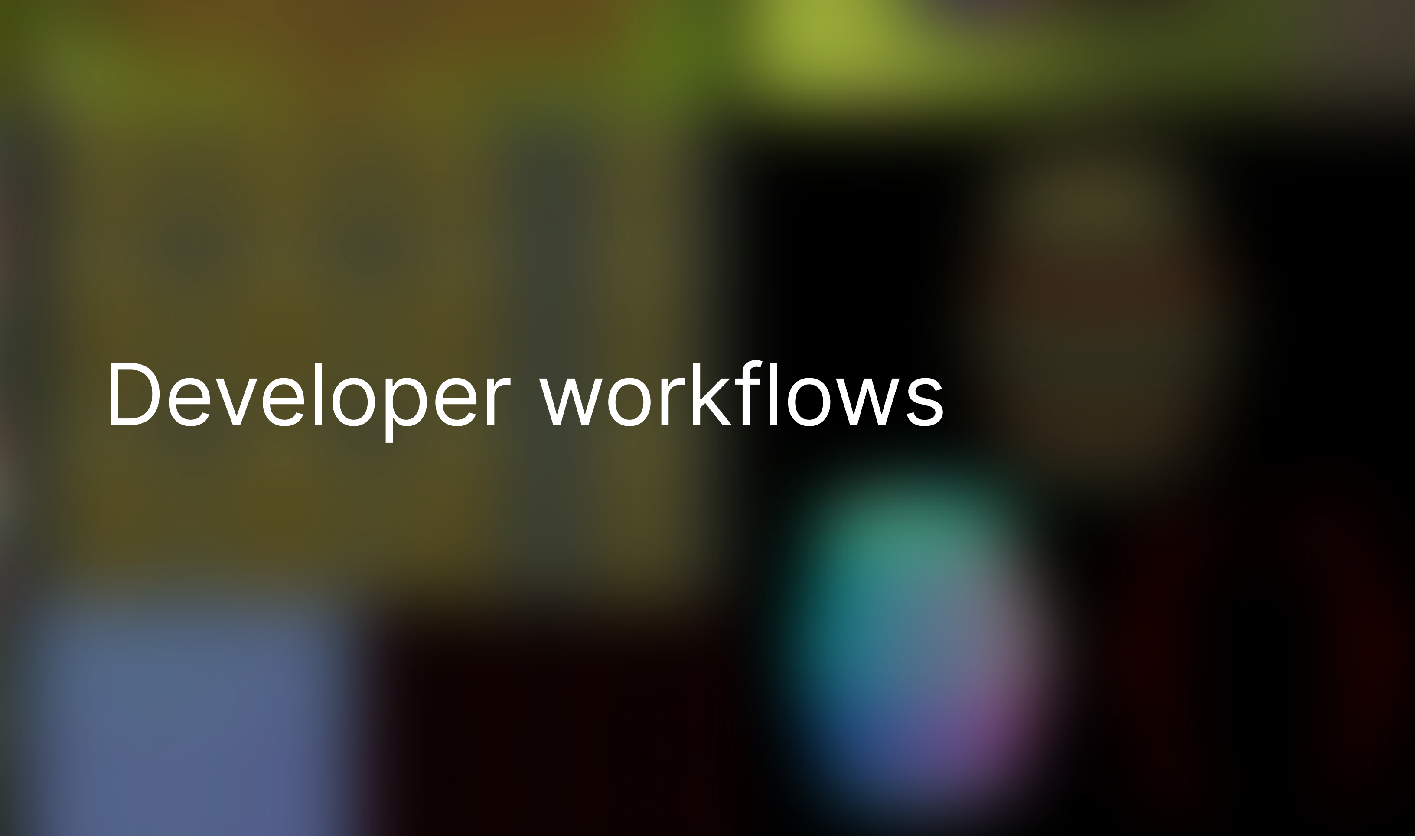
- **Sampling:** The number of samples directly influences the light bake's quality. More samples yield richer lighting details but extend bake times.
- **Denoising:** In certain conditions like low lighting, baking can introduce visual noise. Choose **Auto** to allow HDRP to choose a denoising algorithm automatically. Otherwise, select **Advanced** to select the Direct Denoiser and Indirect Denoiser.
- **Lightmap Compression:** Compression techniques can decrease memory usage but with a potential minor loss in quality.
- **Anti-aliasing:** To optimize performance, consider reducing the anti-aliasing level. For instance, switch from 8x Multi Sampling to 2x Multi Sampling in **Project Settings > Quality**.

5. You can choose between two backends for the Progressive Lightmapper, run on the CPU or the GPU. The Progressive GPU Lightmapper accelerates the generation of baked lightmaps with your computer's GPU and Dedicated Video Ram (VRAM).

   When using the GPU Lightmapper, consider these suggestions to optimize bake speed:

- Close other GPU-accelerated applications, especially those that use VRAM
- Switch to a CPU-based denoiser, like Intel Open Image, to free up VRAM
- If you have multiple GPUs, allocate one for rendering and another for baking
- Reduce the number of Anti-aliasing samples, especially for lightmap sizes of 4096 or above

See this documentation page for more information.



Developer workflows

There are always small but helpful shortcuts and tips that even long-time Unity developers can benefit from. Whether it's a small Property Attribute attached to a script variable or a handy but often-overlooked Editor setting, we're sure that you'll find plenty here to speed up your workflows.

Developer quality-of-life improvements are key to being more efficient and productive in your day-to-day activities. More of Unity is now taking advantage of Burst, giving you shorter iteration times, improved debugging insights, and a more responsive Inspector.

Async and await constructs now give you more efficient asynchronous programming, and you'll find it faster to get in and out of Play mode, resulting in more coding and less waiting.

Attributes

Unity has a variety of Attributes that can be placed above a class, property, or function to indicate special behavior such as creating headers, spacing or ranged fields in the inspector.

Attribute	Description	Example

SerializeField	This forces Unity to serialize a private field and makes it visible in the Inspector.	`[SerializeField]`
		`private GameObject myObject;`

Range	This attribute takes a float or int variable restricted to a specific range. The field appears as a slider in the Inspector.	`[Range(1,6)]`
		`public int integerRange;`
		`[Range(0.2f, 0.8f)]`
		`public float floatRange;`

HideInInspector	This makes a variable not appear in the Inspector but be serialized.	`[HideInInspector]`
		`public int p = 5;`

RequireComponent	This automatically adds required components as dependencies to avoid setup errors.
	Note: This attribute only checks the moment that the Component is added to a GameObject.
		`// PlayerScript requires the GameObject o have a Rigidbody`
		`[RequireComponent(typeof(Rigidbody))]`
		`public class PlayerScript: Monobehaviour`
		`{`
		`    private Rigidbody rBody;`
		`    void Start()`
		`    {`
		`      rBody = GetComponent<Rigidbody>();`
		`    }`
		`}`

Tooltip	This shows a tooltip when the user hovers a mouse over a field in the Inspector.	`public class PlayerScript: Monobehaviour`
		`{`
		`    [Tooltip("Health value between 0 and 100.")]`
		`    int health = 0;`
		` }`

Space	This adds a small space between your fields (without any additional text) to create visual separation between your fields.	`[Space(10)] // 10 pixel of spacing added`
		`int p = 5;`

Header	This adds some bold text and spacing to help organize your variables in the Inspector. Only add this to the first field that you want to belong to the group.	`public class PlayerScript: Monobehaviour`
		`{`
		`    [Header("Health Settings")]`
		`    public int health = 0;`
		`    public int maxHealth = 100;`
		`    [Header("Shield Settings")]`
		`    public int shield = 0;`
		`    public int maxShield = 0;`
		`}`

Multiline	This makes the string editable with the multiline text field. Pass in an optional int to designate the number of lines.
	Tip: Use this for annotating scripts with notes to yourself or another user.
		`[Multiline]`
		`public string textToEdit;`
		`[Multiline(20)]`
		`public string moreTextToEdit;`

SelectionBase	This is useful for selecting an otherwise empty GameObject whose *children* may contain meshes. Add the attribute to any component on the base object. When picking objects in the Editor, the GameObject containing the [SelectionBase] attribute gets selected rather than the children.	`// add this to the base GameObject`
		`[SelectionBase]`
		`public class PlayerScript: Monobehaviour`
		`{`
		`}`

This is just a small sample of the numerous Attributes. Do you want to rename your variables without losing their values? Or invoke some logic without needing an empty GameObject? See the Scripting API for a complete list of Attributes for everything that's possible.

You can even create your own PropertyAttribute to define custom Attributes for your script variables.

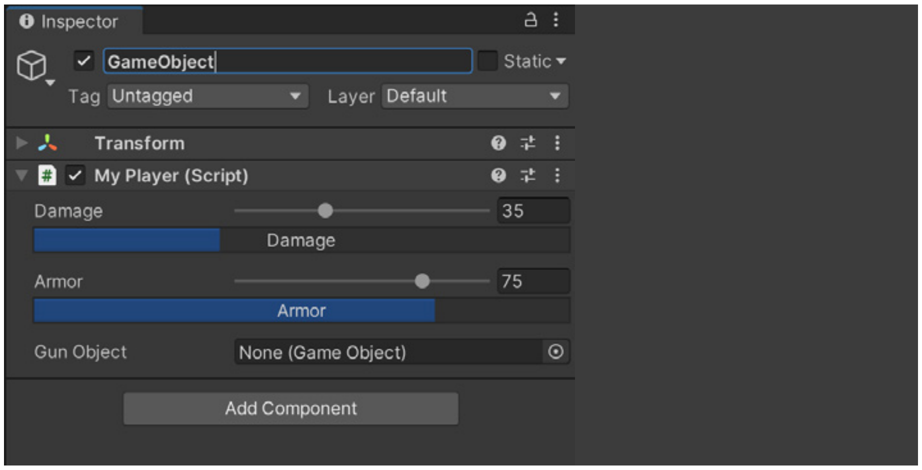
Custom windows and Inspectors

One of Unity's most powerful features is its extensible Editor. We recommend that you use the UI Toolkit package to create Editor UIs such as custom windows and Inspectors (you can also use the immediate mode IMGUI)

UI Toolkit has a workflow similar to standard web development. Use its HTML and XML inspired markup language, **UXML**, to define user interfaces and reusable UI templates. Then, apply **Unity Style Sheets (USS)** to modify the visual style and behaviors of your UIs.

Alternatively, you can use immediate mode IMGUI. Derive from the **Editor** base class, then use the **CustomEditor** attribute.

Either solution can make a **custom Inspector**.



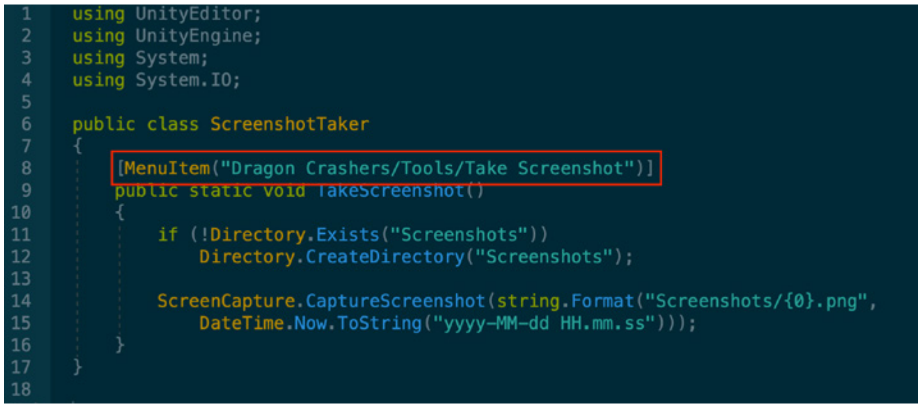
A custom Editor modifies how the MyPlayer script displays in the Inspector.

See **Creating user interfaces (UI)** for more detail on how to implement custom Editor scripts using either UI Toolkit or IMGUI. For a quick introduction to **UI Toolkit**, watch the **Getting Started with Editor Scripting** tutorial.

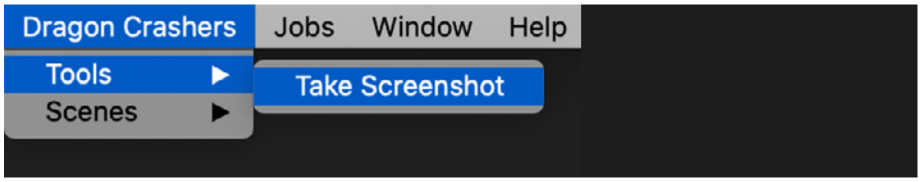
Custom menus

Unity includes a simple way to customize Editor menus and menu items, the **MenuItem** Attribute. You can apply this to any static method in your scripts.

If you have functions for your project that you will use frequently, organize them into menu items. This allows you to build a basic user interface with just a single PropertyAttribute modifier.



```
using UnityEditor;
using UnityEngine;
using System;
using System.IO;

public class ScreenshotTaker
{
    [MenuItem("Dragon Crashers/Tools/Take Screenshot")]
    public static void TakeScreenshot()
    {
        if (!Directory.Exists("Screenshots"))
            Directory.CreateDirectory("Screenshots");

        ScreenCapture.CaptureScreenshot(string.Format("Screenshots/{0}.png",
            DateTime.Now.ToString("yyyy-MM-dd HH.mm.ss")));
    }
}
```



The MenuItem Attribute creates a simple interface to attach the static method (Take Screenshot).

