UWA
MAKE IT SIMPLE

MMO游戏优化经验分享

佑虎科技（上海）有限公司

2016.11.26

Who Are We ?

- 解答了1w+ 技术问题
- 150场+ 技术培训 & 技术分享
- 100人天+ 驻场技术支持
- 40次+ 游戏深度优化和热更新定制服务
- 100篇+ 技术Blog
- 开发了UWA—性能优化工具

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UWA在性能优化方面做了哪些事情？

- Unity游戏性能数据分析报告
  - 进行了1600+次测试
  - 生成和分析了2417万+帧性能数据
- Unity游戏深度性能优化
  - 累积2500页、80万+字数

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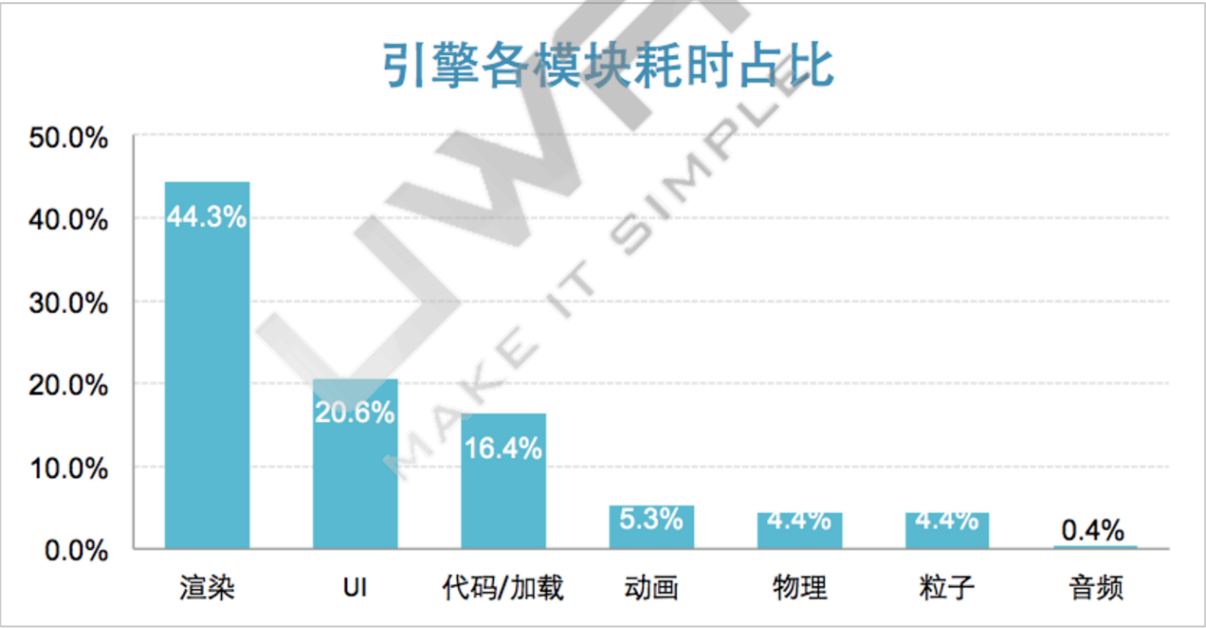
在性能优化方面做了哪些事情？

- MMO游戏性能数分析报告



大纲

- 渲染模块
- UI模块
- 动画模块
- 资源管理

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CPU优化

- 渲染模块

关键参数	MMORPG
Draw Call	45~185 | 215
渲染面片数	~75K（53.9%）
半透明渲染耗时	~4.5ms
不透明渲染耗时	~3.5ms
相机后处理特效	58.3%

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CPU优化

- 渲染模块

函数名	百分比	自身百分比	总耗时	自身耗时	调用帧数
− Camera.Render	-	4%	139723.00 ms	5556.02 ms	11605
− Drawing	78%	2%	109123.49 ms	2373.73 ms	11537
+ Render.OpaqueGeometry	38%	1%	52835.04 ms	1163.97 ms	11440
+ Render.TransparentGeometry	34%	1%	48039.92 ms	964.63 ms	11051
Camera.RenderSkybox	2%	2%	2515.86 ms	2482.08 ms	24
Render.Prepare	2%	2%	2198.27 ms	2198.27 ms	27
− Culling	15%	2%	21387.70 ms	2859.05 ms	1899
− SceneCulling	12%	3%	16118.43 ms	4882.43 ms	995
+ WaitingForJob	3%	1%	4851.09 ms	2006.23 ms	226
UIDrawCall.OnWillRenderObject()	3%	3%	3514.70 ms	3514.70 ms	86
CullAllVisibleLights	1%	1%	1429.68 ms	887.73 ms	18
PrepareSceneCullingParameters	1%	1%	1432.66 ms	850.28 ms	10
− Camera.ImageEffects	2%	0%	3000.92 ms	438.04 ms	88
− Camera.ImageEffects	2%	0%	2562.88 ms	1.96 ms	82
+ Bloom	2%	0%	2560.92 ms	1.66 ms	82

