

# Making Huge Games in Unity with TOOLS!

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Programmer

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e n t e r t a i n m e n t

# Me

- UCI Information and CS (2014)
- Video Game Development Club (4 yrs)



# Me

- Camera Obscura (VGDC Spring 2011 Game Jam)
- Passed Steam Greenlight Jan 2014



# Me

- Obsidian Entertainment
  - Pillars of Eternity (2013-2015)
  - Pillars of Eternity II: Deadfire (2015+)
- Programming (Tools, UI, Gameplay, Graphics)



# Pillars of Eternity

- A huge game
- ~75 different developers over the course of the project
- 61 GB project
- 101000 assets
- 450 scenes



## Mind Wave

Attacks Will  
Requires 10 Focus.

Target becomes the object of a concussive blast of psychic energy, suffering Raw damage from the trauma. Characters in a conical area behind the target failing a Fortitude check are knocked prone from the blast.

Right-click for details.

1st Lev

E10

GAME PAUSED

Quest updated: 'Rogue Knight'  
Auto-Paused: Combat Start (Kat)  
Kana (Ancient Memory): 7 Hit



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# Pillars of Eternity II: Deadfire

- An even bigger game
- ~100 different developers over the course of the project
- 123 GB project
- 222000 assets
- 1000 scenes



# Unity with a Large Project


## Pros

- Fast start
  - Lots of functionality built in
- Popular – lots of resources available

## Cons

- Very slow loads
- Black box
- Pushing the limits

```
ReleaseAllScriptCaches did not release all script caches! (Filename: C:
```

 o != NULL

```
Assembly-CSharp::Persistence  
Assembly-CSharp:Game:DeferredPointLight|
```



# Problems for Huge Games

1. Searching: Is this asset/prefab/script used?  
Where?
2. Maintaining Compatibility: Don't break old data.
3. Standalone Divergence: some bugs only happen in the standalone build.

# Tools

- A program or part of a program that automates or streamlines a development task.
- Help you make your game better, make it faster, and have a better time.



0	89	50	4E	47	0D	0A	1A	0A	00	00	00	DD	49	48	44	52	00	00	00	2B	00	00	00	93	08	06	00	00	00	17	C4	E0	D8	00	00	00	09	70	48	59	73	00	00	0B	13	00	00	0B	13	01	00	9A	90
3B	43	43	50	50	68	6F	74	6F	73	68	6F	70	20	49	43	43	20	70	72	6F	66	69	6C	65	00	00	78	DA	9D	53	67	54	53	E9	16	3D	F7	DE	F4	42	4B	88	80	94	4B	6F	52	15	08	20	52	42	8E
76	09	10	4A	88	21	A1	D9	15	51	C1	11	45	45	04	1B	C8	A0	88	03	8E	8E	80	8C	15	51	2C	0C	8A	0A	D8	07	E4	21	A2	8E	83	A3	88	8A	CA	FB	E1	7B	A3	6B	D6	BC	F7	E6	CD	FE	B5	D7
B1	CF	07	C0	08	0C	96	48	33	51	35	80	0C	A9	42	1E	11	E0	83	C7	C4	C6	E1	E4	2E	40	81	0A	24	70	00	10	08	B3	64	21	73	FD	23	01	00	F8	7E	3C	3C	2B	22	C0	07	BE	00	01	78	D3
EC	C0	30	1C	87	FF	0F	EA	42	99	5C	01	80	84	01	C0	74	91	38	4B	08	80	14	00	40	7A	8E	42	A6	00	40	46	01	80	9D	98	26	53	00	A0	04	00	60	CB	63	62	E3	00	50	2D	00	60	27	7E
127	99	7B	01	00	5B	94	21	15	01	A0	91	00	20	13	65	88	44	00	68	3B	00	AC	CF	56	8A	45	00	58	30	00	14	66	4B	C4	39	00	D8	2D	00	30	49	57	66	48	00	B0	B7	00	C0	CE	10	0B	B2
162	88	85	29	00	04	7B	00	60	C8	23	23	78	00	84	99	00	14	46	F2	57	3C	F1	2B	AE	10	E7	2A	00	00	78	99	B2	3C	B9	24	39	45	81	5B	08	2D	71	07	57	57	2E	1E	28	CE	49	17	2B	14
19D	2E	C2	79	99	19	32	81	34	0F	E0	F3	CC	00	00	A0	91	15	11	E0	83	F3	FD	78	CE	0E	AE	CE	CE	36	8E	B6	0E	5F	2D	EA	BF	06	FF	22	62	62	E3	FE	E5	CF	AB	70	40	00	00	E1	74	7E
1D8	80	3B	06	80	6D	FE	A2	25	EE	04	68	5E	0B	A0	75	F7	8B	66	B2	0F	40	B5	00	A0	E9	DA	57	F3	70	F8	7E	3C	3C	45	A1	90	B9	D9	D9	E5	E4	E4	D8	4A	C4	42	5B	61	CA	57	7D	FE	67
213	F9	7E	3C	FC	F7	F5	E0	BE	E2	24	81	32	5D	81	47	04	F8	E0	C2	CC	F4	4C	A5	1C	CF	92	09	84	62	DC	E6	8F	47	FC	B7	0B	FF	FC	1D	D3	22	C4	49	62	B9	58	2A	14	E3	51	12	71	8E
24E	22	89	42	92	29	C5	25	D2	FF	64	E2	DF	2C	FB	03	3E	DF	35	00	B0	6A	3E	01	7B	91	2D	A8	5D	63	03	F6	4B	27	10	58	74	C0	E2	F7	00	00	F2	BB	6F	C1	D4	28	08	03	80	68	83	E1
289	47	A0	25	00	80	66	49	92	71	00	00	5E	44	24	2E	54	CA	B3	3F	C7	08	00	00	44	A0	81	2A	B0	41	1B	F4	C1	18	2C	C0	06	1C	C1	05	DC	C1	0B	FC	60	36	84	42	24	C4	C2	42	10	42
2C4	29	AC	82	42	28	86	CD	B0	1D	2A	60	2F	D4	40	1D	34	C0	51	68	86	93	70	0E	2E	C2	55	B8	0E	3D	70	0F	FA	61	08	9E	C1	28	BC	81	09	04	41	C8	08	13	61	21	DA	88	01	62	8A	58
2FF	F8	21	C1	48	04	12	8B	24	20	C9	88	14	51	22	4B	91	35	48	31	52	8A	54	20	55	48	1D	F2	3D	72	02	39	87	5C	46	BA	91	3B	C8	00	32	82	FC	86	BC	47	31	94	81	B2	51	3D	D4	0C
33A	84	46	A2	0B	D0	64	74	31	9A	8F	16	A0	9B	D0	72	B4	1A	3D	8C	36	A1	E7	D0	AB	68	0F	DA	8F	3E	43	C7	30	C0	E8	18	07	33	C4	6C	30	2E	C6	C3	42	B1	38	2C	09	93	63	CB	B1	22
375	56	AC	03	BB	89	F5	63	CF	B1	77	04	12	81	45	C0	09	36	04	77	42	20	61	1E	41	48	58	4C	58	4E	D8	48	A8	20	1C	24	34	11	DA	09	37	09	03	84	51	C2	27	22	93	A8	4B	B4	26	BA
3B0	31	87	58	48	2C	23	D6	12	8F	13	2F	10	7B	88	43	C4	37	24	12	89	43	32	27	B9	90	02	49	B1	A4	54	D2	12	D2	46	D2	6E	52	23	E9	2C	A9	9B	34	48	1A	23	93	C9	DA	64	6B	B2	07
3EB	85	E4	9D	E4	C3	E4	33	E4	1B	E4	21	F2	5B	0A	9D	62	40	71	A4	F8	53	E2	28	52	CA	6A	4A	19	E5	10	E5	34	E5	06	65	98	32	41	55	A3	9A	52	DD	A8	A1	54	11	35	8F	5A	42	AD	A1
426	13	34	75	9A	39	CD	83	16	49	4B	A5	AD	A2	95	D3	1A	68	17	68	F7	69	AF	E8	74	BA	11	DD	95	1E	4E	97	D0	57	D2	CB	E9	47	E8	97	E8	03	F4	77	0C	0D	86	15	83	C7	88	67	28	19
461	77	18	AF	98	4C	A6	19	D3	8B	19	C7	54	30	37	31	EB	98	E7	99	0F	99	6F	55	58	2A	B6	2A	7C	15	91	CA	0A	95	4A	95	26	95	1B	2A	2F	54	A9	AA	A6	AA	DE	AA	0B	55	F3	55	CB	54
49C	46	55	33	53	E3	A9	09	D4	96	AB	55	AA	9D	50	EB	53	1B	53	67	A9	3B	A8	87	AA	67	A8	6F	54	3F	A4	7E	59	FD	89	06	59	C3	4C	C3	4F	43	A4	51	A0	B1	5F	E3	BC	C6	20	0B	63	19
4D7	AB	86	75	81	35	C4	26	B1	CD	D9	7C	76	2A	BB	98	FD	1D	BB	8B	3D	AA	A9	A1	39	43	33	4A	33	57	B3	52	F3	94	66	3F	07	E3	98	71	F8	9C	74	4E	09	E7	28	A7	97	F3	7E	8A	DE	14
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54D	2E	AA	6B	A5	1B	A1	BB	44	77	BF	6E	A7	EE	98	9E	BE	5E	80	9E	4C	6F	A7	DE	79	BD	E7	FA	1C	7D	2F	FD	54	FD	6D	FA	A7	F5	47	0C	58	06	B3	0C	24	06	DB	0C	CE	18	3C	C5	35	71
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5C3	CC	CD	A2	CD	D6	99	35	9B	3D	31	D7	32	E7	9B	E7	9B	D7	9B	DF	B7	60	5A	78	5A	2C	B6	A8	B6	B8	65	49	B2	E4	5A	A6	59	EE	B6	BC	6E	85	5A	39	59	A5	58	55	5A	5D	B3	46	AD	9D
5FE	A7	11	A7	B9	4E	93	4E	AB	9E	D6	67	C3	B0	F1	B6	C9	B6	A9	B7	19	B0	E5	D8	06	DB	AE	B6	6D	B6	7D	61	67	62	17	67	B7	C5	AE	C3	EE	93	BD	93	7D	BA	7D	8D	FD	3D	07	0D	87	D9
639	73	B4	72	14	3A	56	3A	DE	9A	CE	9C	EE	3F	7D	C5	F4	96	E9	2F	67	58	CF	10	CF	D8	33	E3	B6	13	CB	29	C4	69	9D	53	9B	D3	47	67	17	67	B9	73	83	F3	88	8B	89	4B	82	CB	2E	97
674	C8	BD	E4	4A	74	F5	71	5D	E1	7A	D2	F5	9D	9B	B3	9B	C2	ED	A8	DB	AF	EE	36	EE	69	EE	87	DC	9F	CC	34	9F	29	9E	59	33	73	D0	C3	C8	43	E0	51	E5	D1	3F	0B	9F	95	30	6B	DF	AC
6AF	B5	E7	23	2F	63	2F	91	57	AD	D7	B0	B7	A5	77	AA	F7	61	EF	17	3E	F6	3E	72	9F	E3	3E	E3	3C	37	DE	32	DE	59	5F	CC	37	C0	B7	C8	B7	CB	4F	C3	6F	9E	5F	85	DF	43	7F	23	FF	64
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760	C6	2E	66	59	CC	D5	58	9D	58	49	6C	4B	1C	39	2E	2A	AE	36	6E	6C	BE	DF	FC	ED	F3	87	E2	9D	E2	0B	E3	7B	17	98	2F	C8	5D	70	79	A1	CE	C2	F4	85	A7	16	A9	2E	12	2C	3A	96	40
79B	41	10	2A	A8	16	8C	25	F2	13	77	25	8E	0A	79	C2	1D	C2	67	22	2F	D1	36	D1	88	D8	43	5C	2A	1E	4E	F2	48	2A	4D	7A	92	EC</																