Enter Play Mode settings

When you enter Play Mode, your project starts and runs as it would in a build. Any changes you make in the Editor during Play Mode reset when you exit Play Mode.

Each time that you enter Play Mode in the Editor, Unity performs two significant actions:

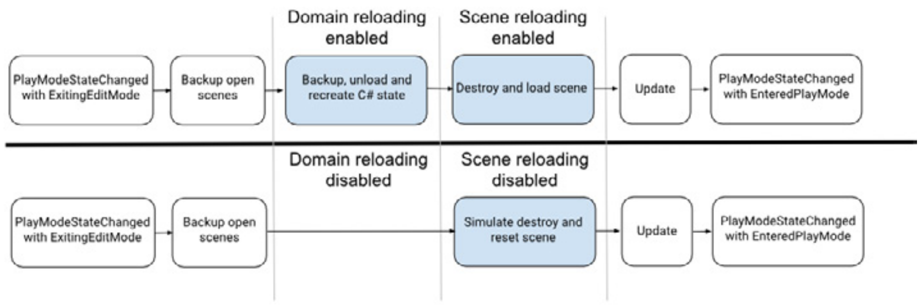
— **Domain Reload:** Unity backs up, unloads, and recreates scripting states.

— **Scene Reload:** Unity destroys the Scene and loads it again.

These two actions take more and more time as your scripts and Scenes become more complex.

If you don’t plan on making any more script changes, the **Enter Play Mode Settings (Edit > Project Settings > Editor)** can save you a bit of compile time. Unity gives you the option to disable either Domain Reload, Scene Reload, or both. This can speed up entering and exiting Play Mode.

Just remember that if you *do* plan on making further script changes, you need to re-enable Domain Reload. Likewise, if you modify the Scene Hierarchy, you should re-enable Scene Reload. Otherwise, unexpected behavior could result.



Domain reloading enabled
Scene reloading enabled
PlayModeStateChanged with ExitingEditMode
Backup open scenes
Backup, unload and recreate C# state
Destroy and load scene
Update
PlayModeStateChanged with EnteredPlayMode
Domain reloading disabled
Scene reloading disabled
PlayModeStateChanged with ExitingEditMode
Backup open scenes
Simulate destroy and reset scene
Update
PlayModeStateChanged with EnteredPlayMode

The effects of disabling the Reload Domain and Reload Scene settings.

Enter Play Mode optimizations

In Unity 2022 LTS, the Enter Play Mode performance is optimized to speed up iteration times. This improvement includes faster scene saving, increased use of multi-threading to speed up static batching and particle prewarming, and a reduced cost on some package initialization times (e.g., TerrainTools and Visual Studio packages).

Script templates

Do you find that you make the same changes every time you create a new script? Do you instinctively add a namespace or delete the update event function? Save yourself a few keystrokes and create consistency across the team by setting up the script template for your preferred starting point.

Every time you create a new script or shader, Unity uses a template stored in **%EDITOR_PATH%\Data\Resources\ScriptTemplates**:

— Windows: *C:\Program Files\Unity\Editor\Data\Resources\ScriptTemplates*

— Mac: */Applications/Hub/Editor/[version]/Unity/Unity.app/Contents/Resources/ScriptTemplates*

The default Monobehaviour template is this one:
`81-C# Script-NewBehaviourScript.cs.txt`

There are also templates for shaders, other behavior scripts, and assembly definitions.

For project-specific script templates, create an **Assets/ScriptTemplates** folder. Copy the script templates into this folder to override the defaults.

You can also modify the default script templates directly for all projects, but make sure that you backup the originals before making any changes.

The original **`81-C# Script-NewBehaviourScript.cs.txt`** file looks like this:

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
#ROOTNAMESPACEBEGIN#
public class #SCRIPTNAME# : MonoBehaviour
{
    // Start is called before the first frame update
    void Start()
    {
        #NOTRIM#
    }
    // Update is called once per frame
    void Update()
    {
        #NOTRIM#
    }
}
#ROOTNAMESPACEEND#
```

There are two keywords that may be helpful to you:

— **#SCRIPTNAME#** indicates the filename entered or the default filename (for example, NewBehaviourScript).

— **#NOTRIM#** ensures that the brackets contain a line of whitespace.

For example, you may want to set up the default Monobehaviour to have default regions in order to stay organized:

```
/*
 * Modified template by Unity Support.
 */

using UnityEngine;

public class #SCRIPTNAME# : MonoBehaviour
{
    #region Public Fields
    #endregion

    #region Unity Methods
    void Start()
    {
    }

    void Update()
    {
    }
    #endregion

    #region Private Methods
    #endregion
}
```

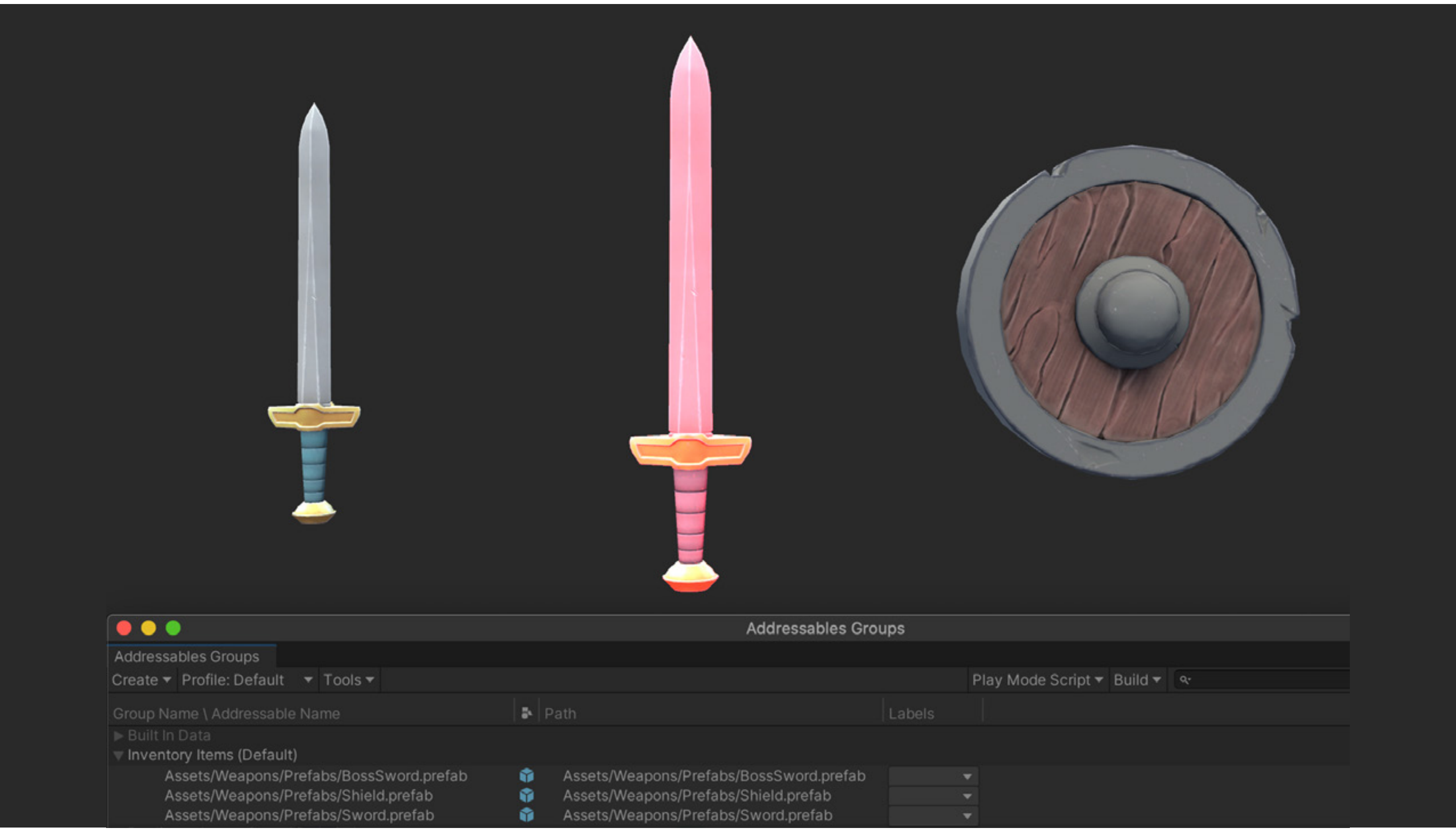
Relaunch the Unity Editor, and your changes should appear every time you create a custom Monobehaviour.

Modify the other templates in a similar fashion. Remember to keep a copy of your original and modifications somewhere outside the Unity project for safekeeping.

Addressables

The Addressable Asset System simplifies how you manage the assets that make up your game. Any asset, including Scenes, Prefabs, text assets, and so on, can be marked as "addressable" and given a unique name. You can call this alias from anywhere.

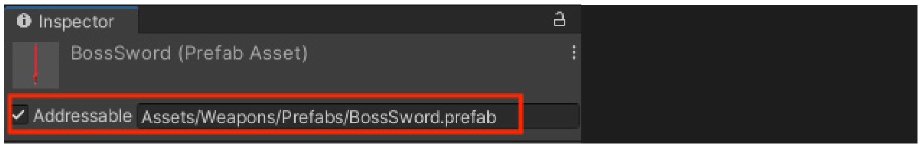
Adding this extra level of abstraction between the game and its assets can streamline certain tasks, such as creating a separate downloadable content pack. This system makes referencing those asset packs easier as well, whether they're local or remote.



Group Name \ Addressable Name	Path	Labels
▶ Built In Data		
▼ Inventory Items (Default)		
Assets/Weapons/Prefabs/BossSword.prefab	Assets/Weapons/Prefabs/BossSword.prefab	
Assets/Weapons/Prefabs/Shield.prefab	Assets/Weapons/Prefabs/Shield.prefab	
Assets/Weapons/Prefabs/Sword.prefab	Assets/Weapons/Prefabs/Sword.prefab	

In this example, Addressables tracks the inventory of Prefabs.

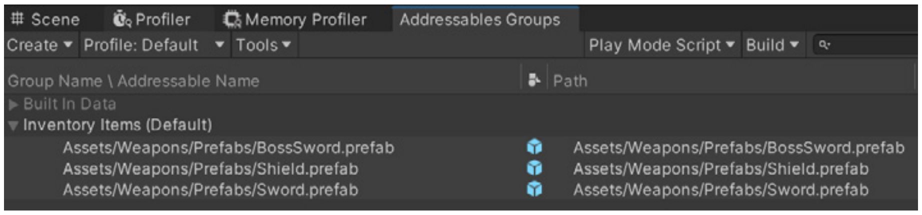
To begin, install the Addressables package from the Package Manager, and add some basic settings to the project. Each asset or Prefab in the project should have the option to be made “addressable” as a result. Checking the option under an asset’s name in the Inspector assigns it a default unique address.



✓ Addressable Assets/Weapons/Prefabs/BossSword.prefab

Addressable option enabled with default Addressable Name

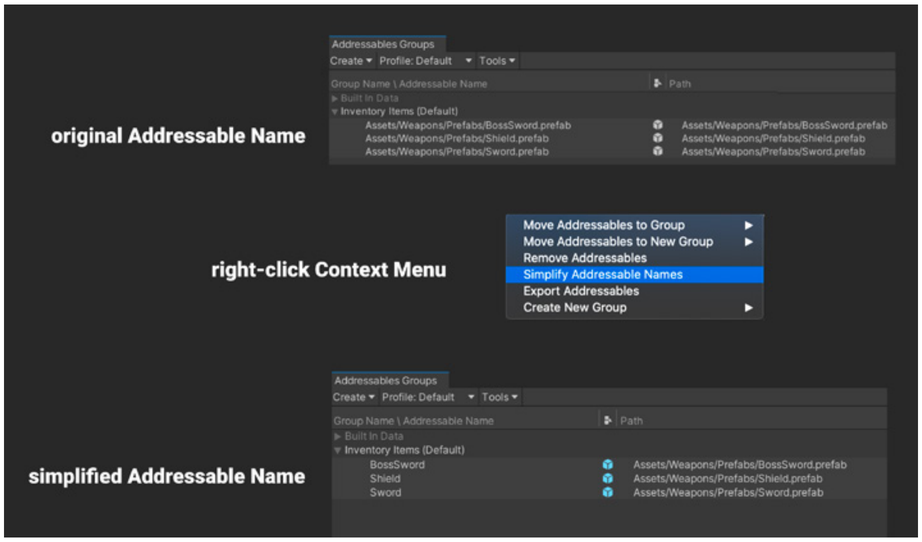
Once marked, the corresponding assets appear in the **Window > Asset Management > Addressables > Groups** window.



Group Name \ Addressable Name	Path
▶ Built In Data	
▼ Inventory Items (Default)	
Assets/Weapons/Prefabs/BossSword.prefab	Assets/Weapons/Prefabs/BossSword.prefab
Assets/Weapons/Prefabs/Shield.prefab	Assets/Weapons/Prefabs/Shield.prefab
Assets/Weapons/Prefabs/Sword.prefab	Assets/Weapons/Prefabs/Sword.prefab

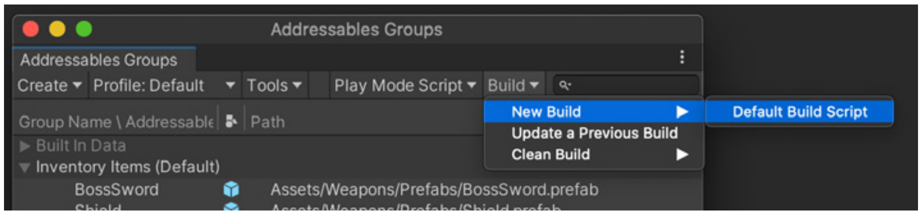
In Addressables Groups, you can see each asset’s custom address, paired with its location.

For convenience, you can either rename each address in the asset’s individual Address field or simplify them at once.


original Addressable Name
right-click Context Menu
Move Addressables to Group
Move Addressables to New Group
Remove Addressables
Simplify Addressable Names
Export Addressables
Create New Group
simplified Addressable Name

Group Name \ Addressable Name	Path
▶ Built In Data	
▼ Inventory Items (Default)	
BossSword	Assets/Weapons/Prefabs/BossSword.prefab
Shield	Assets/Weapons/Prefabs/Shield.prefab
Sword	Assets/Weapons/Prefabs/Sword.prefab

Simplify the Addressable Names with a single menu action, or rename them individually.



Use the default build script to generate an Addressable Group asset bundle.

Bundle these assets to be hosted on a server elsewhere or distribute them locally with your project. Wherever each asset resides, the system will locate it using the Addressable Name string.

You can now use your addressable assets using the Addressables API.

For example, without Addressables, if you wanted to instantiate a Prefab in your scene, you might do this:

```
public GameObject prefabToCreate;
public void CreatePrefab()
{
    GameObject.Instantiate(prefabToCreate);
}
```

The disadvantage here is that any referenced Prefab (like prefabToCreate) would load into memory, even if the scene didn't require it.

Using Addressables, you could instead do this:

```
public string prefabByAddress;
…
public void CreatePrefabWithAddress()
{
    Addressables.Instantiate(prefabByAddress, instantiationPa-
rameters, bool);
}
```

This loads the asset by its address string. The Prefab does not load into memory until it's needed (when we invoke Adressables.Instantiate inside CreatedPrefabWithAddress). In addition, Addressables provides high-level reference counting and automatically unloads bundles and their associated assets when they're no longer in use.

Tales from the Optimization Trenches: Saving Memory with Addressables offers an example of how to organize your Addressable Groups to be more memory efficient. You can also check out the **Addressables: Introduction to Concepts** tutorial for a quick overview of how the Addressable Asset system can work in your project.

Operating live games: Cloud Content Delivery with Addressables

If you are operating a live game, then you might want to consider using Unity's Cloud Content Delivery (CCD) solution with Addressables. The Addressables system stores and catalogs game assets so that they can be automatically found and called, and then CCD pushes those assets directly to your players, completely separate from your code. This reduces your build size and eliminates the need to have your players download and install new game versions whenever you want to make an update. To learn more, read this blog post on the integration between Addressables and Cloud Content Delivery.

Preprocessor directives

The Platform Dependent Compilation feature allows you to partition your scripts to compile and execute code for a specifically targeted platform.

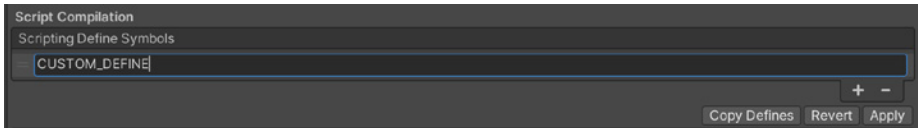
This example makes use of the existing platform **#define** directives with the **#if** compiler directive:

```
using UnityEngine;
using System.Collections;

public class PlatformDefines : MonoBehaviour
{
  void Start ()
  {
    #if UNITY_EDITOR
      Debug.Log(“Unity Editor”);
    #endif

    #if UNITY_IOS
      Debug.Log(“Iphone”);
    #endif

    #if UNITY_STANDALONE_OSX
      Debug.Log(“Stand Alone OSX”);
    #endif

    #if UNITY_STANDALONE_WIN
      Debug.Log(“Stand Alone Windows”);
    #endif

  }
}
```

Use the **DEVELOPMENT_BUILD** #define to identify whether your script is running in a player which was built with the **Development Build** option.

You can also compile selectively for specific Unity versions and/or scripting backends.

You can supply your own custom #define directives when testing in the Editor. Open the **Other Settings** panel of the Player settings, and navigate to **Scripting Define Symbols**.


Script Compilation
Scripting Define Symbols
CUSTOM_DEFINE

See Platform Dependent Compilation for more information about Unity’s preprocessor directives.

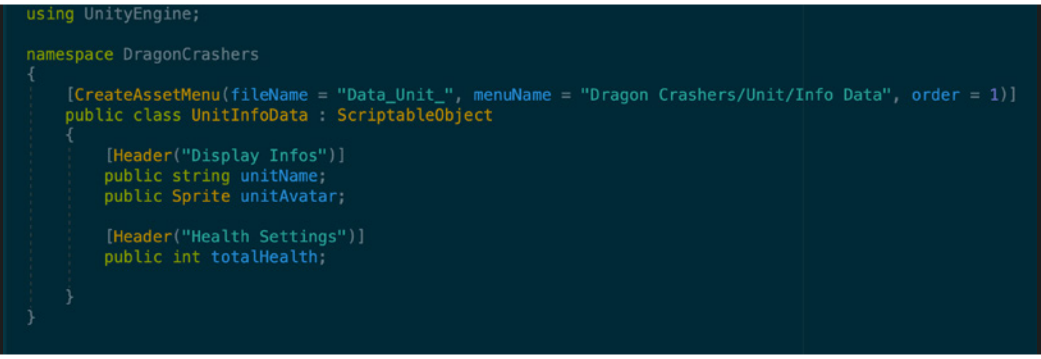
ScriptableObjects

A ScriptableObject is a data container that saves large amounts of data, independent of class instances. ScriptableObjects can reduce your project's memory usage by avoiding copies of values.

ScriptableObjects can help promote clean coding practices by separating data from logic. This means it's easier to make changes without causing unintended side effects, which improves testability and modularity. They're also useful when you're collaborating with non-programmers like artists and designers.

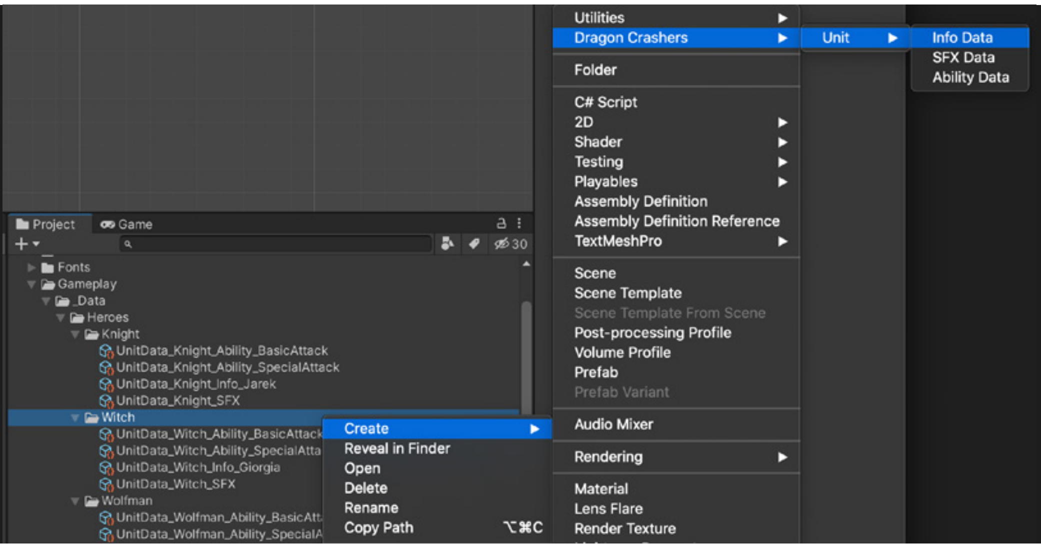
Let's use the example of a project that has a prefab that stores unchanging data in an attached MonoBehaviour script. Unlike with MonoBehaviours, the data saved to ScriptableObjects is written to disk as an asset and not attached to a GameObject. Thus, it can persist between sessions.

Dragon Crashers demonstrates a typical use case. A UnitInfoData class inherits from **ScriptableObject**. Each of its instances contains the unit's name, sprite, and health settings. This data remains constant over the course of gameplay, making it especially suitable for storage inside a ScriptableObject.



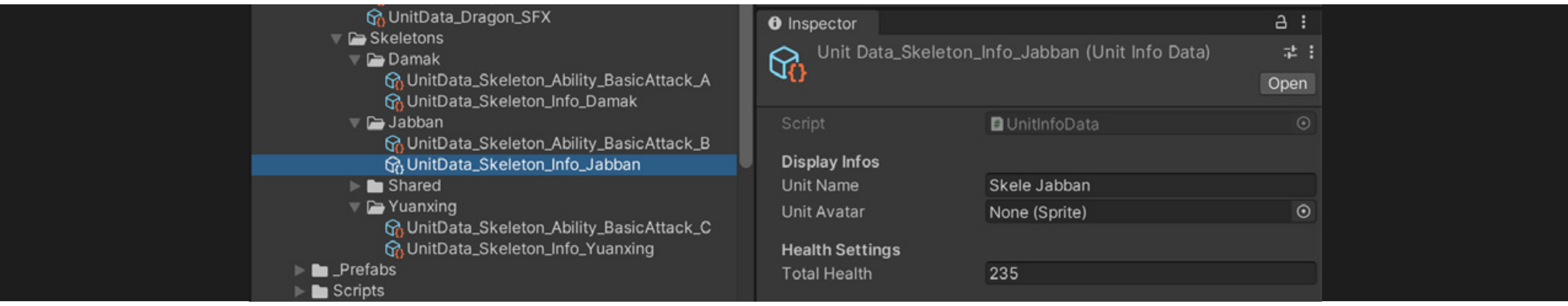
```
using UnityEngine;

namespace DragonCrashers
{
    [CreateAssetMenu(fileName = "Data_Unit_", menuName = "Dragon Crashers/Unit/Info Data", order = 1)]
    public class UnitInfoData : ScriptableObject
    {
        [Header("Display Infos")]
        public string unitName;
        public Sprite unitAvatar;

        [Header("Health Settings")]
        public int totalHealth;