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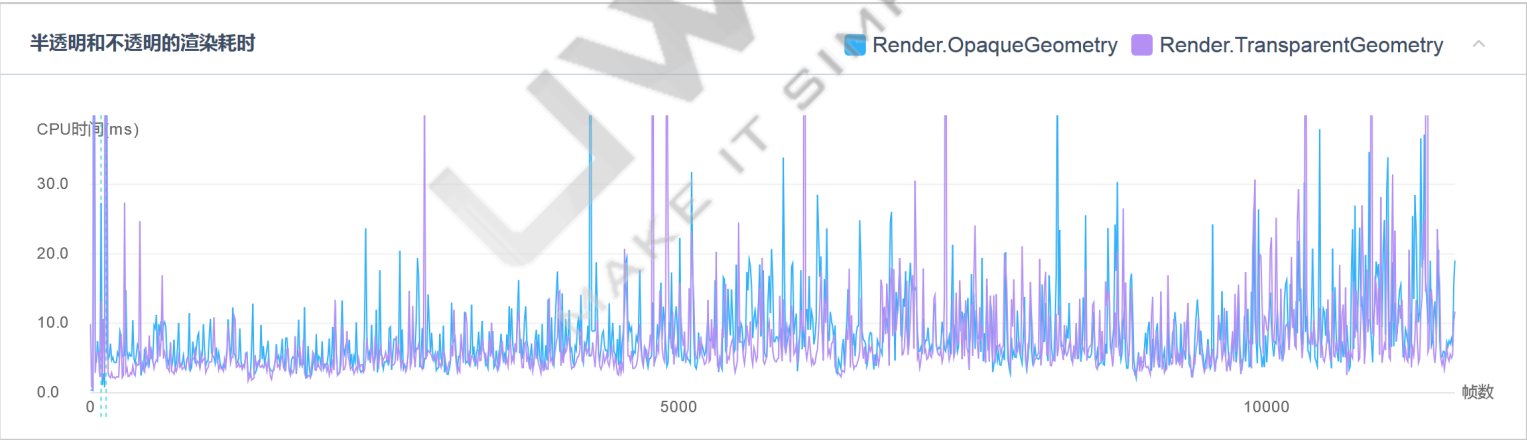
CPU优化

- 渲染模块
  - 半透明物体渲染 & 不透明物体渲染



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CPU优化

函数名	百分比	自身百分比	总耗时	自身耗时	调用帧数
━ Camera.Render	-	4%	139723.00 ms	5556.02 ms	11605
━ Drawing	78%	2%	109123.49 ms	2373.73 ms	11537
━ Render.OpaqueGeometry	38%	1%	52835.04 ms	1163.97 ms	11440
━ RenderForwardOpaque.Render	35%	11%	48906.81 ms	14826.49 ms	11218
✚ MeshSkinning.Render	13%	1%	18538.17 ms	1754.26 ms	1914
✚ MeshRenderer.Render	4%	0%	5877.90 ms	511.40 ms	126
Batch.DrawStatic	4%	4%	5456.87 ms	5456.87 ms	169
Clear	2%	2%	3411.61 ms	3411.61 ms	48
RenderForwardOpaque.Sort	1%	1%	1678.58 ms	1678.39 ms	18
━ Render.TransparentGeometry	34%	1%	48039.92 ms	964.63 ms	11051
━ RenderForwardAlpha.Render	32%	8%	44250.87 ms	11393.19 ms	10622
━ MeshRenderer.Render	15%	1%	20732.42 ms	1591.04 ms	2366
Mesh.DrawVBO	10%	10%	13850.00 ms	13850.00 ms	612
Mesh.CreateVBO	4%	4%	5291.39 ms	5291.39 ms	109
ParticleSystem.RenderSingle	3%	2%	4578.66 ms	3032.76 ms	147
SpriteRenderer.RenderBatch	2%	2%	2451.41 ms	2451.41 ms	31
Projector.Render	1%	1%	1683.51 ms	862.25 ms	35
RenderForwardAlpha.Sort	1%	1%	1651.79 ms	1651.68 ms	29