# Tools

- A program or part of a program that automates or streamlines a development task.
- Help you make your game better, make it faster, and have a better time.
- As a programmer, they make people like you.



# Tools

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- Help you make your game better, make it faster, and have a better time.
- As a programmer, they make people like you.
- Not the primary goal.

# Tools

1. Have an idea
2. Evaluate development time versus savings
  - Time savings
  - Improved results
  - Enjoy work more
3. Make it
4. Use it



HOW LONG CAN YOU WORK ON MAKING A ROUTINE TASK MORE EFFICIENT BEFORE YOU'RE SPENDING MORE TIME THAN YOU SAVE?  
(ACROSS FIVE YEARS)

		HOW OFTEN YOU DO THE TASK					
		50/DAY	5/DAY	DAILY	WEEKLY	MONTHLY	YEARLY
HOW MUCH TIME YOU SHAVE OFF	1 SECOND	1 DAY	2 HOURS	30 MINUTES	4 MINUTES	1 MINUTE	5 SECONDS
	5 SECONDS	5 DAYS	12 HOURS	2 HOURS	21 MINUTES	5 MINUTES	25 SECONDS
	30 SECONDS	4 WEEKS	3 DAYS	12 HOURS	2 HOURS	30 MINUTES	2 MINUTES
	1 MINUTE	8 WEEKS	6 DAYS	1 DAY	4 HOURS	1 HOUR	5 MINUTES
	5 MINUTES	9 MONTHS	4 WEEKS	6 DAYS	21 HOURS	5 HOURS	25 MINUTES
	30 MINUTES		6 MONTHS	5 WEEKS	5 DAYS	1 DAY	2 HOURS
	1 HOUR		10 MONTHS	2 MONTHS	10 DAYS	2 DAYS	5 HOURS
	6 HOURS				2 MONTHS	2 WEEKS	1 DAY
1 DAY					8 WEEKS	5 DAYS	

# Re-use

- There are already great tools for solving a lot of common problems.
- There is often still a (time) cost to integrate free tools.

# In-Unity Tools

- Property Drawer
- Custom Inspector
- Editor Window
- Gizmos



# Property Drawer

- Change how fields of a particular type are drawn in the inspector
- Good for removing the need to expand serialized classes

Max Pressure	100
▼ Fluid Item	
Type	None (Fluid Type) ⓘ
Amount	0
Temperature	0
▼ Connections	
Size	4