    }
}
```

A ScriptableObject defines a data container object.



The CreateAssetMenu attribute generates a context menu item to help you generate an asset on disk. Each unit has additional ScriptableObjects for sound effects and special abilities.

With the assets created in the project window, you can fill in the correct values using the Inspector: Unit Name, Unity Avatar (Sprite), and Total Health.


UnitData_Dragon_SFX
Skeletons
Damak
UnitData_Skeleton_Ability_BasicAttack_A
UnitData_Skeleton_Info_Damak
Jabban
UnitData_Skeleton_Ability_BasicAttack_B
UnitData_Skeleton_Info_Jabban
Shared
Yuanxing
UnitData_Skeleton_Ability_BasicAttack_C
UnitData_Skeleton_Info_Yuanxing
_Prefabs
Scripts
Inspector
Open

Unit Data_Skeleton_Info_Jabban (Unit Info Data)

Script UnitInfoData

Display Infos

Unit Name Skele Jabban

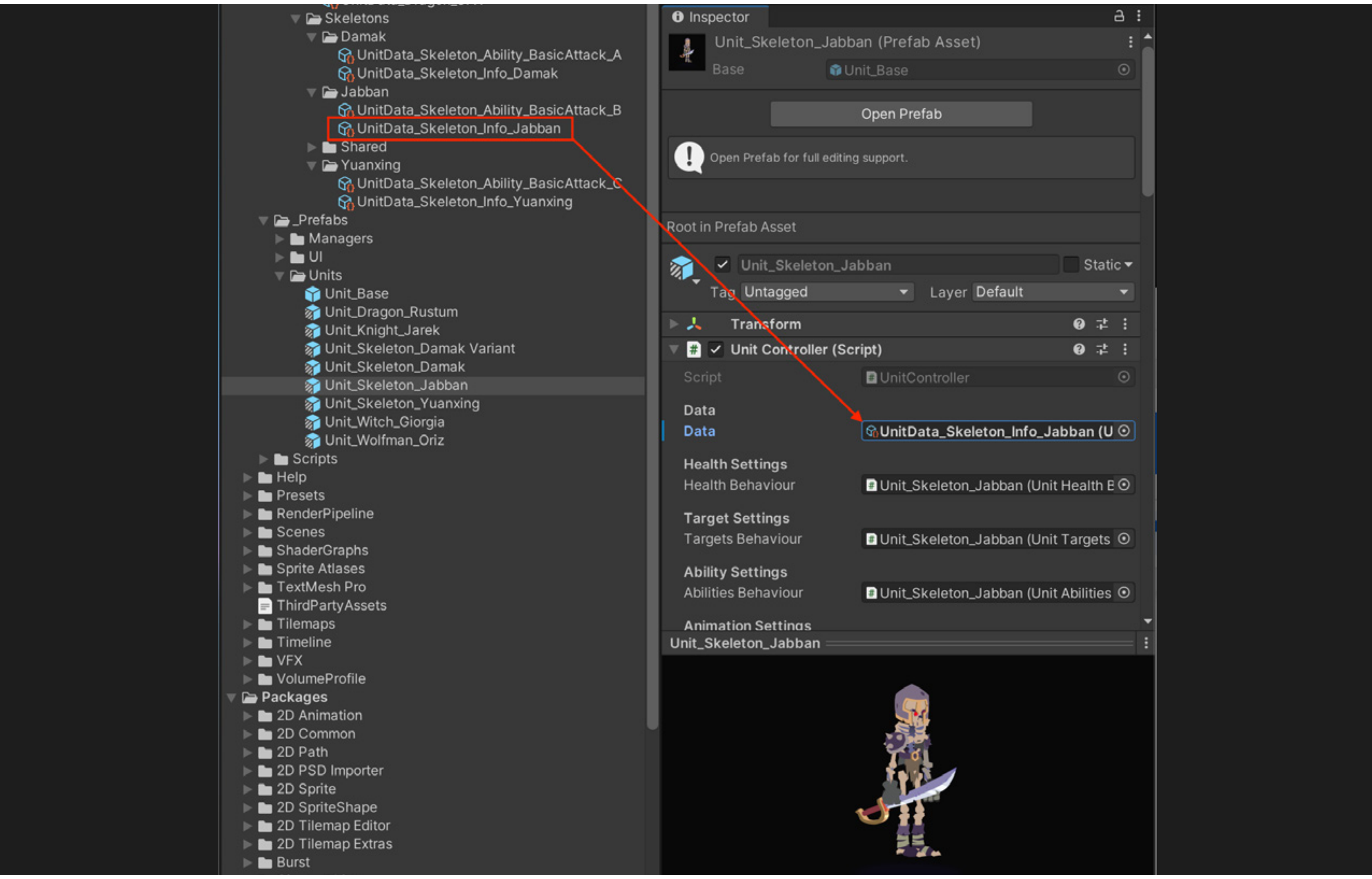
Unit Avatar None (Sprite)

Health Settings

Total Health 235

Use the Inspector to fill out values for the ScriptableObject asset. These values won't change during gameplay.

A GameObject (like the UnitController in this case) can then reference the ScriptableObject asset. If the Scene suddenly fills with units, the data on the ScriptableObject asset does not duplicate, saving memory.



Unit_Skeleton_Jabban (Prefab Asset)

Base Unit_Base

Open Prefab for full editing support.

Root in Prefab Asset

Unit_Skeleton_Jabban Static

Tag Untagged Layer Default

Unit Controller (Script)

Script UnitController

Data

Data UnitData_Skeleton_Info_Jabban (U

Health Settings

Health Behaviour Unit_Skeleton_Jabban (Unit Health E

Target Settings

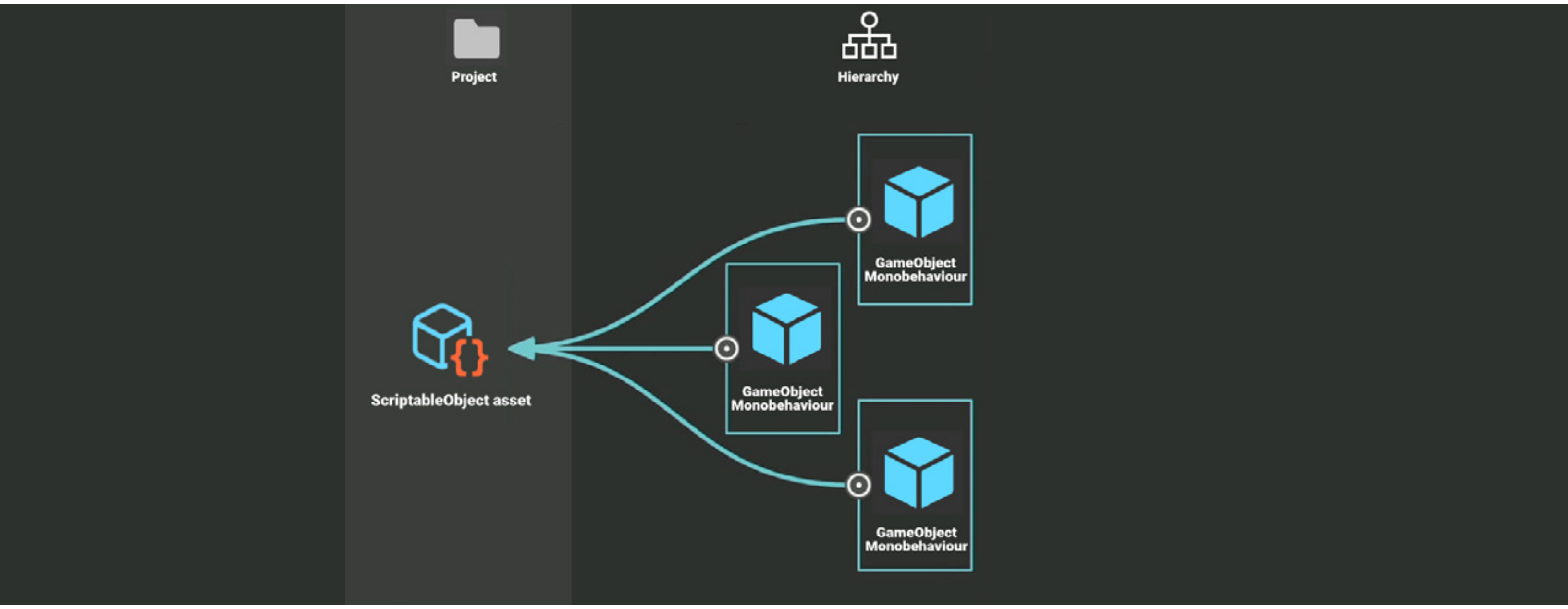
Targets Behaviour Unit_Skeleton_Jabban (Unit Targets

Ability Settings

Abilities Behaviour Unit_Skeleton_Jabban (Unit Abilities

Animation Settings

The Monobehaviour object (UnitController, shown above) refers to the ScriptableObject data asset in the project.



Save memory and stay organized with ScriptableObjects. Set static data and settings in the asset in the project just once, even if you have lots of GameObjects.

Even if you add a thousand instances of a Prefab to your Scene, they still refer to the same data stored in your asset. Setting up the set of values just once guarantees consistency.

As your game scales up with more unit types, simply create more ScriptableObject assets and swap them out appropriately. Maintain your gameplay data just by tweaking the centrally stored assets.

ScriptableObjects don't replace keeping persistent data for the rest of your application's save files, where the data may change during gameplay. It's a workflow suited more for storing your static gameplay settings and values. Unlike parsing data from JSON or XML, reading a ScriptableObject asset won't generate garbage (and, as a bonus, it's faster).

More resources

— Create modular game architecture with ScriptableObjects in Unity

— ScriptableObjects Paddle Ball demo project

— ScriptableObject documentation

— Achieve Better Scene Workflow with ScriptableObjects

Optimization tip

You can use binary serialization formats such as MessagePack or Protocol Buffers for saving data, rather than text-based ones such as JSON or XML. In Project Reviews, these binary serialization formats reduce the memory and performance issues associated with the latter.

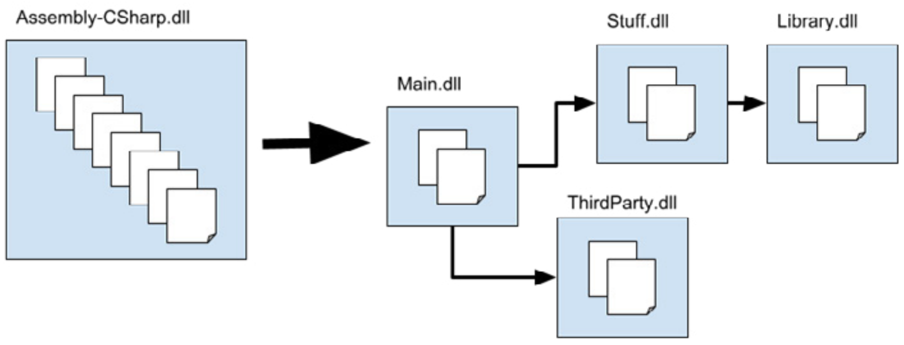
Managing assemblies

An assembly is a C# code library, a collection of types and resources that are built to work together and form a logical unit of functionality. By default, Unity compiles almost all of your game scripts into the predefined assembly, **Assembly-CSharp.dll**. This works for small projects, but it has some drawbacks:

- Every time you change a script, Unity recompiles all other scripts;
- Any script can access types defined in any other script;
- All scripts are compiled for all platforms.

Organizing your scripts into custom assemblies promotes modularity and reusability. It prevents them from getting added to the default assemblies automatically and limits which other scripts they can access.

You might split up your code into multiple assemblies, as shown in the diagram above. Here, any changes to the code in Main cannot affect the code in Stuff.



The project split into multiple assemblies

Similarly, because Library doesn't depend on any other assemblies, you can more easily reuse the code in Library in another project.

Assemblies in .NET has general information about assemblies in C#. Refer to Assembly definitions in the Unity documentation for more information about defining your own assemblies in Unity.

IDEs and debugging

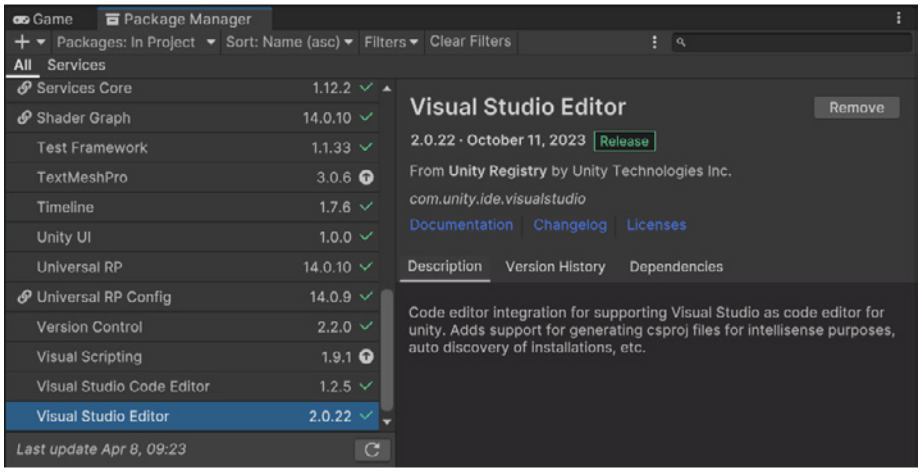
Unity offers support for the following integrated development environments (IDEs):

— **Visual Studio** (default IDE on Windows and macOS)

— **Visual Studio Code** (Windows, macOS, Linux)

— **JetBrains Rider** (Windows, macOS, Linux)

IDE integrations for all three of these environments appear as packages in the Package Manager.



Services Core	1.12.2 ✓
Shader Graph	14.0.10 ✓
Test Framework	1.1.33 ✓
TextMeshPro	3.0.6
Timeline	1.7.6 ✓
Unity UI	1.0.0 ✓
Universal RP	14.0.10 ✓
Universal RP Config	14.0.9 ✓
Version Control	2.2.0 ✓
Visual Scripting	1.9.1
Visual Studio Code Editor	1.2.5 ✓
Visual Studio Editor	2.0.22 ✓

Last update Apr 8, 09:23

Visual Studio Editor

2.0.22 · October 11, 2023 Release

From **Unity Registry** by Unity Technologies Inc.

com.unity.ide.visualstudio

Documentation Changelog Licenses

Code editor integration for supporting Visual Studio as code editor for unity. Adds support for generating csproj files for intellisense purposes, auto discovery of installations, etc.

IDE integrations as packages

Visual Studio is installed by default when you install Unity on **Windows** and **macOS**. If you want to use another IDE, simply browse for the editor in **Unity > Preferences > External Tools > External Script Editor**.

Rider is built on top of ReSharper and includes most of its features. It supports C# debugging on the .NET 4.6 scripting runtime in Unity (C# 8.0). For more information, see JetBrains's documentation on Rider for Unity.

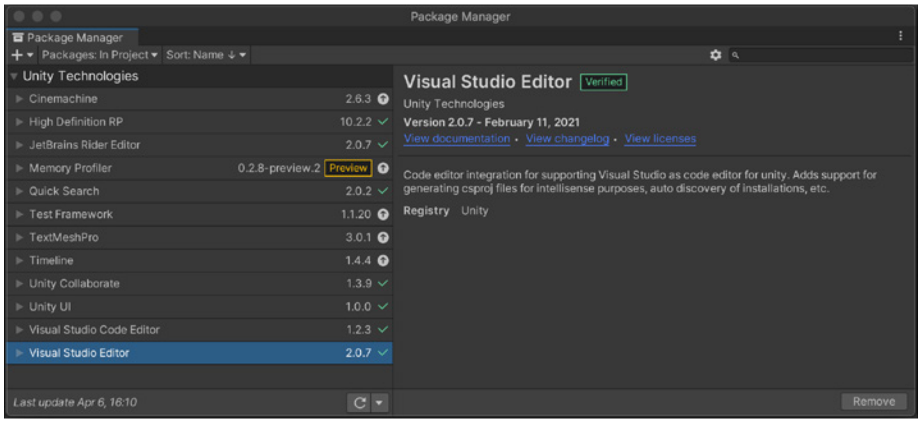
VS Code works with many available extensions to function as a full-scale IDE and is a popular code editor for web developers.

You'll need to complete several steps to use VS Code in Unity.

1. Download and install Visual Studio Code from its website, where you'll find versions for Windows, macOS, or Linux.

2. Get the Visual Studio Editor package for Unity. In the Package Manager window, **be sure to install or, if you have an older version of the package, upgrade to version 2.0.20 or above**.

Note: The Visual Studio Editor package now handles the entire family of Visual Studio products. Don't confuse it with the package named Visual Studio Code Editor, which is no longer supported.


Package Manager

Packages: In Project ▾ Sort: Name ↓ ▾

Unity Technologies

Cinemachine	2.6.3
High Definition RP	10.2.2 ✓
JetBrains Rider Editor	2.0.7 ✓
Memory Profiler	0.2.8-preview.2 Preview
Quick Search	2.0.2 ✓
Test Framework	1.1.20
TextMeshPro	3.0.1
Timeline	1.4.4
Unity Collaborate	1.3.9 ✓
Unity UI	1.0.0 ✓
Visual Studio Code Editor	1.2.3 ✓
Visual Studio Editor	2.0.7 ✓

Last update Apr 6, 16:10

Visual Studio Editor Verified

Unity Technologies

Version 2.0.7 - February 11, 2021

View documentation • View changelog • View licenses

Code editor integration for supporting Visual Studio as code editor for unity. Adds support for generating csproj files for intellisense purposes, auto discovery of installations, etc.

Registry Unity

Remove

Install the Visual Studio Editor from the Package Manager

3. After installing VS Code and the Visual Studio Editor package, you'll need to set VS Code as the external script editor. Do this via **Unity > Preferences > External Tools** in the Editor. Under **External Script Editor**, choose **Visual Studio Code** from the drop-down menu. If VS Code doesn't appear in the list, click Browse and locate the VS Code executable on your system. The next time you open a C# file in Unity, Unity will open Visual Studio Code for you.

4. The next step is to install the Unity extension for Visual Studio Code, which provides a streamlined Unity development experience on Visual Studio Code. It builds on top of the rich C# capabilities provided by the C# Dev Kit and C# extensions as well as integrating natively with Visual Studio Code.

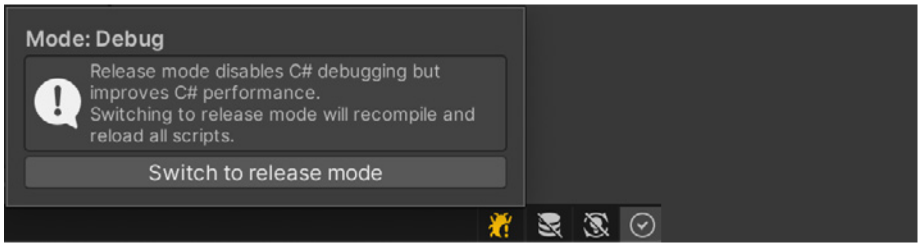
   Go to the Visual Studio Marketplace for the extension. After you click to download it, a window will open prompting you to open it in the Visual Studio Code application. VS Code will then install the Unity extensions, including C# Dev Kit and C# extensions.

Each IDE has its own productive merits. See Integrated development environment (IDE) support for more information about choosing an IDE.

Debugging

The Unity Debugger allows you to debug your C# code while the Unity Entity is in Play Mode. You can attach breakpoints within the code editor in order to inspect the state of your script code and its current variables at runtime.

Set the Code Optimization mode to **Debug** in the bottom right of the Unity Editor Status Bar. You can also change this mode on startup at **Edit > Preferences > General > Code Optimization On Startup**.

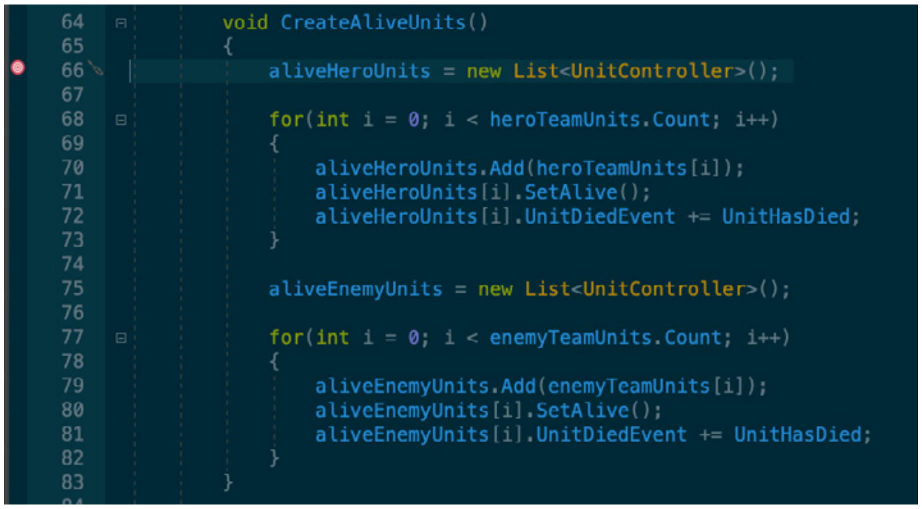

Mode: Debug

Release mode disables C# debugging but improves C# performance.
Switching to release mode will recompile and reload all scripts.

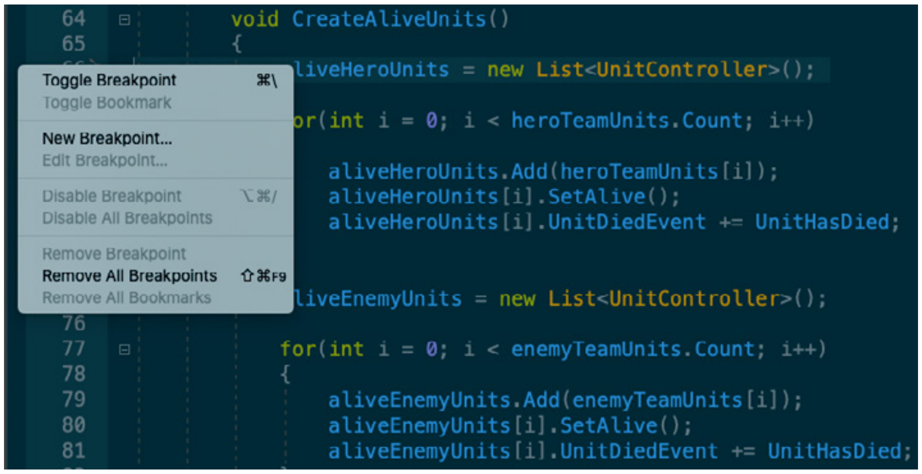
Switch to release mode

Debug Mode

In the code editor, set a breakpoint where you want the debugger to pause execution. Simply click over the left margin/gutter area where you want to toggle a breakpoint (or right-click there to use the context menu for more options). A red circle appears next to the line number of the highlighted line (see image below).



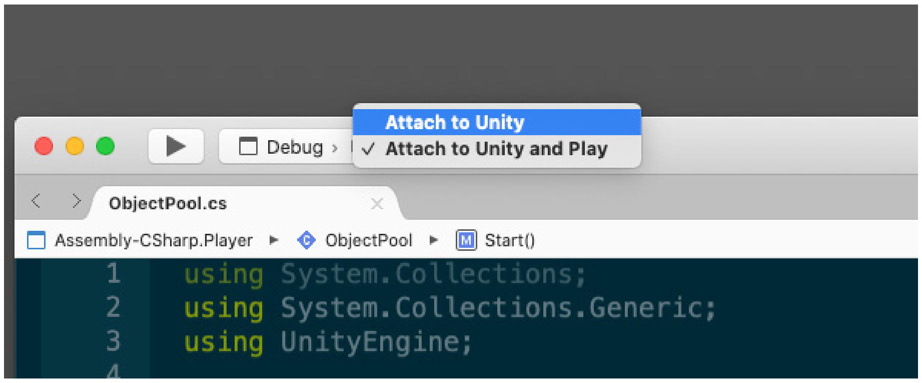
```
void CreateAliveUnits()
{
    aliveHeroUnits = new List<UnitController>();