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CPU优化

- 渲染模块
  - MeshRender.Render

    控制Draw Call

    简化Mesh

CPU优化

- 渲染模块
  - MeshRender.Render

    Draw Call Batching、Texture Packing（MeshBaker等）

    Asset Store上的模型简化工具（SimpleLOD等）

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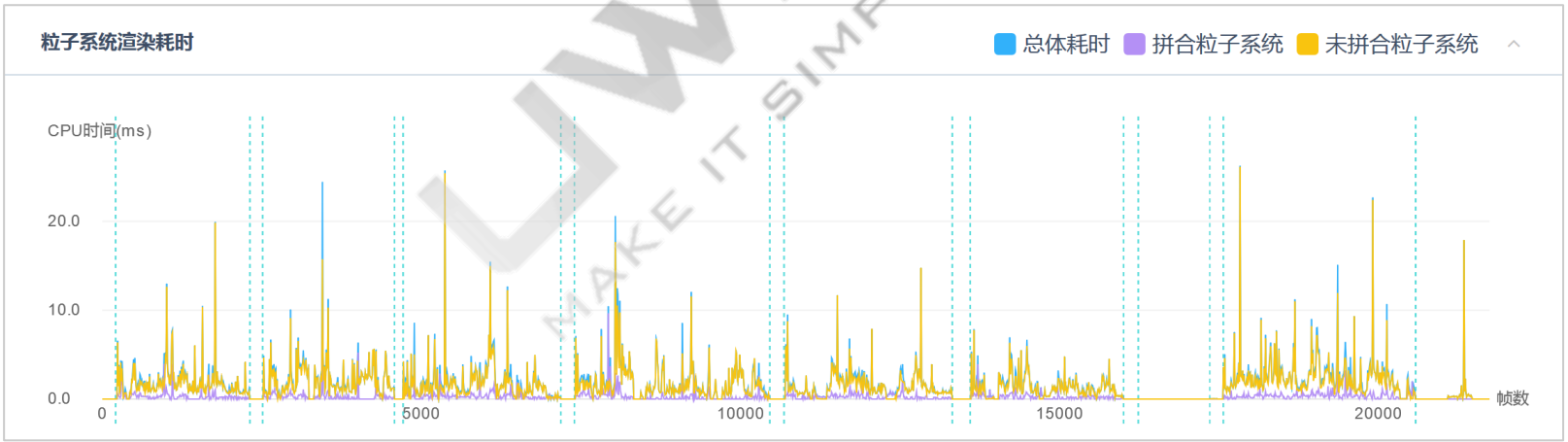
CPU优化

- 渲染模块
  - 粒子系统渲染



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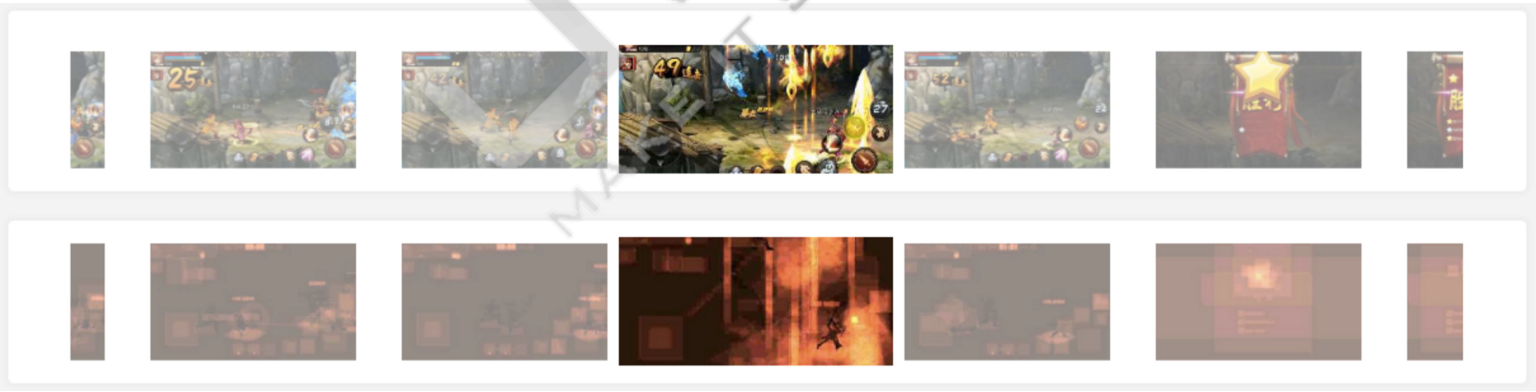
CPU优化