Max Pressure	100
Fluid Item	0 × None (Fluid Type) ⓘ
▼ Connections	
Size	4

# Property Drawer

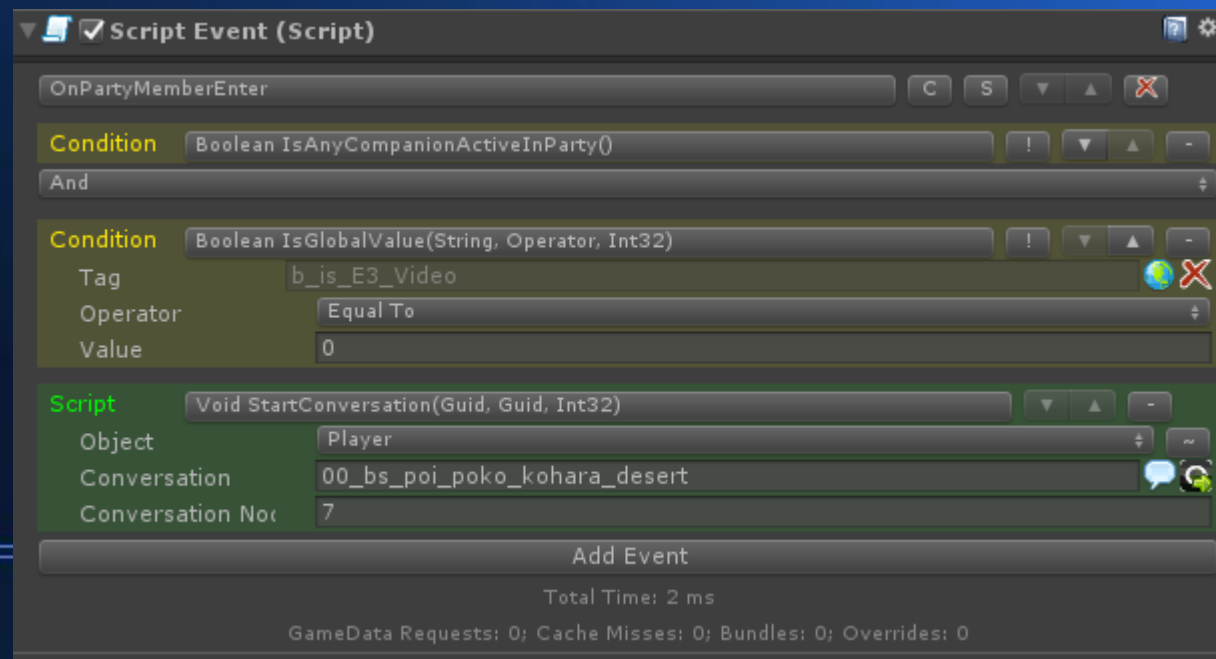
- Create a script in a folder called 'Editor'
  - A magic folder that excludes the scripts from standalone builds
- Inherit 'UnityEditor.PropertyDrawer'
- Add a [CustomPropertyDrawer] attribute
- Use methods on UnityEngine.GUI[Layout], UnityEditor.EditorGUI[Layout]

```
1 using UnityEditor;
2 using UnityEngine;
3
4 [CustomPropertyDrawer(typeof(Item))]
5 public class ItemPropertyDrawer : PropertyDrawer
6 {
7     private GUIContent m_separatorContent;
8
9     public override void OnGUI(Rect position, SerializedProperty property, GUIContent label)
10    {
11        // find the nested fields on the serialized object to draw
12        SerializedProperty qtyProp = property.FindPropertyRelative("Quantity");
13        SerializedProperty typeProp = property.FindPropertyRelative("m_type");
14
15        // create a multiplication sign string
16        if (m_separatorContent == null)
17        {
18            m_separatorContent = new GUIContent("\u00D7");
19        }
20
21        // draw the name of the field
22        position = EditorGUI.PrefixLabel(position, label);
23
24        // temporarily reset the indentLevel so it doesn't throw off the elements we're about to draw
25        int indent = EditorGUI.indentLevel;
26        EditorGUI.indentLevel = 0;
27
28        Rect qtyBox = new Rect(position);
29        qtyBox.width = 60f;
30        Rect separatorBox = new Rect(
31            qtyBox.xMax + EditorGUIUtility.standardVerticalSpacing,
32            position.y,
33            EditorStyles.label.CalcSize(m_separatorContent).x,
34            position.height);
35        Rect itemTypeBox = new Rect(
36            separatorBox.xMax + EditorGUIUtility.standardVerticalSpacing,
37            position.y,
38            position.width - separatorBox.width - qtyBox.width - EditorGUIUtility.standardVerticalSpacing * 2,
39            position.height);
40
41        EditorGUI.PropertyField(qtyBox, qtyProp, GUIContent.none);
42        EditorGUI.LabelField(separatorBox, m_separatorContent);
43        EditorGUI.PropertyField(itemTypeBox, typeProp, GUIContent.none);
44
45        EditorGUI.indentLevel = indent;
46    }
47 }
48
```



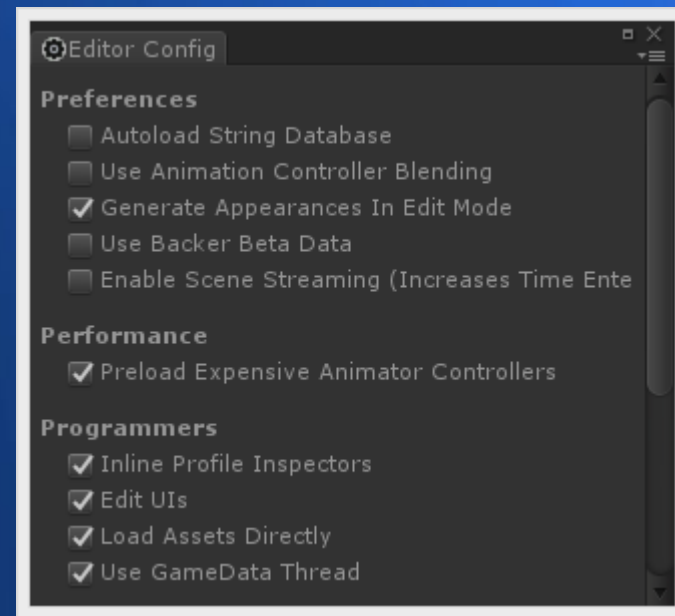
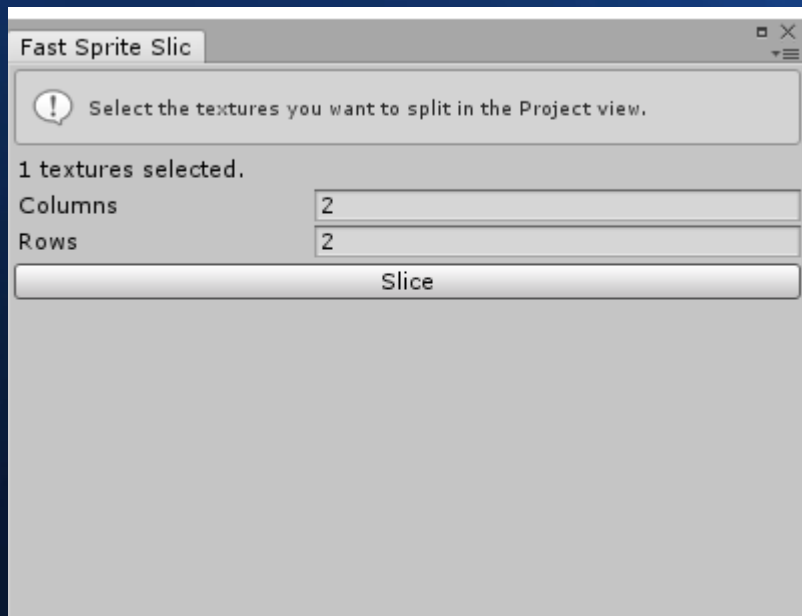
# Custom Inspector

- Change how an entire component is drawn in the inspector
- Can also append custom controls to the default inspector



# Editor Window

- Create a new editor window that can be docked or float



# Editor Window

- Create a class that extends `EditorWindow`
- Implement `OnGUI`
- Add a way to show the window

```
using UnityEditor;
using UnityEngine;

public class FastSpriteSlicer : EditorWindow
{
    [MenuItem("Window/Fast Sprite Slicer")]
    static void ShowWindow()
    {
        GetWindow<FastSpriteSlicer>().Focus();
    }

    private void OnEnable()
    {
        titleContent = new GUIContent("Fast Sprite Slicer");
    }

    private void OnGUI()
    {
        EditorGUILayout.HelpBox("Select the textures you want to split in",
                                MessageType.Info);

        // code here
    }
}
```



# Gizmos

- Draw controls and other helpful information in the scene view

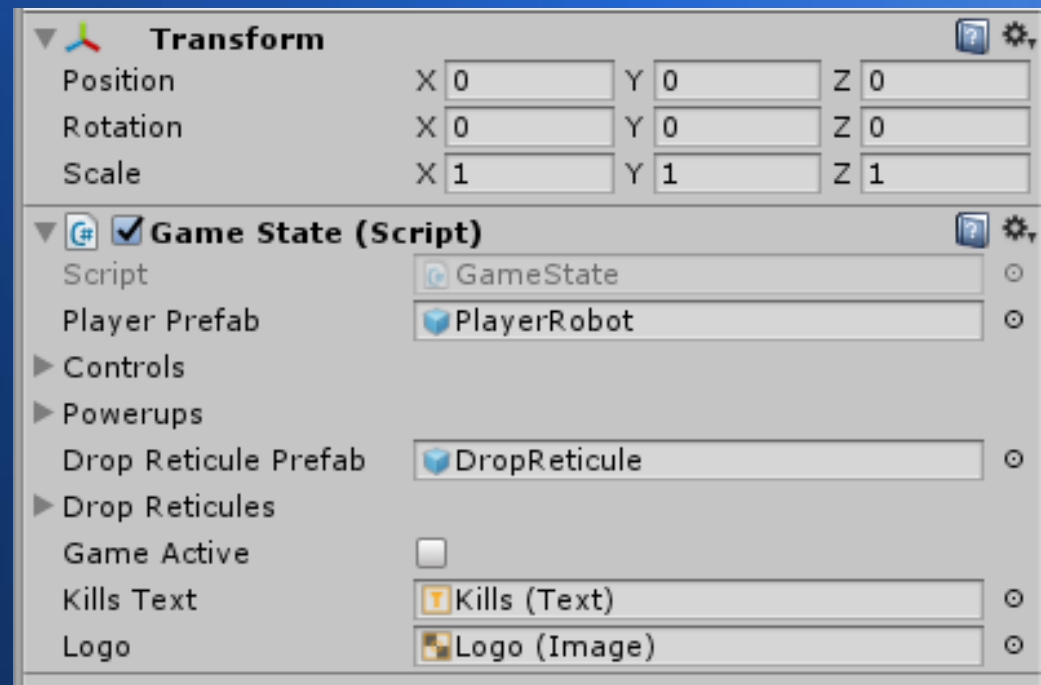


# 1. Searching

- Problem: is this asset/prefab script used?  
Where?
- This can come up when:
  - You want to delete an unused asset
  - You (or a producer) wants to evaluate work to  
e.g. add audio to all creatures
  - You want to make a change to it and check that  
it's safe
  - Many other cases