    for(int i = 0; i < heroTeamUnits.Count; i++)
    {
        aliveHeroUnits.Add(heroTeamUnits[i]);
        aliveHeroUnits[i].SetAlive();
        aliveHeroUnits[i].UnitDiedEvent += UnitHasDied;
    }

    aliveEnemyUnits = new List<UnitController>();

    for(int i = 0; i < enemyTeamUnits.Count; i++)
    {
        aliveEnemyUnits.Add(enemyTeamUnits[i]);
        aliveEnemyUnits[i].SetAlive();
        aliveEnemyUnits[i].UnitDiedEvent += UnitHasDied;
    }
}
```



```
void CreateAliveUnits()
{
liveHeroUnits = new List<UnitController>();

or(int i = 0; i < heroTeamUnits.Count; i++)

        aliveHeroUnits.Add(heroTeamUnits[i]);
        aliveHeroUnits[i].SetAlive();
        aliveHeroUnits[i].UnitDiedEvent += UnitHasDied;

liveEnemyUnits = new List<UnitController>();

    for(int i = 0; i < enemyTeamUnits.Count; i++)
    {
        aliveEnemyUnits.Add(enemyTeamUnits[i]);
        aliveEnemyUnits[i].SetAlive();
        aliveEnemyUnits[i].UnitDiedEvent += UnitHasDied;
```

Toggling a breakpoint

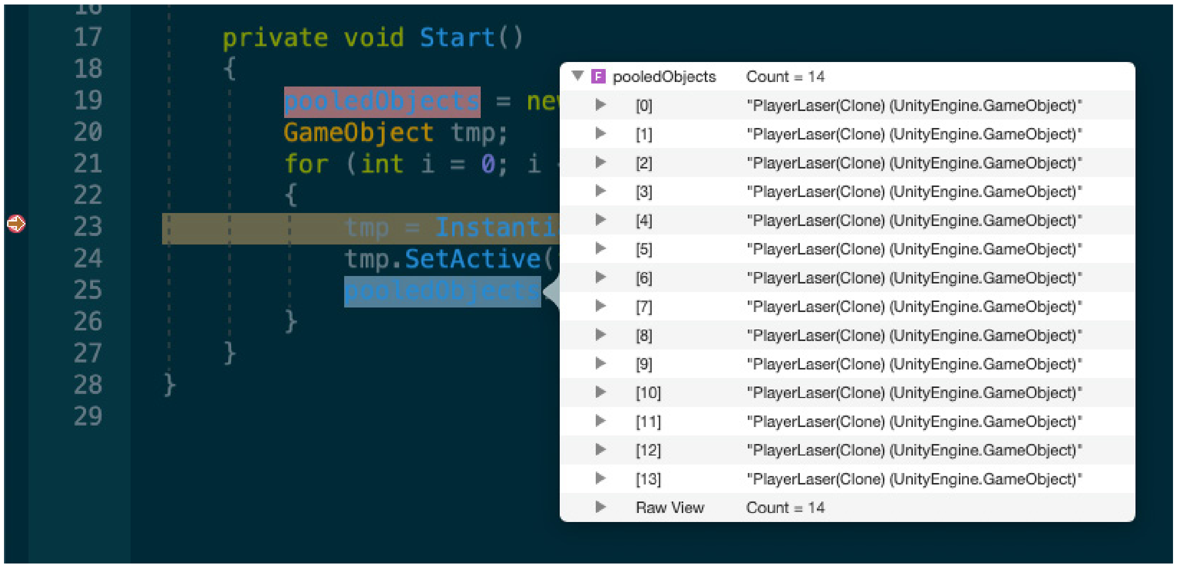
Select **Attach to Unity** in your code editor. In the Unity Editor, run the project.



```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;
```

Attaching the Debugger to Unity

In Play Mode, the application will pause at the breakpoint, giving you time to inspect variables and investigate any unintended behavior.

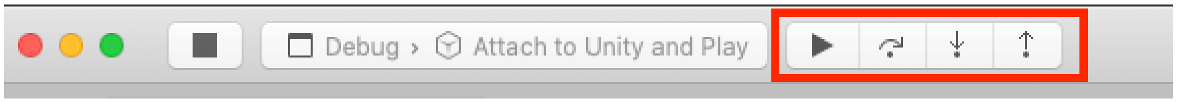


```
    private void Start()
    {
        pooledObjects = ne
        GameObject tmp;
        for (int i = 0; i
        {
            tmp = Instanti
            tmp.SetActive(
            pooledObject
        }
    }
}
```

```
▼ pooledObjects    Count = 14
  ▶ [0]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [1]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [2]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [3]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [4]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [5]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [6]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [7]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [8]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [9]      "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [10]     "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [11]     "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [12]     "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ [13]     "PlayerLaser(Clone) (UnityEngine.GameObject)"
  ▶ Raw View Count = 14
```

Debugging variables

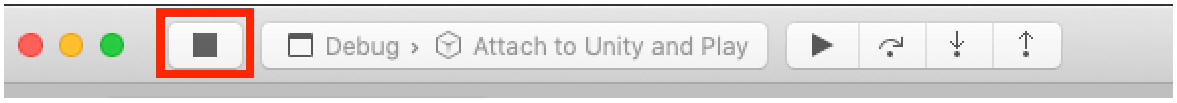
In the example above, you can inspect the variables when debugging, watching the list build up one step at a time during execution.



Debug controls: Continue Execution, Step Over, Step Into, and Step Out

Use the **Continue Execution**, **Step Over**, **Step Into** and **Step Out** controls to navigate the control flow.

Press **Stop** to discontinue debugging and resume execution in the Editor.



Debug controls: Stop

You can debug script code in a Unity Player as well. Just make sure that **Development Build** and **Script Debugging** are both enabled in the **File > Build Settings** before you build the Player. Check **Wait for Managed Debugger** to wait for the debugger before the Player executes any script code.

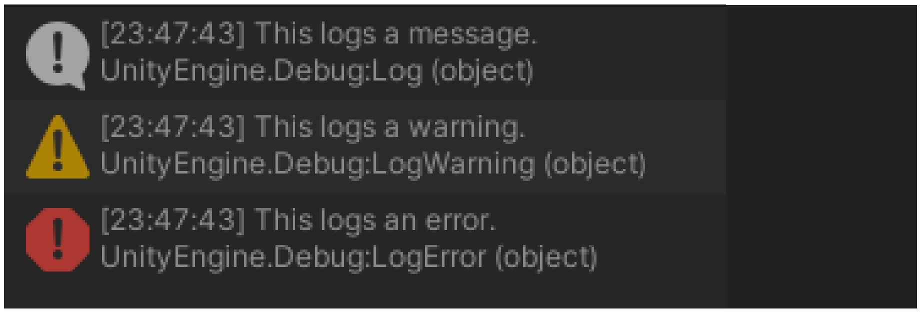
To attach the code editor to the Unity Player, select the IP address (or machine name) and port of your player. Then proceed normally in Visual Studio with the **Attach To Unity** option.

Additional debugging tips

Unity also includes a Debug class to help you visualize information in the Editor while it is running. Use it to print messages or warnings into the Console window, draw visualization lines in the Scene view and Game view, and pause Play Mode in the Editor from script.

1. Pause execution with **Debug.Break**. This is useful if you want to check certain values in the Inspector when the application is difficult to pause manually.

2. You should be familiar with **Debug.Log**, **Debug.LogWarning**, and **Debug.LogError** for printing Console messages. Also handy is **Debug.Assert**, which asserts a condition and logs an error on failure (only works if UNITY_ASSERTIONS symbol is defined).