- 渲染模块
  - 粒子系统渲染

简化粒子系统、减小屏幕的覆盖面积



CPU优化

- 渲染模块
  - 粒子系统渲染

    简化粒子系统、减小屏幕的覆盖面积

    尝试升级到Unity 5.3版本以后

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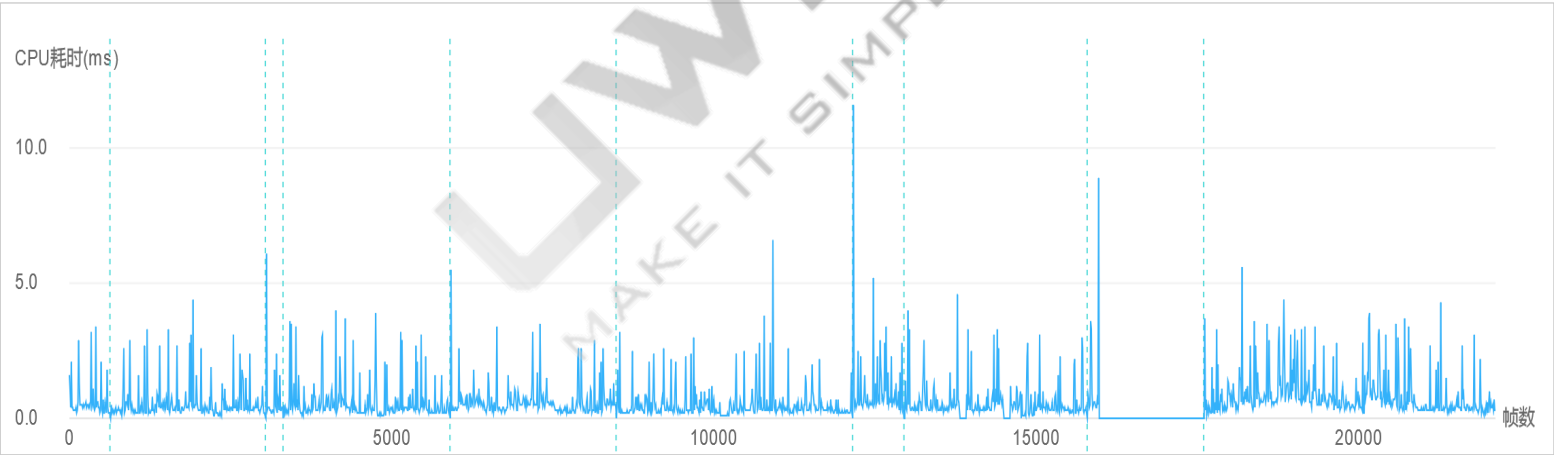
CPU优化

- 渲染模块
  - 蒙皮网格渲染



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CPU优化

- 渲染模块
  - 蒙皮网格渲染

减少Skinned Mesh面片数

降低Draw Call（MeshBaker）

资源名称	生命周期(场景数)	内存占用	数量峰值	Vertex数量	Triangles数量	Normal数量	Colors数量	Tangents数量	BoneWeights
mesh	4	1.2 MB	1	8933	12344	8933	0	8933	8933
mesh	4	920.2 KB	1	6706	6896	6706	0	6706	6706
mesh	6	874.5 KB	1	5337	6824	5337	5337	5337	5337
mesh	7	830.3 KB	1	5330	6704	5330	0	5330	5330
mesh	7	746.1 KB	1	5295	6992	5295	0	5295	5295
mesh	6	735.0 KB	1	4906	3651	4906	0	4906	4906
mesh	7	729.6 KB	1	4637	6408	4637	0	4637	4637
mesh	2	691.3 KB	1	4449	5314	4449	0	4449	4449
mesh	7	459.1 KB	1	4087	6244	4087	0	0	4087
mesh	6	624.8 KB	1	4086	4016	4086	0	4086	4086

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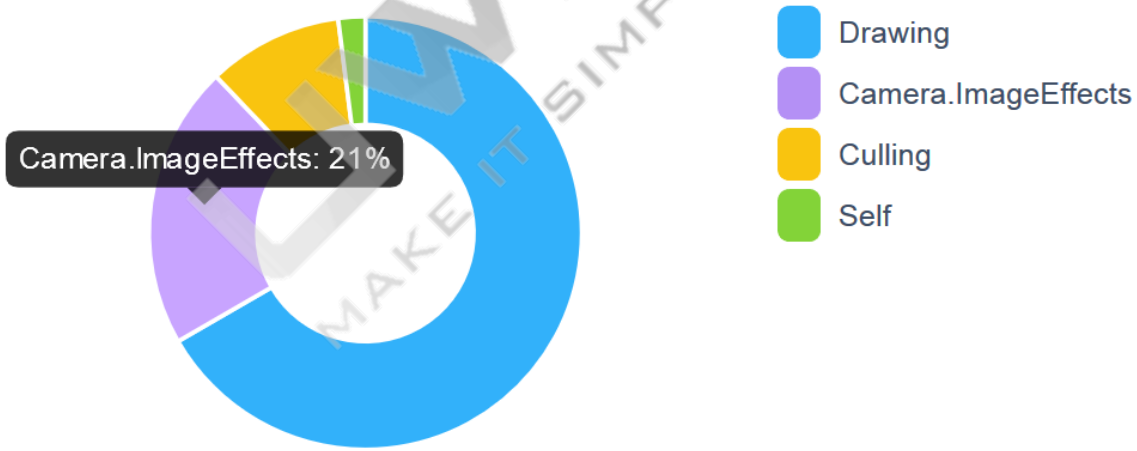
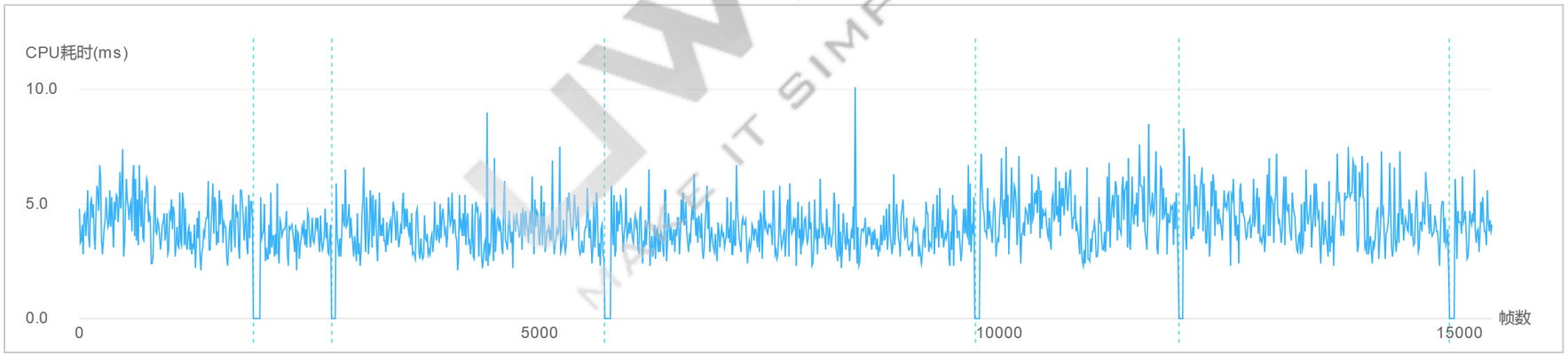
CPU优化