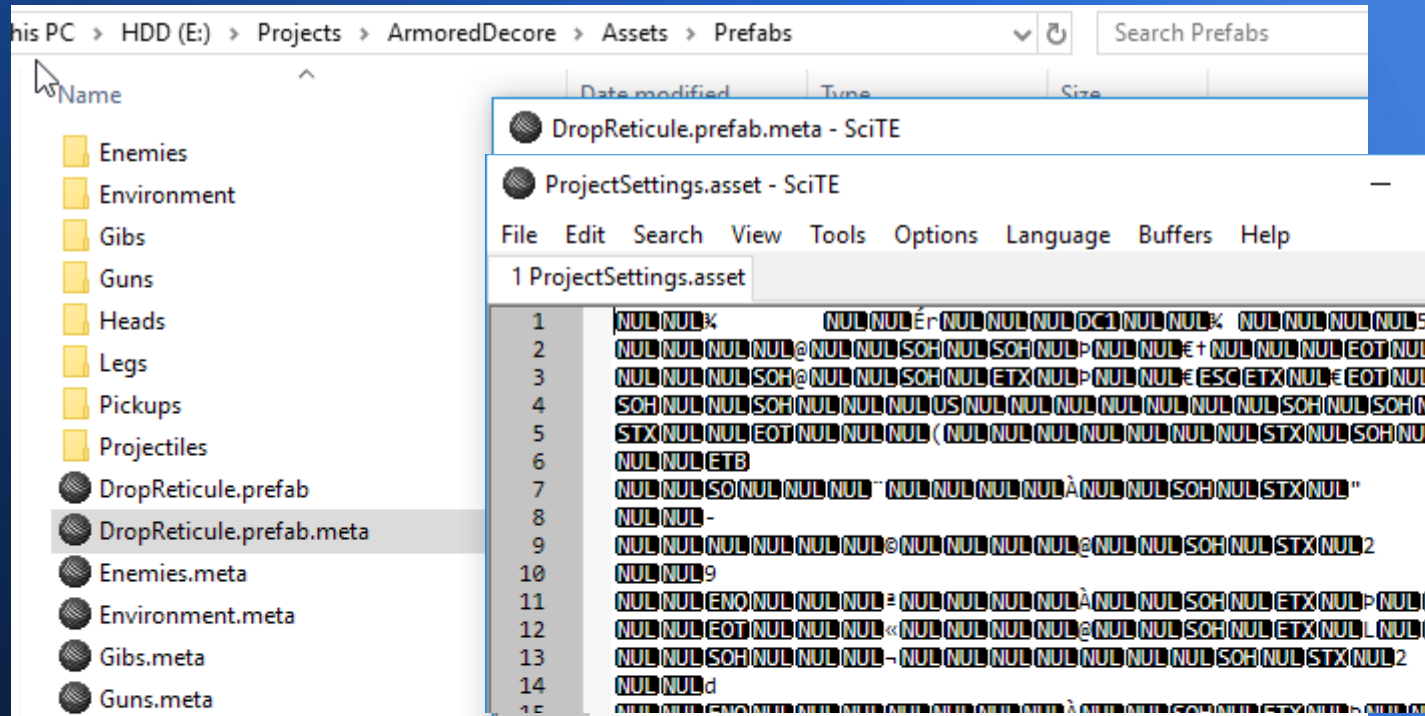
# 1. Searching

- Unity makes it very easy to navigate to the object being referenced.
- But there's no easy way to go the other direction.



# 1. Searching

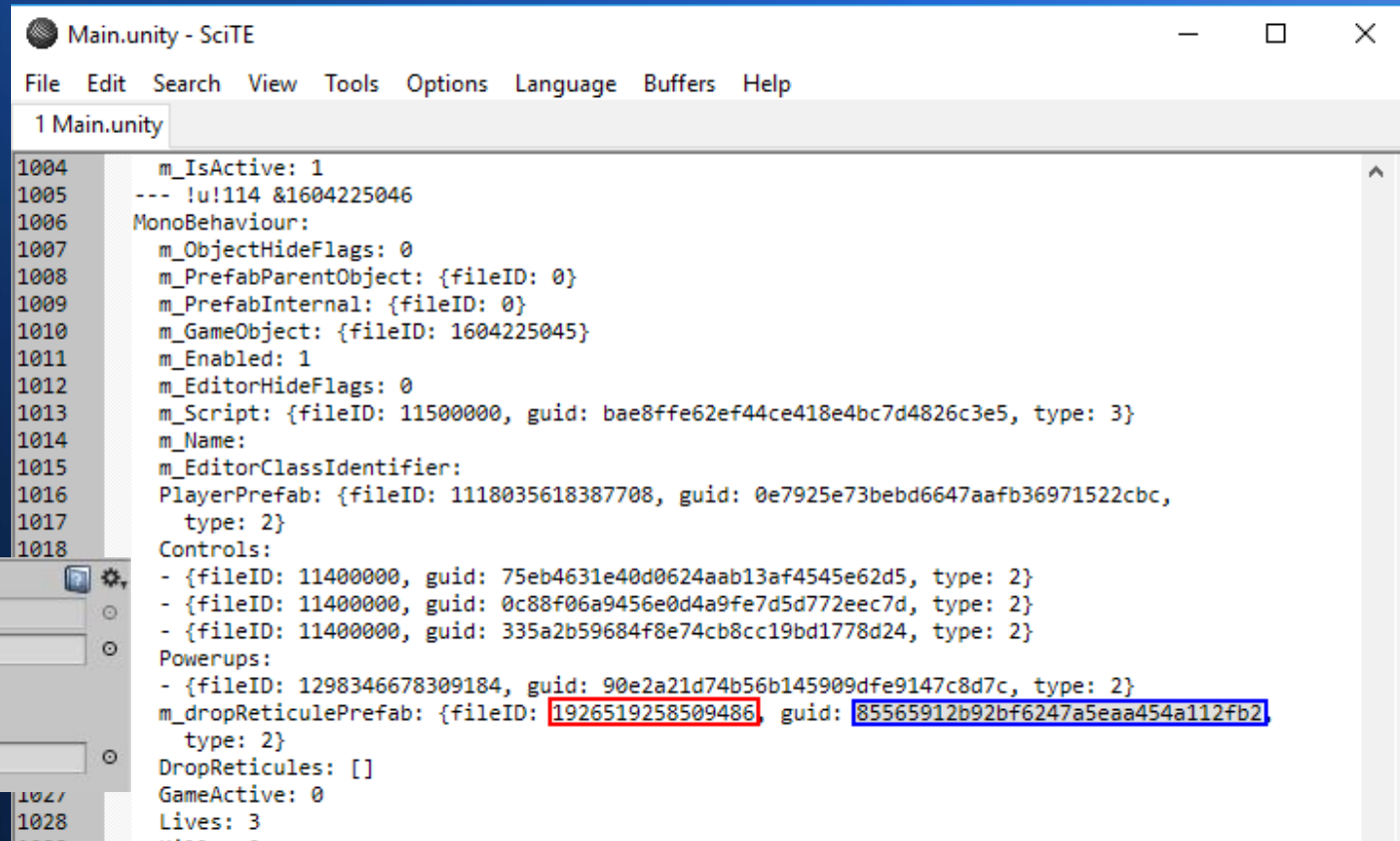
- For starters, we can use grep.
- Each file in a Unity project has a unique 'guid'
- Edit -> Project Settings -> Editor -> Asset Serialization -> Mode