```
[23:47:43] This logs a message.
UnityEngine.Debug:Log (object)
[23:47:43] This logs a warning.
UnityEngine.Debug:LogWarning (object)
[23:47:43] This logs an error.
UnityEngine.Debug:LogError (object)
```

Log messages, warnings, and errors in the Console

3. When using **Debug.Log**, you can pass in an object as the context. If you click on the message in the Console, Unity highlights the GameObject in the Hierarchy window.

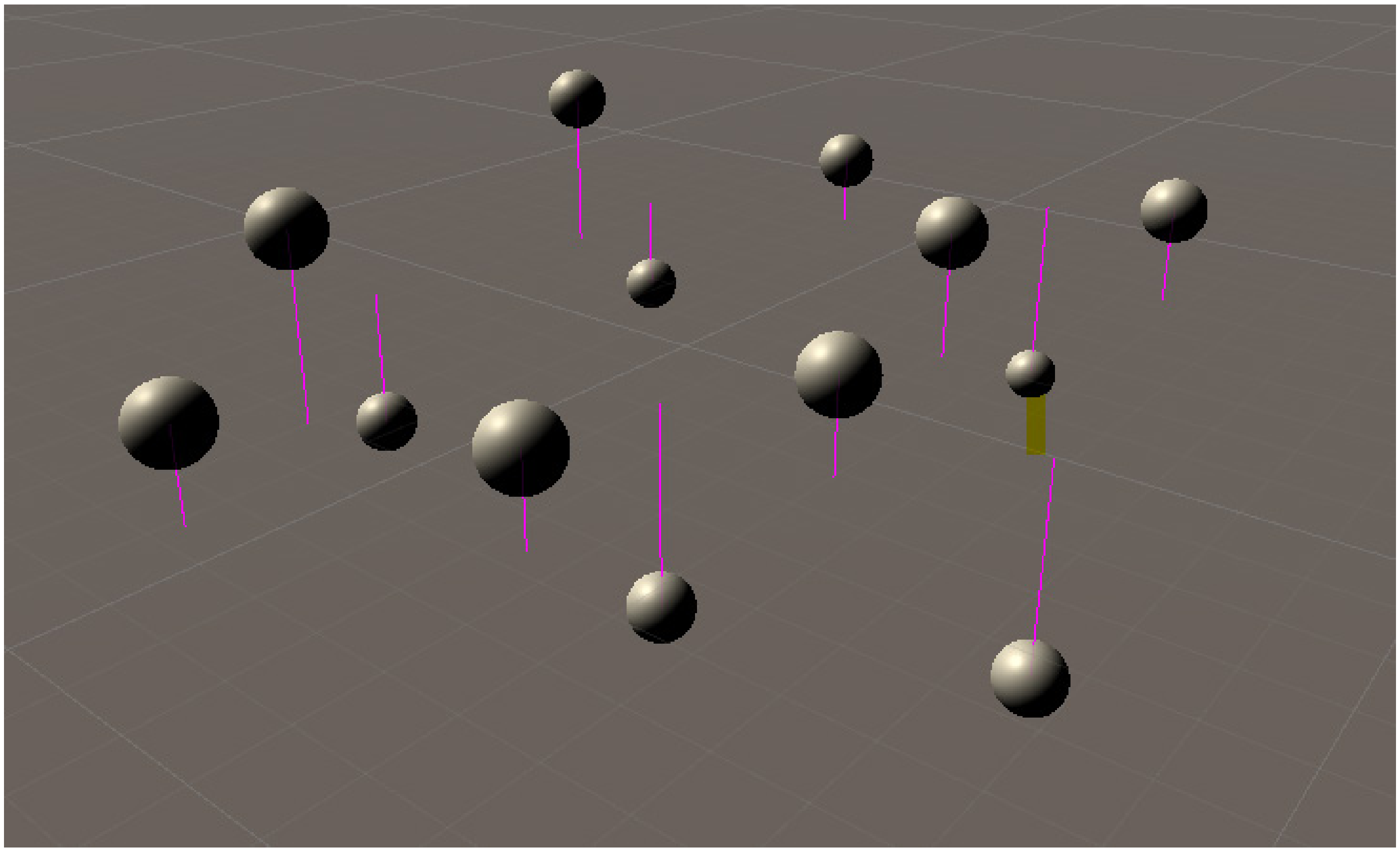
4. Use Rich Text to mark up your **Debug.Log** statements. This can help you enhance error reports in the Console.

5. Unity does not strip the **Debug** logging APIs from non-development builds automatically. Wrap your **Debug Log** calls in custom methods and decorate them with the **[Conditional]** attribute.

   Removing the corresponding **Scripting Define Symbol** from the Player Settings compiles out the Debug Logs all at once. This is identical to wrapping them in **#if… #endif** preprocessor blocks.

   See this General Optimizations guide for an example.

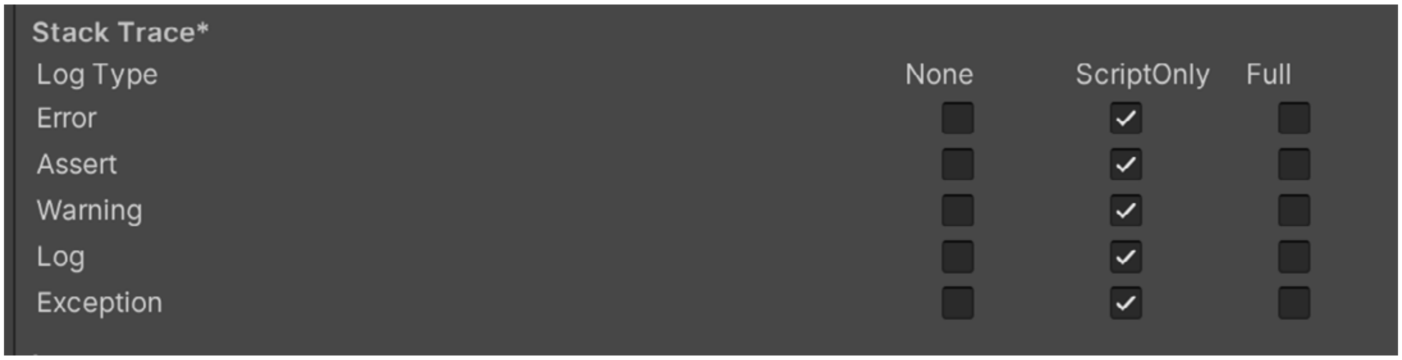
6. Troubleshooting physics? **Debug.DrawLine** and **Debug.DrawRay** can help you visualize raycasting.



Debug.DrawLine

7. If you only want code to run when **Development Build** is enabled, check if **Debug.isDebugBuild** returns true.

8. Use **Application.SetStackTraceLogType** or the equivalent checkboxes in PlayerSettings to decide which kinds of log messages should include stack traces. Stack traces can be useful, but they are slow and generate garbage.



Stack Trace*

Log Type	None	ScriptOnly	Full
Error		✓	
Assert		✓	
Warning		✓	
Log		✓	
Exception		✓	

Visual Studio shortcuts

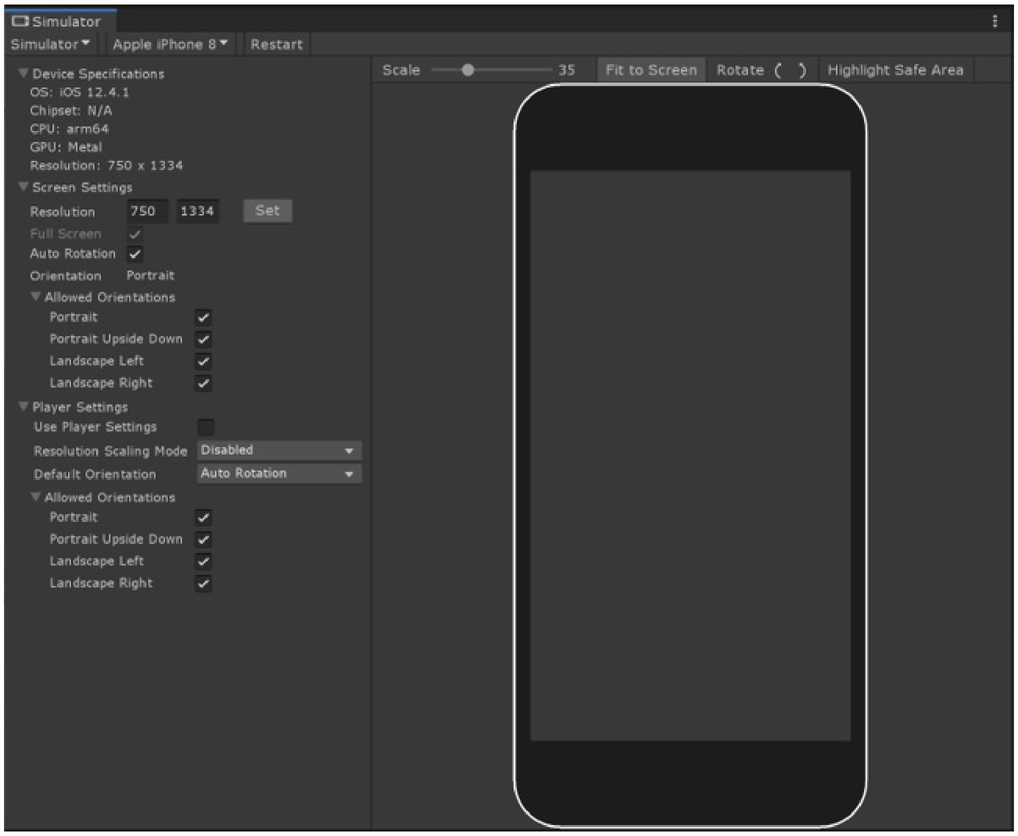
If you use Visual Studio as your IDE of choice, these shortcuts may prove useful.

Action	Shortcut (Windows)	Shortcut (macOS)
Search your entire project for anything.	**Ctrl + T**	**Cmd + .**
Implement Unity Messages (boilerplate code)	**Ctrl + Shift + M**	**Cmd + Shift + M**
Comment out code blocks	**Ctrl + K / Ctrl + C**	**Cmd + /**
Uncomment blocks of code	**Ctrl + K / Ctrl + U**	**Cmd + /**
Copy from clipboard history	**Ctrl + Shift + V**	
View task list	**Ctrl + T**	No default keybinding, but you can bind it.
Insert a surrounding snippet such as namespace	**Ctrl + K + S**	No default keybinding, but you can bind it.
Rename a variable while updating all references	**Ctrl + R**	**Cmd + R**
Compile the code	**Ctrl + Shift + B**	**Cmd + Shift + B**

Watch Visual Studio tips and tricks to boost your productivity for more workflow improvements with Visual Studio.

Device Simulator

If you're developing for mobile and tablets, the **Device Simulator** can help you simulate your application on different devices. Even if you have physical access to all of your targeted hardware, building the content for each device can be time consuming.



Device Specifications
OS: iOS 12.4.1
Chipset: N/A
CPU: arm64
GPU: Metal
Resolution: 750 x 1334

Screen Settings

Resolution	750 1334
Full Screen	✓
Auto Rotation	✓
Orientation	Portrait

Allowed Orientations

Portrait	✓
Portrait Upside Down	✓
Landscape Left	✓
Landscape Right	✓

Player Settings

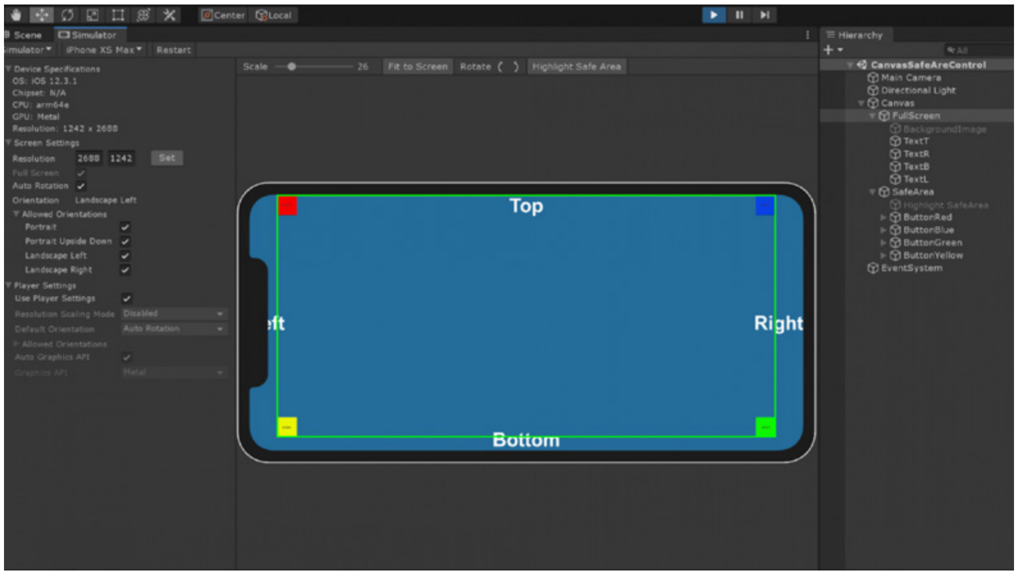
Use Player Settings	
Resolution Scaling Mode	Disabled
Default Orientation	Auto Rotation

Allowed Orientations

Portrait	✓
Portrait Upside Down	✓
Landscape Left	✓
Landscape Right	✓

The Simulator view

Use the Simulator view to run a quick preview before you need to make an actual build. You can simulate specific resolutions or hardware conditions and adjust your UI to the physical notch/cutouts in Game view. When using the Simulator view, you can switch between different screens for devices with multiple screens.



Device Specifications
OS: iOS 12.3.1
Chipset: N/A
CPU: arm64e
GPU: Metal
Resolution: 1242 x 2688

Screen Settings

Resolution	2688 1242
Full Screen	✓
Auto Rotation	✓
Orientation	Landscape Left

Allowed Orientations

Portrait	✓
Portrait Upside Down	✓
Landscape Left	✓
Landscape Right	✓

Player Settings

Use Player Settings	✓
Resolution Scaling Mode	Disabled
Default Orientation	Auto Rotation
Allowed Orientations	
Auto Graphics API	✓
Graphics API	Metal