- 渲染模块
  - 相机屏幕后处理特效



CPU优化

- 渲染模块
  - 相机屏幕后处理特效



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CPU优化

- 渲染模块
  - 相机屏幕后处理特效
    - 使用Asset Store中Mobile Ready的插件
    - 在中低端机器上适度使用复杂特效
    - 开启多线程渲染功能

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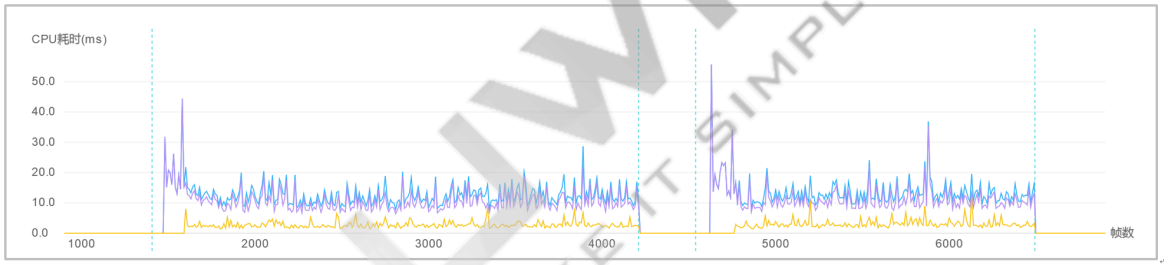
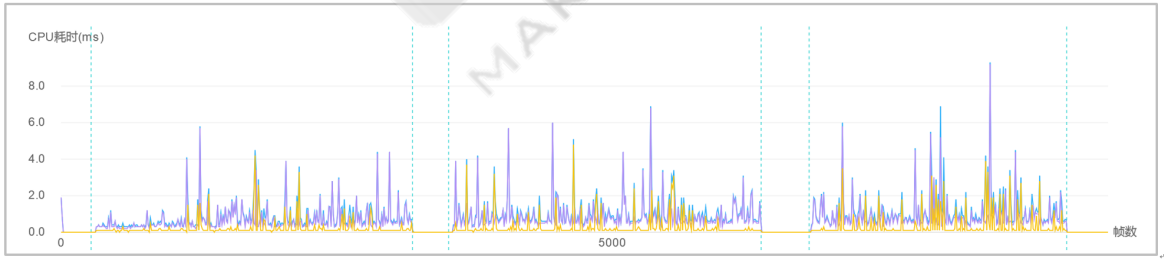
CPU优化