# 1. Searching

- References have the 'guid' of the file and a 'fileID'



```
1004     m_IsActive: 1
1005     --- !u!114 &1604225046
1006     MonoBehaviour:
1007       m_ObjectHideFlags: 0
1008       m_PrefabParentObject: {fileID: 0}
1009       m_PrefabInternal: {fileID: 0}
1010       m_GameObject: {fileID: 1604225045}
1011       m_Enabled: 1
1012       m_EditorHideFlags: 0
1013       m_Script: {fileID: 11500000, guid: bae8ffe62ef44ce418e4bc7d4826c3e5, type: 3}
1014       m_Name:
1015       m_EditorClassIdentifier:
1016       PlayerPrefab: {fileID: 1118035618387708, guid: 0e7925e73bebd6647aafb36971522cbc,
1017         type: 2}
1018       Controls:
1019         - {fileID: 11400000, guid: 75eb4631e40d0624aab13af4545e62d5, type: 2}
1020         - {fileID: 11400000, guid: 0c88f06a9456e0d4a9fe7d5d772eec7d, type: 2}
1021         - {fileID: 11400000, guid: 335a2b59684f8e74cb8cc19bd1778d24, type: 2}
1022       Powerups:
1023         - {fileID: 1298346678309184, guid: 90e2a21d74b56b145909dfe9147c8d7c, type: 2}
1024       m_dropReticulePrefab: {fileID: 1926519258509486, guid: 85565912b92bf6247a5aaa454a112fb2,
1025         type: 2}
1026       DropReticules: []
1027       GameActive: 0
1028       Lives: 3
```

**Game State (Script)**

Script	GameState
Player Prefab	PlayerRobot
Controls	
Powerups	
Drop Reticule Prefab	DropReticule

# 1. Searching

- 'guid' identifies the file
- 'fileID' identifies the object inside the file

```
Main.unity - SciTE
File Edit Search View Tools
1 Main.unity
1004     m_IsActive: 1
1005     --- !u!114 &1604225046
1006     MonoBehaviour:
1007     m_ObjectHideFlags: 0
1008     m_PrefabParentObject:
1009     m_PrefabInternal: {fileID: 0}
1010     m_GameObject: {fileID: 0}
1011     m_Enabled: 1
1012     m_EditorHideFlags: 0
1013     m_Script: {fileID: 115464287, guid: 59b844e27cc454e2ab9bc2a5b4d52727, type: 3}
1014     m_Name:
1015     m_EditorClassIdentifier:
1016     PlayerPrefab: {fileID: 11400000, guid: 75eb4631e40d0624aab13af4545e62d5, type: 2}
1017     type: 2}
1018     Controls:
1019     - {fileID: 11400000, guid: 75eb4631e40d0624aab13af4545e62d5, type: 2}
1020     - {fileID: 11400000, guid: 0c88f06a9456e0d4a9fe7d5d772eec7d, type: 2}
1021     - {fileID: 11400000, guid: 335a2b59684f8e74cb8cc19bd1778d24, type: 2}
1022     Powerups:
1023     - {fileID: 1298346678309184, guid: 90e2a21d74b56b145909dfe9147c8d7c, type: 2}
1024     m_dropReticulePrefab: {fileID: 1926519258509486, guid: 85565912b92bf6247a5eaa454a112fb2, type: 2}
1025     type: 2}
1026     DropReticules: []
1027     GameActive: 0
1028     Lives: 3
```

```
DropReticule.prefab - SciTE
File Edit Search View Tools Options Language Buffers Help
1 DropReticule.prefab
11     m_ParentPrefab: {fileID: 0}
12     m_RootGameObject: {fileID: 1926519258509486}
13     m_IsPrefabParent: 1
14     --- !u!1 &1926519258509486
15     GameObject:
16     m_ObjectHideFlags: 0
17     m_PrefabParentObject: {fileID: 0}
18     m_PrefabInternal: {fileID: 100100000}
19     serializedVersion: 5
20     m_Component:
21     - component: {fileID: 4444989479848500}
22     - component: {fileID: 212860541670955134}
23     - component: {fileID: 114386756248514454}
24     m_Layer: 0
25     m_Name: DropReticule
26     m_TagString: Untagged
27     m_Icon: {fileID: 0}
28     m_NavMeshLayer: 0
29     m_StaticEditorFlags: 0
30     m_IsActive: 1
```

grepWin : E:\Projects\ArmoredDecore

Press F1 for help [About grepWin](#)

Search in:

Search:

Regex search  Text search

Search for:

Replace with:

Search case-sensitive  Dot matches newline  Create backup files  Treat files as UTF8

Limit search:

All sizes  Size is   KB

Include system items  Include hidden items  Include subfolders  Include binary files

Exclude dirs (Regex):

File Names match:

Regex match  Text match

Only one instance

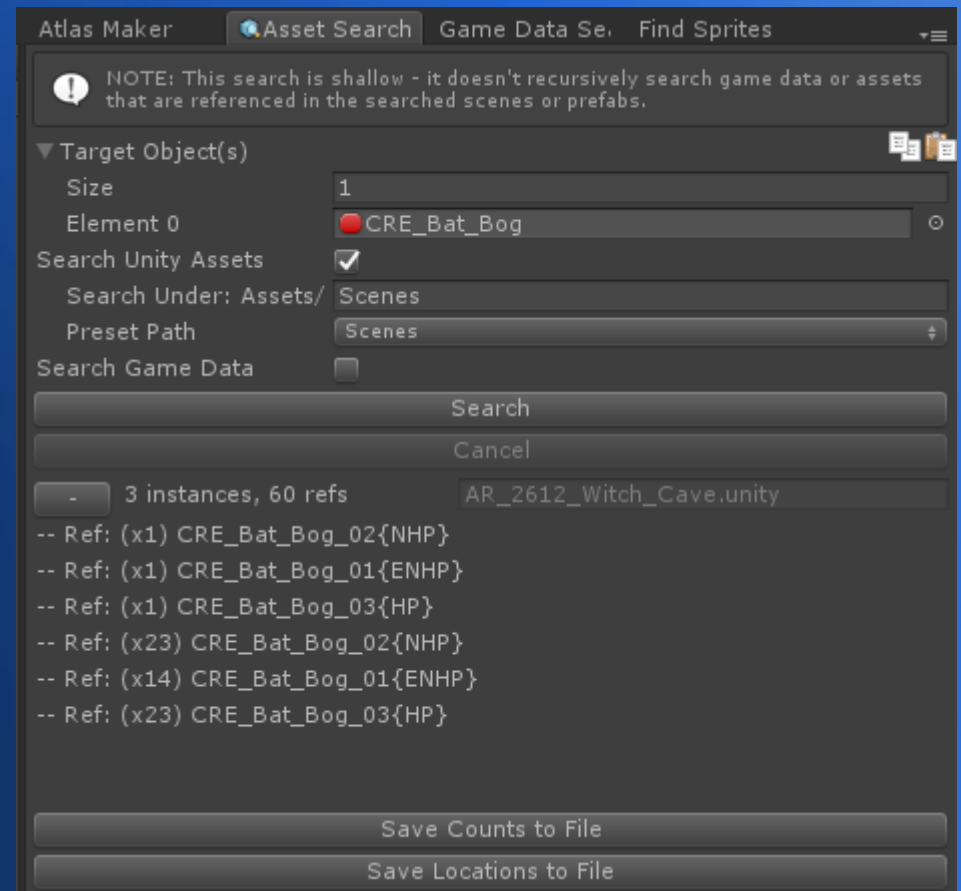
Search results:

Name	Size	Matches	Path	Encoding	Date modified
Main.unity	31.0 KB	1	E:\Projects\ArmoredDecore\Assets	ANSI	2/4/2018 9:17:...
DropReticule.prefab.meta	209 bytes	1	E:\Projects\ArmoredDecore\Assets\Prefabs	ANSI	2/4/2018 9:17:...