```
CanvasSafeAreControl
  Main Camera
  Directional Light
  Canvas
    FullScreen
      BackgroundImage
      TextT
      TextR
      TextB
      TextL
    SafeArea
      Highlight SafeArea
      ButtonRed
      ButtonBlue
      ButtonGreen
      ButtonYellow
  EventSystem
```

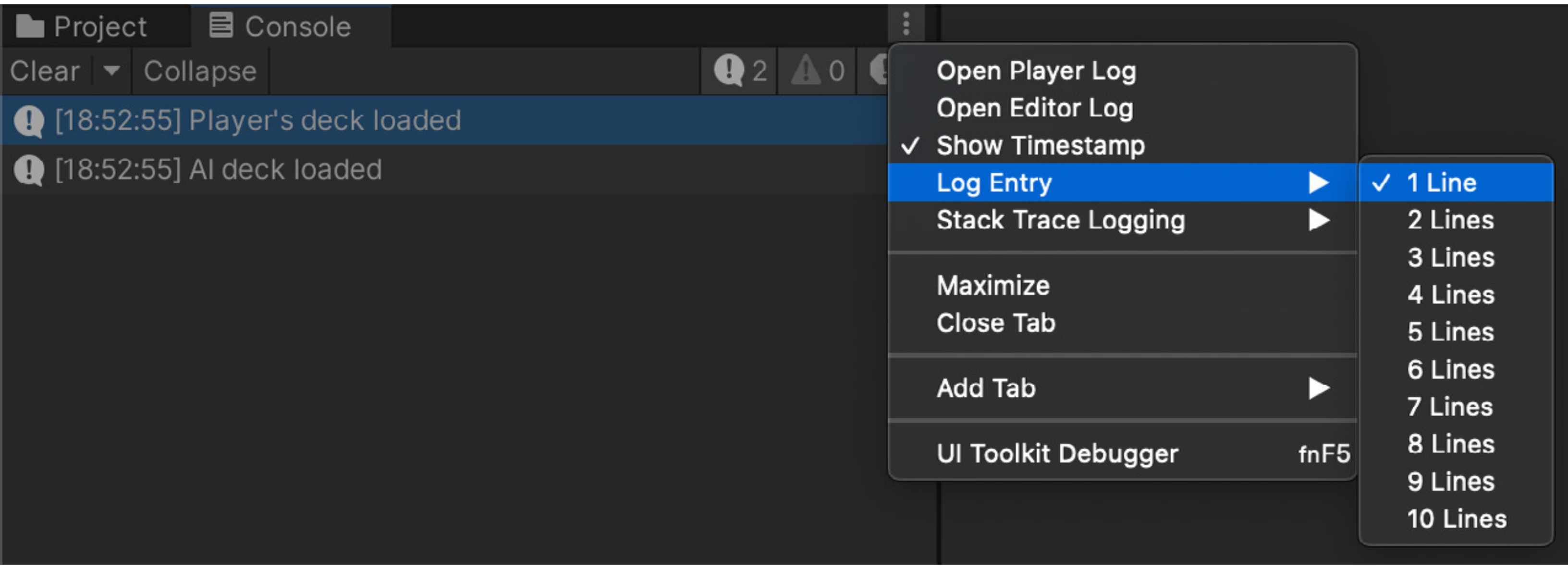
Adjusting the UI to the device's physical screen

A list of predefined phones and tablets comes with the package (in the **com.unity.device-simulator/com.unity.device-simulator folder**). Device definitions are stored in JSON files, and the list of devices regularly expands through package updates.

Read "Speed up mobile iteration with the Device Simulator" for more tips or watch this demo of the Device Simulator in action.

Console Log Entry

By default, the Console Log Entry shows two lines. For improved readability, you can configure this to be more streamlined with one line (see image).



```
[18:52:55] Player's deck loaded
[18:52:55] AI deck loaded
```

The Console Log Entry options

Alternatively, you can also use more lines if you want longer entries.

Custom Compiler status

When Unity compiles, the icon in the lower right corner is hard to see. Use this custom Editor script to call EditorApplication.isCompiling. This makes the Compiler status more visible in a floating window.

Launch the MenuItem to initialize the window. Optionally, you can modify its appearance with a new GUIStyle to suit your preferences.