- 渲染模块
  - 多线程渲染功能



关闭多线程渲染



开启多线程渲染

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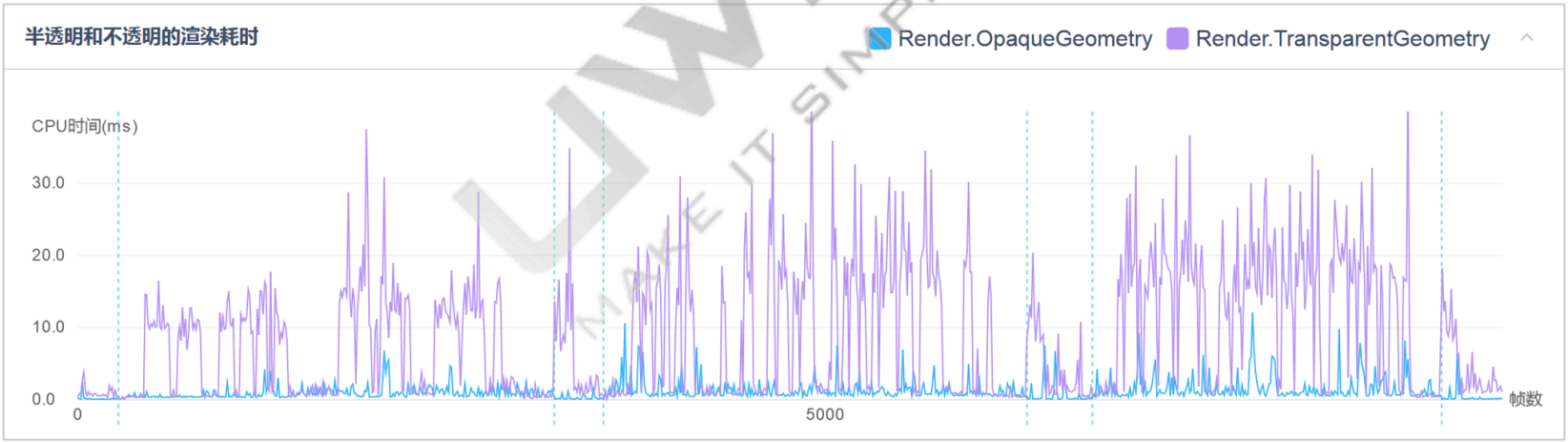
CPU优化

- 渲染模块
  - 多线程渲染功能



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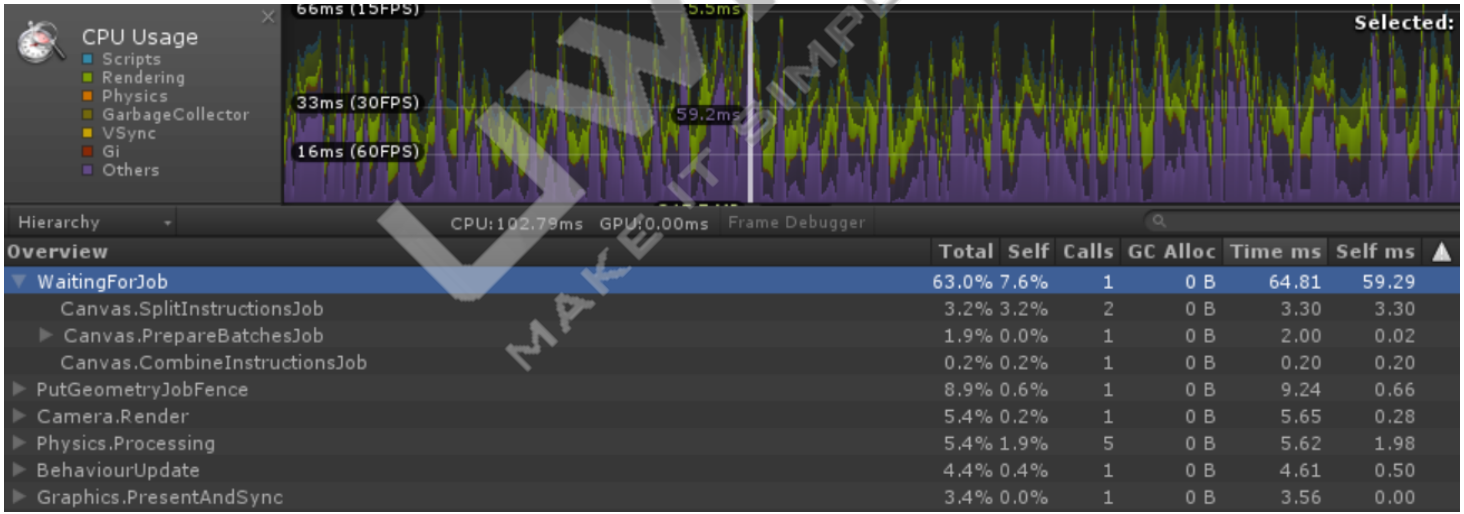
CPU优化

- 渲染模块
  - 多线程渲染功能



Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms
WaitingForJob	63.0%	7.6%	1	0 B	64.81	59.29
Canvas.SplitInstructionsJob	3.2%	3.2%	2	0 B	3.30	3.30
Canvas.PrepareBatchesJob	1.9%	0.0%	1	0 B	2.00	0.02
Canvas.CombineInstructionsJob	0.2%	0.2%	1	0 B	0.20	0.20
PutGeometryJobFence	8.9%	0.6%	1	0 B	9.24	0.66
Camera.Render	5.4%	0.2%	1	0 B	5.65	0.28
Physics.Processing	5.4%	1.9%	5	0 B	5.62	1.98
BehaviourUpdate	4.4%	0.4%	1	0 B	4.61	0.50
Graphics.PresentAndSync	3.4%	0.0%	1	0 B	3.56	0.00