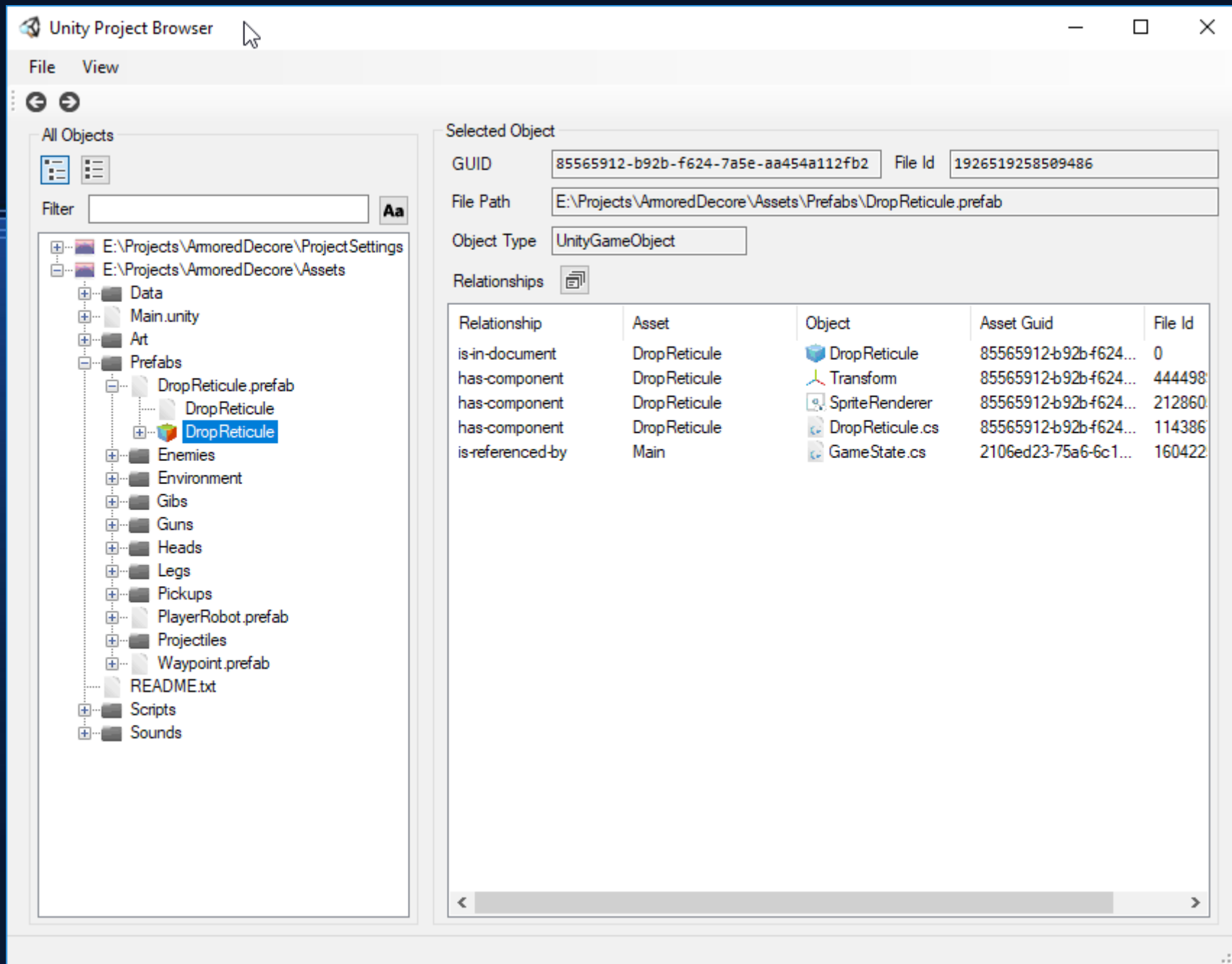
Searched 3547 files, skipped 3 files. Found 2 matches in 2 files.  Files  Content

# 1. Searching

- Integrated into the editor
- Drag-and-drop the target
- See the name of the referencing object
- Downside: still have to wait for the search







# 1. Searching (Takeaways)

- Unity is, in part, a tool for editing its own files.
- You can circumvent it and edit them directly if it helps you.
- Read or edit them.

## 2. Maintaining Compatibility

- Problem: Making changes to the game without breaking existing data.

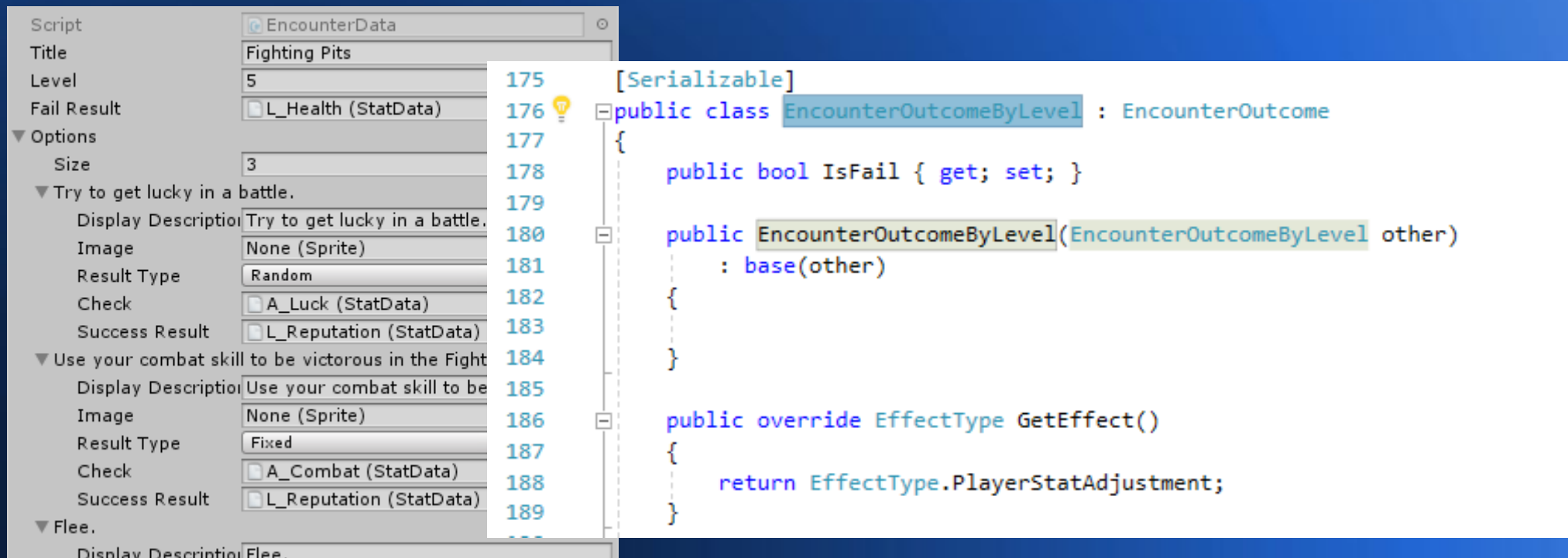
## 2. Maintaining Compatibility

- ✓ OK: Moving or renaming files.
  - Recall that all references are by GUID.
  - The meta file also needs to be moved.
  - This is done for you if you do it in Unity.



# 2. Maintaining Compatibility

- ✓ OK: Renaming serialized classes.



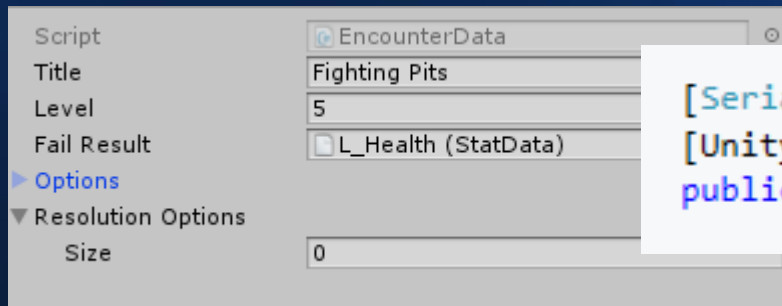
The image shows a Unity Inspector window on the left and a Code Editor window on the right. The Inspector window displays the configuration for an `EncounterData` script. The `Options` section is expanded, showing three encounter options. The first option, "Try to get lucky in a battle", has a `Result Type` of `Random` and a `Success Result` of `L_Reputation (StatData)`. The second option, "Use your combat skill to be victorious in the Fight", has a `Result Type` of `Fixed` and a `Success Result` of `L_Reputation (StatData)`. The third option, "Flee", has a `Result Type` of `Fixed` and a `Success Result` of `L_Reputation (StatData)`.