```
using UnityEditor;
using UnityEngine;
public class CustomCompileWindow : EditorWindow
{
    [MenuItem(“Examples/CustomCompileWindow”)]
    static void Init()
    {
        EditorWindow window = GetWindowWithRect(typeof(-
CustomCompileWindow), new Rect(0, 0, 200, 200));
        window.Show();
    }
   void OnGUI()
    {
        EditorGUILayout.LabelField(“Compiling:”, Edito-
rApplication.isCompiling ? “Yes” : “No”);
       this.Repaint();
    }
}
```

More resources

— *Ultimate guide to profiling Unity games*

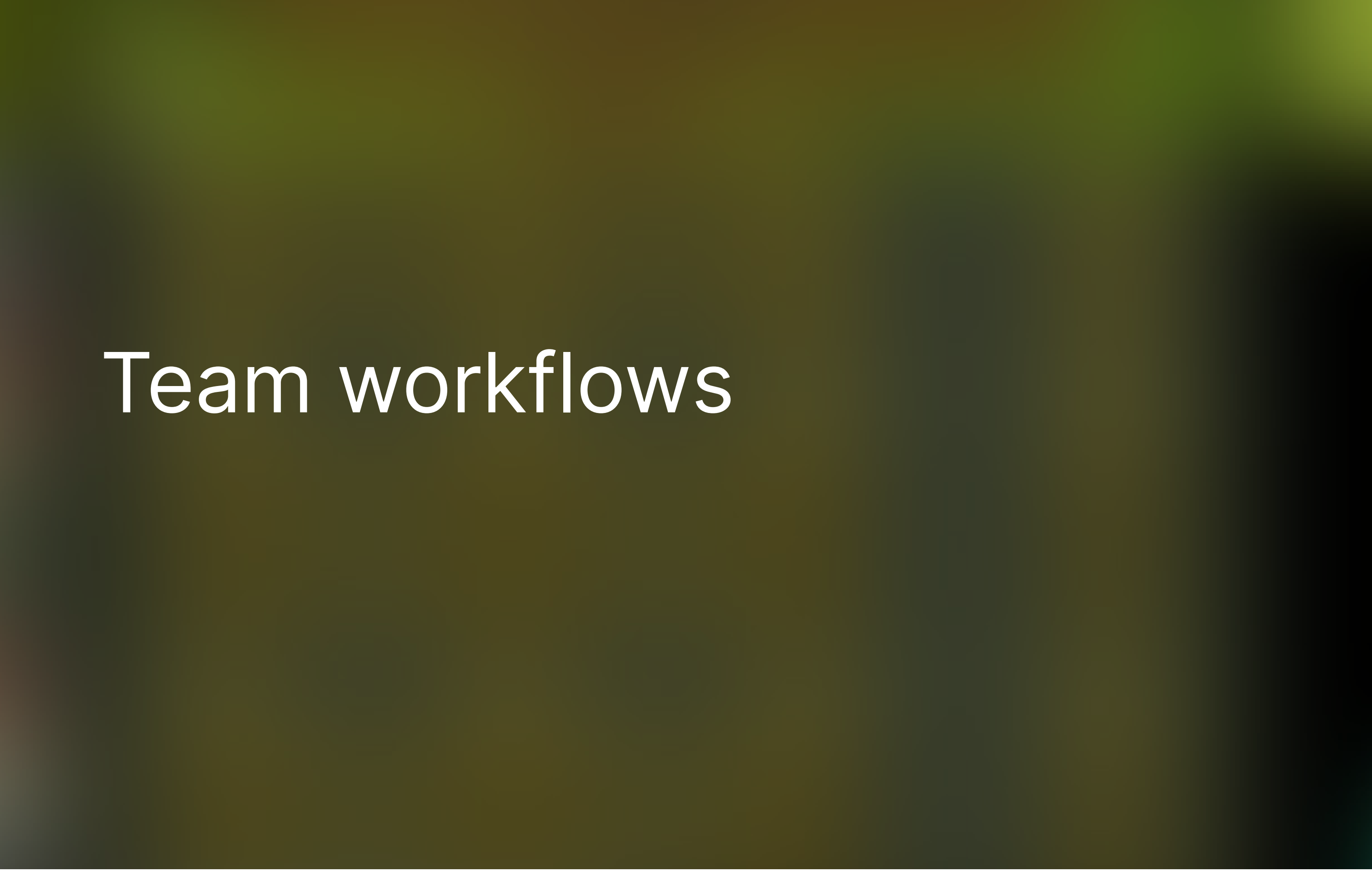
— How to debug game code with Roslyn Analyzers

— How to run automated tests for your games with the Unity Test Framework

— Speed up your debugging workflow with Microsoft Visual Studio Code

— How to debug your code with Microsoft Visual Studio 2022

— Testing and quality assurance tips for Unity projects



Team workflows

Unity DevOps consists of two core components: Unity Version Control and Unity Build Automation.

When you sign up for Unity DevOps, you'll get access to both the Version Control and Build Automation components.

You can pick which Unity DevOps component you use. For example, the Build Automation workflows can work with any version control including GitHub. Additionally, Unity Version Control remains compatible with any engine, slotting seamlessly into your existing tech stack.

Unity DevOps is a consumption-based tool. This means that you'll only pay for what you use once you exceed the monthly free tier. You can learn more about pricing on the Unity DevOps page.

Unity helps your team collaborate.

Unity Version Control

Unity Version Control (Unity VCS) is a version control and source code management tool for game and real-time 3D development to improve team collaboration and scalability with any engine.

There are two ways to use Unity Version Control. The Unity VCS web experience provides deeply integrated role-based workflows, code reviews, and user and user group management. You can read about setting up the web experience here.

You can also install the Unity Version Control package for the Editor. Follow the set up instructions in the package documentation.

Migrating from Git

UVCS can push and pull changes directly to any remote Git server. This is because UVCS supports the https:// and git:// protocols for pushing and pulling changesets.

This feature immediately turns UVCS into a distributed version control system (DVCS) that's fully compatible with Git. The advantage of this is that you can use UVCS or Git on your workstation and still participate in Git projects (GitHub, CodePlex, and many more).

What is GitSync?
GitSync is a native Windows DVCS connected to GitHub. So, it virtually turns UVCS into a full-fledged Windows client for Git.

Note: GitSync is not technically a new Git client. You would be using UVCS on the client-side but can push/pull to Git servers (using https or Git protocols).

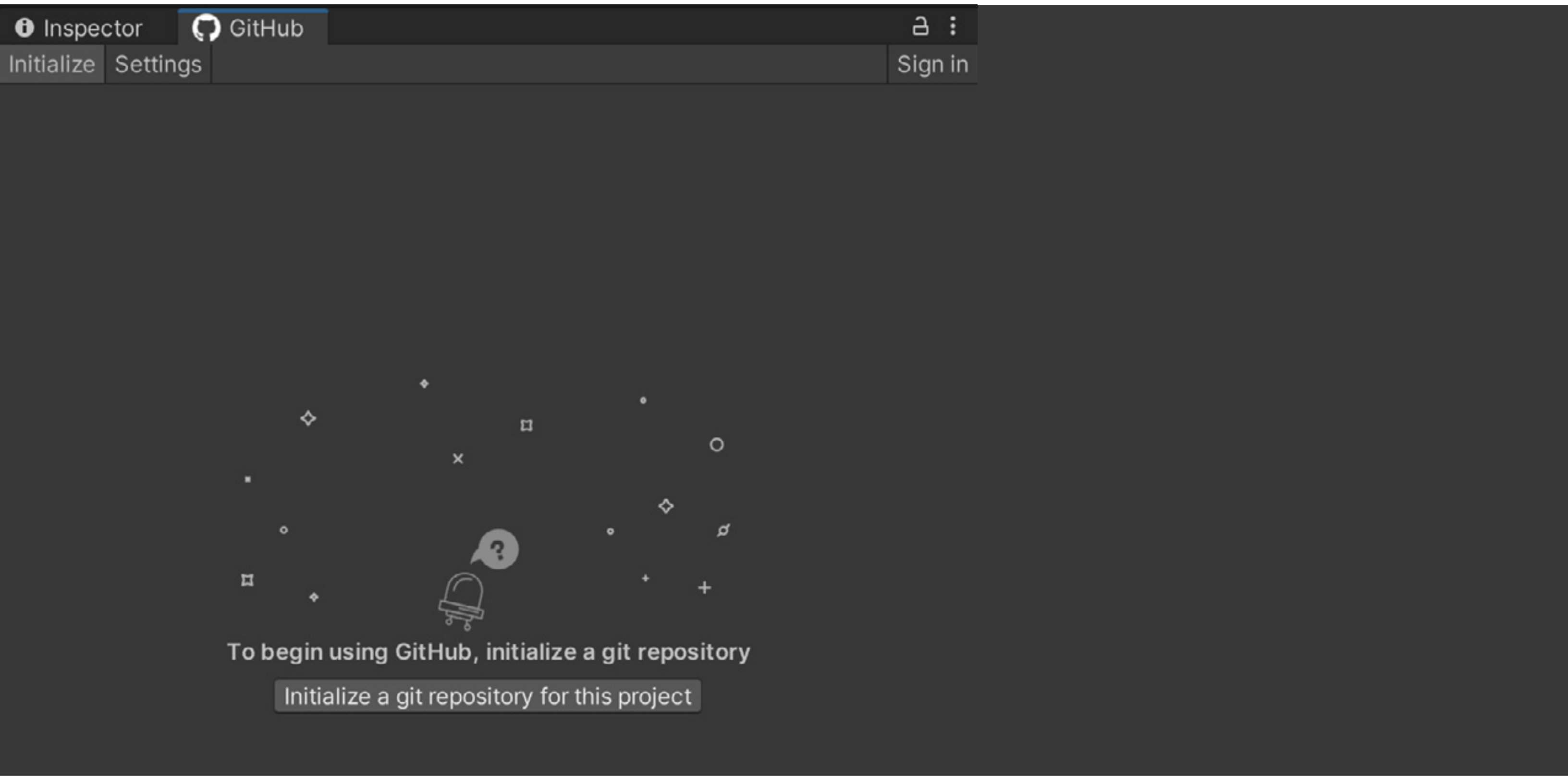
If you're a developer using GitHub (or Bitbucket, or maybe CodePlex), there are things you like, like using a cloud-based repository for your code and Windows to develop – and things you don't like, like being forced to use the CLI and lacking really awesome GUI tools.

If you wish you had everything – Cloud repositories, the DVCS power, and tools for Windows – that's what you get with GitSync.

Learn more about migrating from Git in the UVCS manual.

Using Git as an external VCS
You can also use an external system, such as Git, including Git LFS (Large File Support) for more efficient version control of your larger assets, like graphics and sound resources.

Unity maintains a .gitignore file. This can help you decide what should and shouldn't go into the git repository and enforce those rules.


Inspector
GitHub
Initialize
Settings
Sign in
To begin using GitHub, initialize a git repository
Initialize a git repository for this project

The GitHub for Unity extension

If you're interested in learning how to set up version control for your team and Unity projects download the free, in-depth guide *Version control and project organization best practices for game developers*.

Unity Build Automation

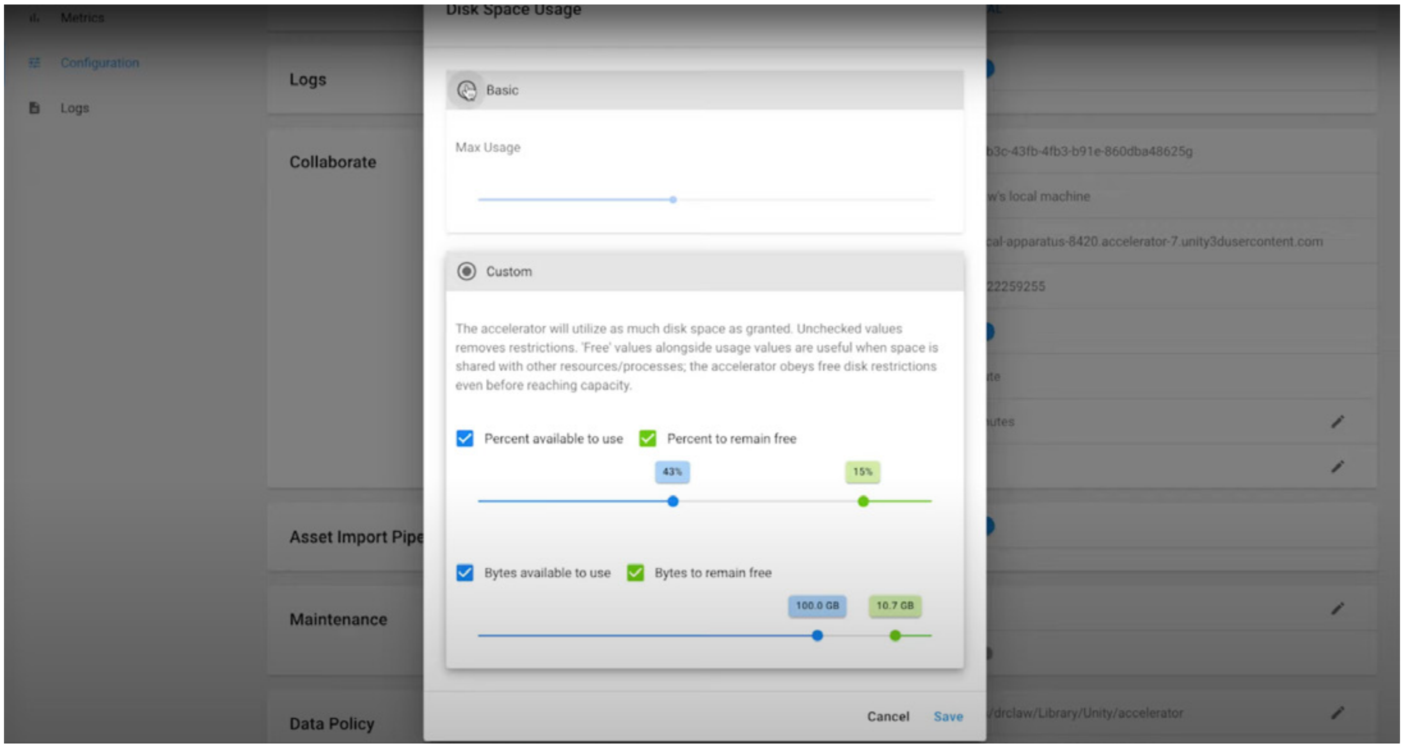
Unity DevOps Build Automation, formerly known as Cloud Build, is a turnkey continuous integration and deployment (CI/CD) solution that can execute and deploy builds in the cloud. It empowers you to build and release more often for higher-quality, more innovative releases.

Build Automation can be connected to any source control repository in a matter of minutes and set up to execute builds manually or automatically once any change is committed to version control. Build Automation also supports multiple platforms including iOS, Android, Windows, and Unity Web, eliminating the need to maintain unique build infrastructure for every platform.

Unity Accelerator

Unity Accelerator removes waiting time by caching copies of your team's assets. This means that only one person needs to perform the actual import, and the results will automatically be cached to the Unity Accelerator. The next time a team member goes to import the same version of the asset, the Unity Editor first checks the cache before starting the import process on their local machine.

A local administrator dashboard for the Accelerator enables you to configure the tool, see statistics like disk space usage or how much time you've saved, and diagnose issues with logs.



The accelerator will utilize as much disk space as granted. Unchecked values removes restrictions. 'Free' values alongside usage values are useful when space is shared with other resources/processes; the accelerator obeys free disk restrictions even before reaching capacity.

Percent available to use: 43%
Percent to remain free: 15%
Bytes available to use: 100.0 GB
Bytes to remain free: 10.7 GB

Unity Accelerator

The Accelerator in Unity 2022 LTS provides corruption detection. Accelerator cached assets can be corrupted (modified bytes) on storage or during transmission. A hash of the content detects corrupt content; when content is seen as invalid, it's discarded and imports locally. You can configure this behavior using the Content Validation setting in the Project Settings window (Editor/Cache Server/Content Validation).

See the requirements and installation procedure for more information about the Unity Accelerator.

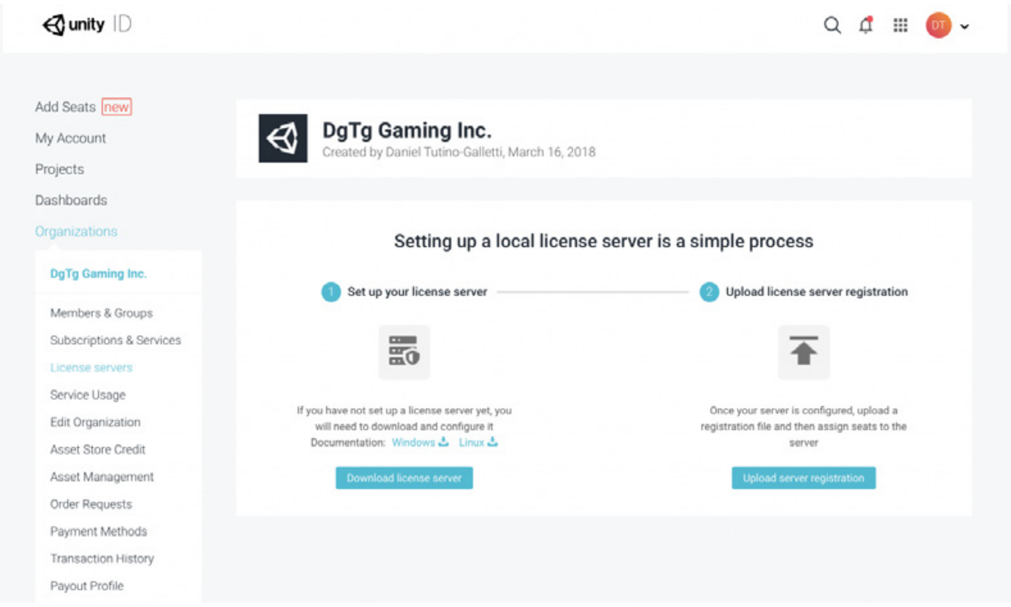
Unity Build Server

Consider enhancing your team's productivity by offloading the building process to network hardware using the **Unity Build Server**. This will help your creative team build the project as often as needed, allowing them to iterate more autonomously.

As your Unity project grows in size and complexity, generating a build consumes more and more time. If you're using your development workstations to build a project, you will lose productivity while your team waits for the build to complete.

Unity Build Server runs Unity in batch mode, exclusively for building Unity projects. Team members can request builds on demand at their own pace. This reduces wait time for bug fixes and releasing new features for testing. Building on separate machines reduces each developer's downtime and allows everyone to iterate more quickly.

See the Unity Build Server page for more information on how to access the service and pricing.



DgTg Gaming Inc.
Created by Daniel Tutino-Galletti, March 16, 2018

Setting up a local license server is a simple process

If you have not set up a license server yet, you will need to download and configure it
Documentation: Windows Linux

Once your server is configured, upload a registration file and then assign seats to the server

Setting up the Unity Build Server

Resources for all Unity developers

You can find additional productivity tips, best practices, and news on the Unity Blog, by searching the **#unitytips** hashtag, and on the community forums and Unity Learn.

The Unity Developer Tools microsite makes it easy for you to find some of the best resources for developing with Unity, including documentation, the Knowledge Base, Issue Tracker, as well as our latest roadmap and release information.

Technical Support Success Plans from Unity

Unity provides three tiers of success plans for professional developers and studios. Our success plans are designed to help you minimize technical and strategic obstacles during your game development. Our technical support team will help:

— **Prevent technical roadblocks**: Get recommendations to anticipate, correct, and prevent blockers.

— **Streamline development**: Work directly with Unity experts to help ensure your projects are optimized to achieve your goals.

— **Mitigate risk**: Put guardrails in place that can help you avoid future issues, ensuring your project stays on track and on budget.

Learn more about Unity Success plans or contact us to get more information about what we can offer.

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unity.com