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CPU优化

- 渲染模块
  - 多线程渲染功能

CPU优化

- 渲染模块
  - 多线程渲染功能

Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms
WaitingForJob	59.5%	55.4%	1	0 B	32.64	30.39
PutGeometryJobFence	9.1%	0.1%	1	0 B	5.00	0.08
Camera.Render	7.5%	0.3%	1	0 B	4.11	0.20
Overhead	5.1%	5.1%	1	0 B	2.81	2.81
Graphics.PresentAndSync	4.1%	0.0%	1	0 B	2.29	0.00

CPU优化

- 渲染模块
  - 实时阴影渲染

    Built-in Shadow Map

    适合多人

    Projector

    适合单人

函数名	百分比	自身百分比	总耗时	自身耗时	调用帧数
− Camera.Render	-	2%	171007.91 ms	3009.40 ms	11163
− Drawing	91%	0%	154764.73 ms	781.40 ms	10960
− Render.OpaqueGeometry	54%	0%	92744.69 ms	541.17 ms	10501
− RenderForwardOpaque.Render	51%	7%	87494.96 ms	11233.46 ms	10496
+ Shadows.RenderShadowmap	13%	1%	22400.47 ms	1298.40 ms	4113
+ MeshRenderer.Render	10%	1%	17831.27 ms	1245.23 ms	1691
Clear	8%	8%	13292.02 ms	13292.02 ms	560
MeshRenderer.RenderStaticBatch	6%	6%	9979.20 ms	9979.20 ms	573
Shader.SetPass	4%	4%	6822.62 ms	6822.62 ms	173
+ MeshSkinning.Render	3%	0%	5867.90 ms	386.58 ms	235
RenderForwardOpaque.Prepare	2%	1%	4074.08 ms	2432.91 ms	76
+ Render.TransparentGeometry	35%	0%	59378.94 ms	456.75 ms	9820
Render.Prepare	1%	1%	1771.78 ms	1771.78 ms	36
− Culling	8%	1%	12977.06 ms	2383.26 ms	489
+ Culling	6%	1%	10487.79 ms	2089.08 ms	312

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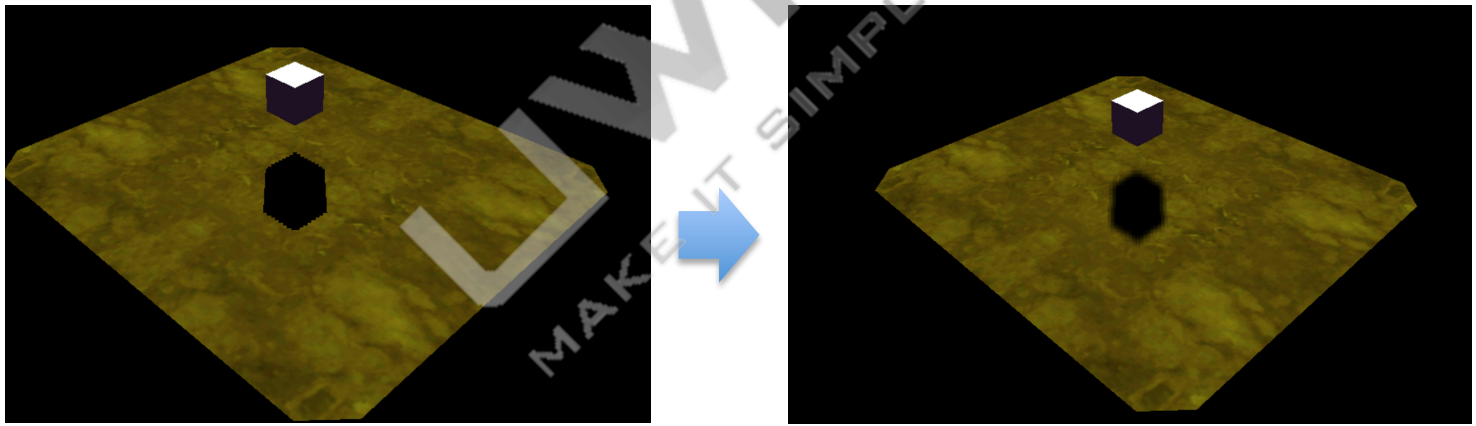
CPU优化