The Code Editor window shows the following C# code:

```
175 [Serializable]
176 public class EncounterOutcomeByLevel : EncounterOutcome
177 {
178     public bool IsFail { get; set; }
179
180     public EncounterOutcomeByLevel(EncounterOutcomeByLevel other)
181         : base(other)
182     {
183     }
184
185     public override EffectType GetEffect()
186     {
187         return EffectType.PlayerStatAdjustment;
188     }
189 }
```

## 2. Maintaining Compatibility

- ⚠️OK: Renaming serialized fields.
  - Apply the `[FormerlySerializedAs]` attribute



```
[SerializeField]  
[UnityEngine.Serialization.FormerlySerializedAs("m_failResult")]  
public EncounterOutcomeByLevel FailResult = null;
```

# 2. Maintaining Compatibility

- **⚠️ OK:** Changing the type of serialized fields.
- `ISerializationCallbackReceiver`

```
1  using System;
2  using UnityEngine;
3
4  namespace Assets.Scripts
5  {
6      public class TestScript : MonoBehaviour, ISerializationCallbackReceiver
7      {
8          // OLD!
9          [HideInInspector]
10         [Obsolete("Use NewLevel instead.")]
11         public int Level = 1;
12
13         // NEW!
14         public float NewLevel = 1.0f;
15
16         #region ISerializationCallbackReceiver implementation
17
18         public void OnAfterDeserialize()
19         {
20             #pragma warning disable 612, 618
21             if (Level >= 0)
22             {
23                 // assumes that -1 is an invalid value for Level
24                 NewLevel = Level;
25                 Level = -1;
26             }
27             #pragma warning restore
28         }
29
30         public void OnBeforeSerialize()
31         {
32         }
33     }
34
35     #endregion
36 }
37
38
```

## 2. Maintaining Compatibility

- **x BAD:** Reordering enumerations.
- **✓ OK:** Renaming enum elements.

```
public enum CardinalFacing
{
    N,
    NE,
    E,
    SE,
    S,
    SW,
    W,
    NW
}
```

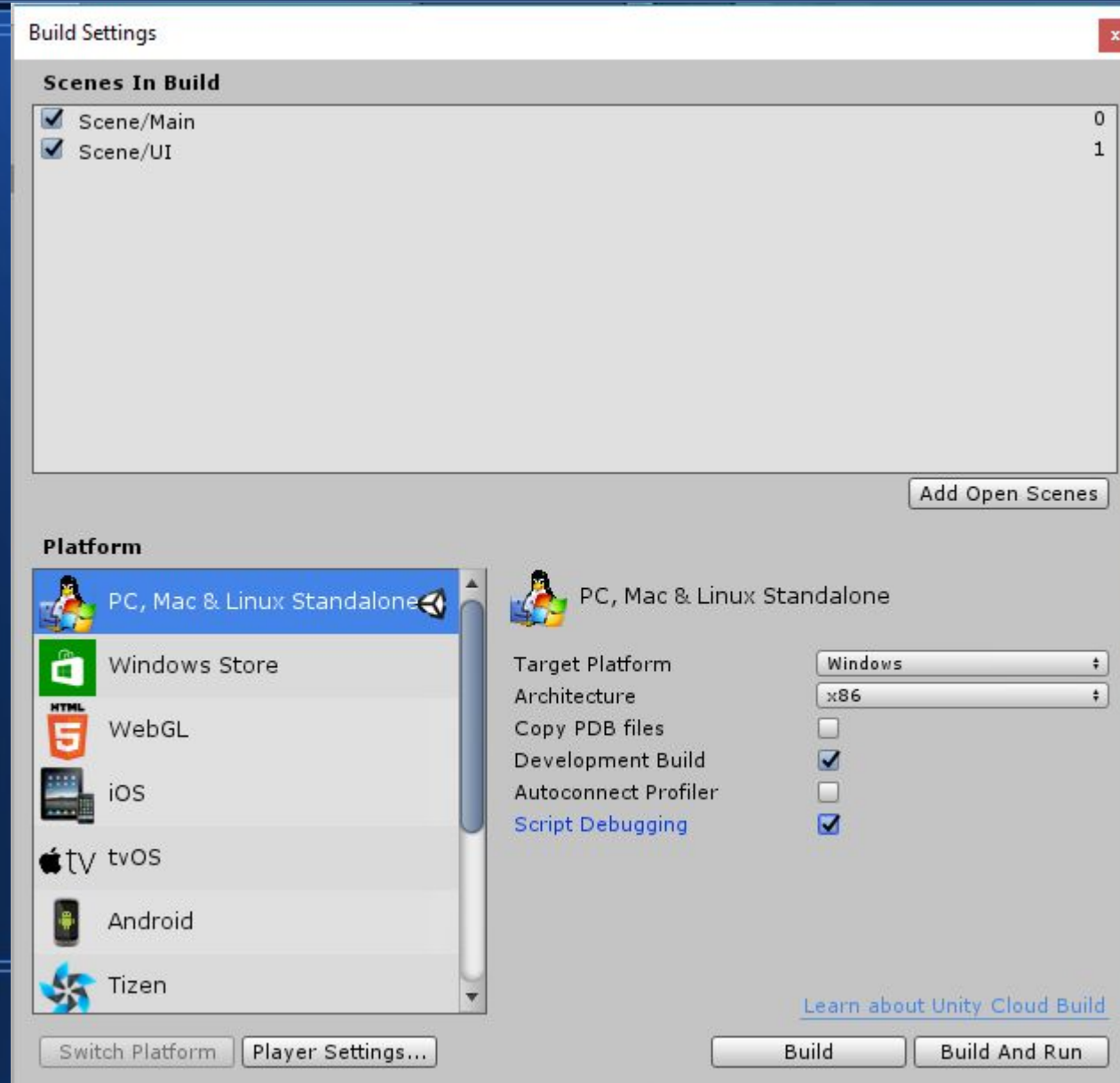


# 3. Standalone Divergence

- Problem: The standalone build has a problem that the editor doesn't have.
- You don't have the ability to attach the debugger, look at objects in the inspector, etc.

# 3. Standalone Divergence

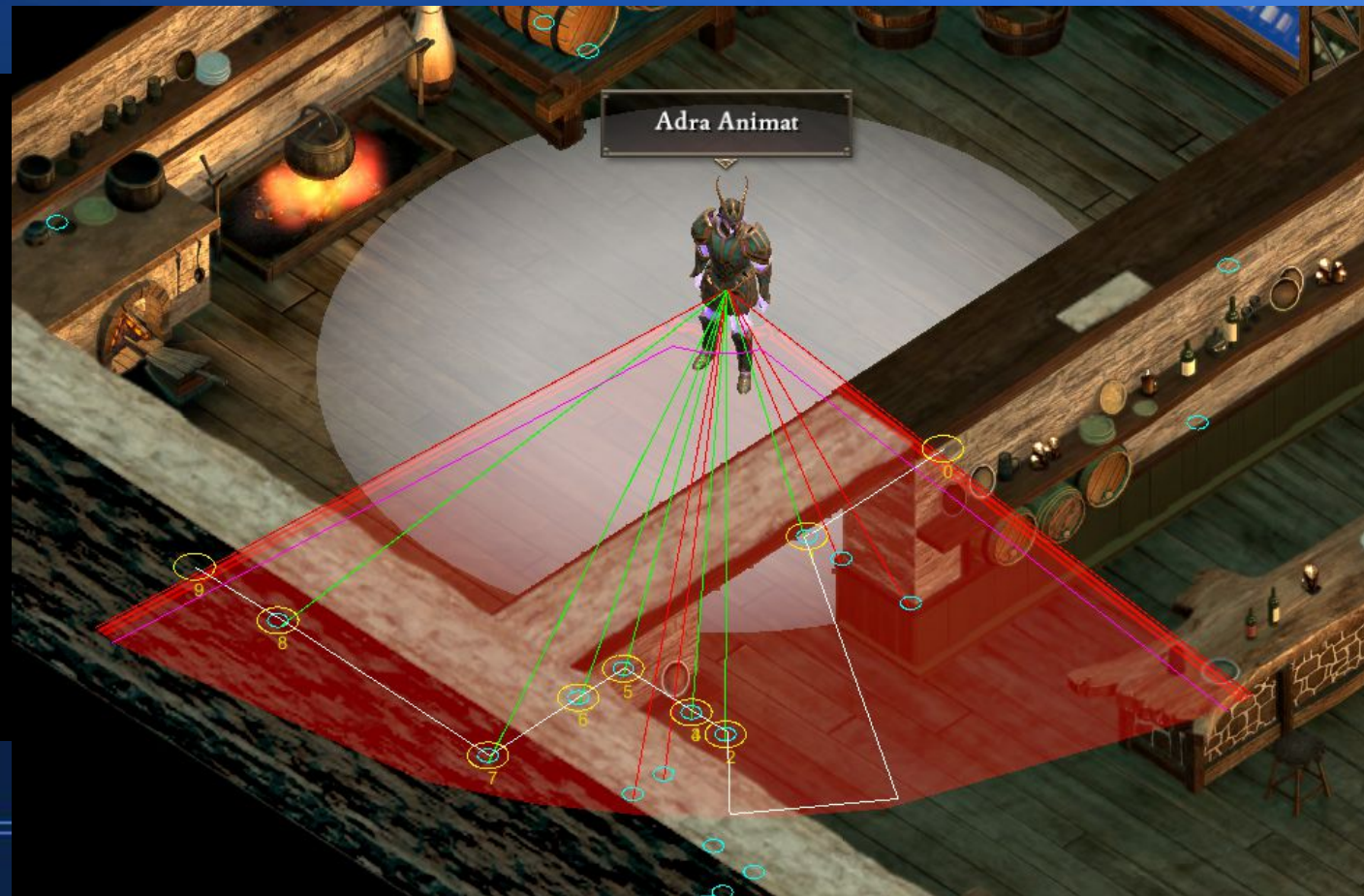
- Solution: Make a profile/dev build.
- Can attach the debugger (Debug → Attach Visual Studio Debugger)



# 3. Standalone Divergence

- On-screen debug output

```
-- Mouse Cursor Debug --  
Mouse Screen Pos: (1208.0, 1155.0, 0.0)  
Mouse Delta: (20.0, 23.0, 0.0)  
Mouse World Pos: (25.8, 0.0, -8.5)  
Cursor: Normal, UI Cursor: Normal  
3,000 ? X Mode: Default  
Generic Object Under Cursor: Null  
Character Under Cursor: Null  
UI Under Cursor: DimBackground  
Collider Under Cursor: Null  
Unusable Under Cursor: Null  
Mouse0: Down: 1, Up: 1
```





## Hierarchy

- ▶ combat\_test\_poe2
- DirectionLight
- ▶ Trap\_Test
- ▶ TriggerVolume\_Test
- ▶ AlarmTest
- ▶ SceneTransition\_Stair\_Up
- TEMP
- TransientLightProbe
- FogOfWar
- ▶ StreamTileParent\_combat\_test\_poe2
- ▶ Game Global Objects
- ▼ Cross Scene Objects
  - Store\_CityMap\_PortMaje\_Crew
  - Store\_CityMap\_Takuro
  - Store\_CityMap\_Crookspur
  - Store\_CityMap\_Tikawara
  - Store\_CityMap\_SplinteredReef
  - Store\_CityMap\_PortMaje
  - Store\_CityMap\_Neketaka
  - Store\_CityMap\_Dunnage
  - ▼ Player\_VS(Clone)
    - Mesh
      - ▶ Skeleton
      - ▶ Selection\_Circle(Clone)
    - ▶ Destination\_Circle(Clone)
    - Target\_Circle(Clone)
    - ▶ Companion\_Maia(Clone)
    - ▶ Destination\_Circle(Clone)
    - Target\_Circle(Clone)
    - ▶ Companion\_Xoti(Clone)
    - ▶ Destination\_Circle(Clone)

## Inspector

- Player\_VS(Clone)
- Tag: Untagged
- Layer: Dynamics
- ▶ UnityEngine.Transform
- ▶ UnityEngine.Rigidbody
- ▶ Game.AnimationController
- ▶ Game.Faction
- ▶ Game.Health
- ▶ Game.Player
- ▶ Game.CharacterStatsMutable
- ▼ Game.Equipment
  - (Game.Equipment)
  - ▶TypeID 97213dc3-7dad-4559-866c-0da6ba0c0a1a
  - SaveVersion 2
  - m\_loadVersion 0
  - ▶ m\_persistentEquipment
  - ▶ BaseEquipment Empty
  - ▶ StartingItems
  - m\_activeProps null
  - m\_isSwappingSummoned
  - <IsChangeFormEquip>
  - ▶ OnEquipmentChanged
  - ▶ OnEquipmentVisualsChg
  - ▶ s\_equipmentSlotNames
  - (Onyx.OnyxBehavior)
  - ▶ EnabledEvent
  - ▶ DisabledEvent
  - m\_defaultValuesSet
  - m\_preactivated
  - m\_awakeCalled
  - m\_startCalled

# Reflection: What is it?

- .NET API for examining the structure of your code at runtime
- `Object.GetType()`



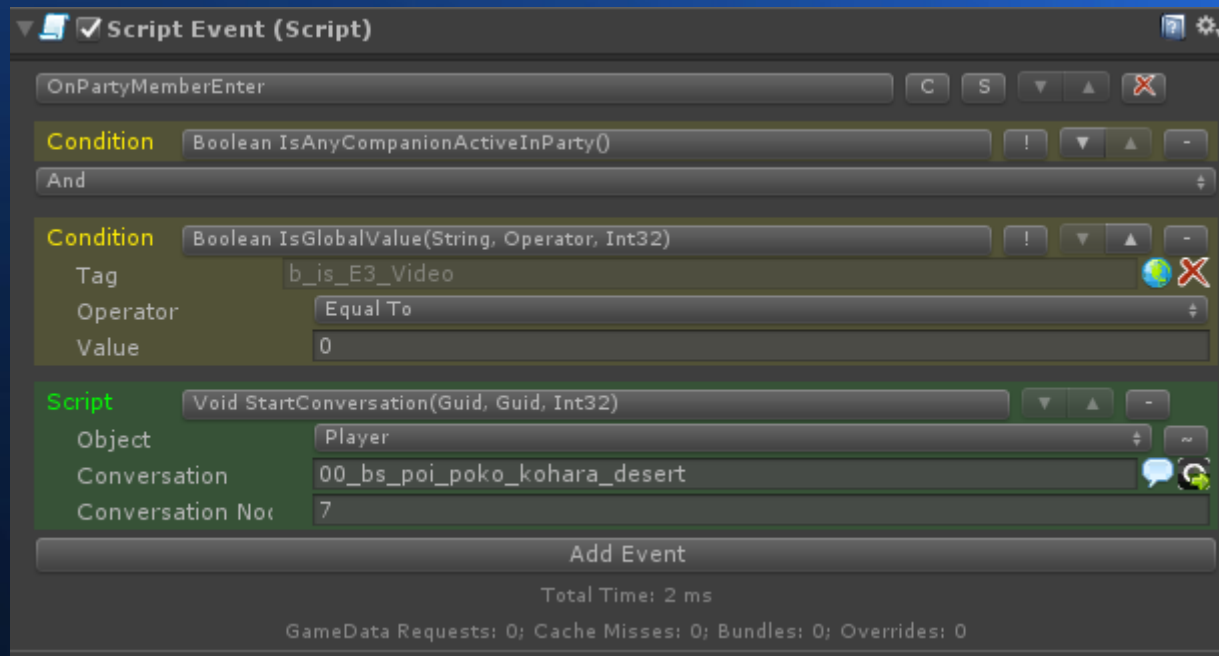
# Reflection: What can it do?

- Command line
- A static class with static methods
- Call any static method from the command line



# Reflection: What can it do?

- Scripting



# Thanks!

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