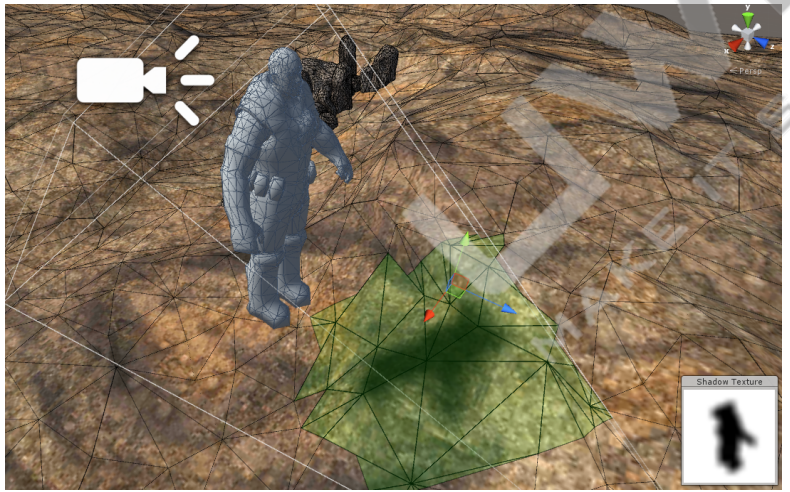
- 渲染模块
  - 实时阴影渲染 –分辨率



ScreenSpaceShadowMask Blur推荐（作者：赵忠健，blog.uwa4d.com）

CPU优化

- 渲染模块
  - 实时阴影渲染 – Receiver网格数据量



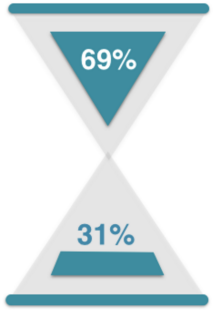
Fast Shadow Receiver插件（Asset Store）

同时支持Shadowmap和Projector

CPU优化

- UI模块

MMORPG类型



NGUI (上) / UGUI使用占比

NGUI模块CPU耗时主体范围为：0.8~10.6ms，均值为3.8ms；
UWA推荐：0~5ms，达标率: 21.6%。

21.6% FAIL

UGUI模块CPU耗时主体范围: 0.1 ~ 5.4ms，均值为1.7ms；
UWA推荐：0~5ms，达标率: 48.6%。

48.6% FAIL

UIPanel.LateUpdate: 0.4 ~ 8.4 ms；
每10K帧的堆内存分配：7.6~180.8 MB；
UWA推荐：＜20 MB，达标率: 35.8%。

35.8% FAIL

Canvas.BuildBatch: 0.0 ~ 3.2 ms;
Canvas.SendWillRenderCanvases: 0.0 ~ 2.5 ms；
每10K帧的堆内存分配：0.0~39.0 MB；
UWA推荐：＜2MB，达标率：54.1%。

54.1% FAIL

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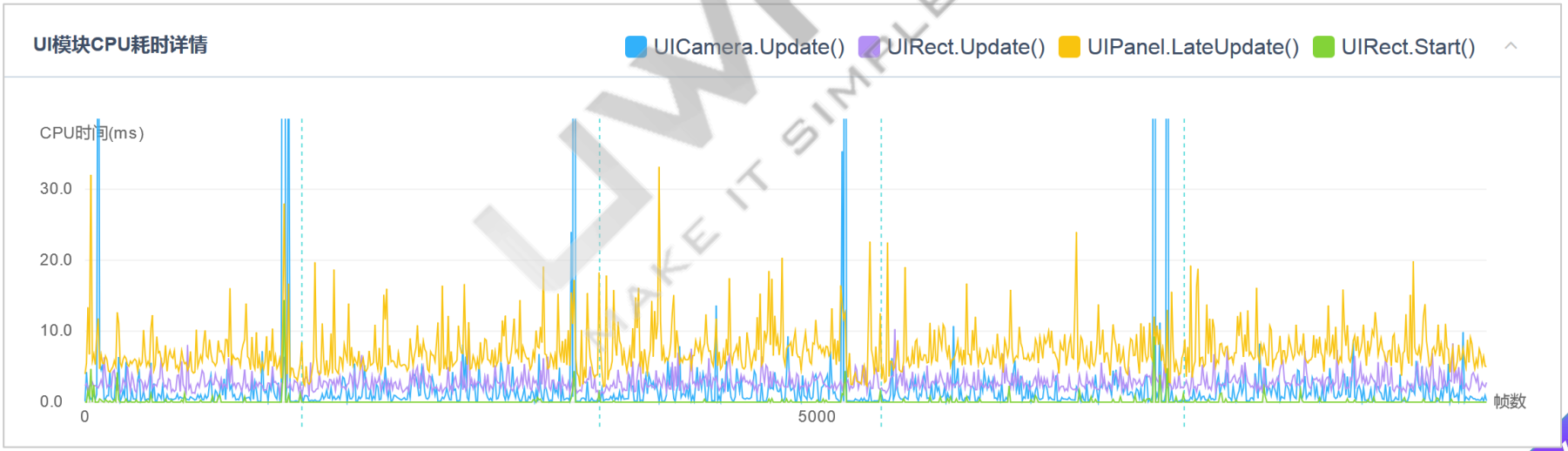
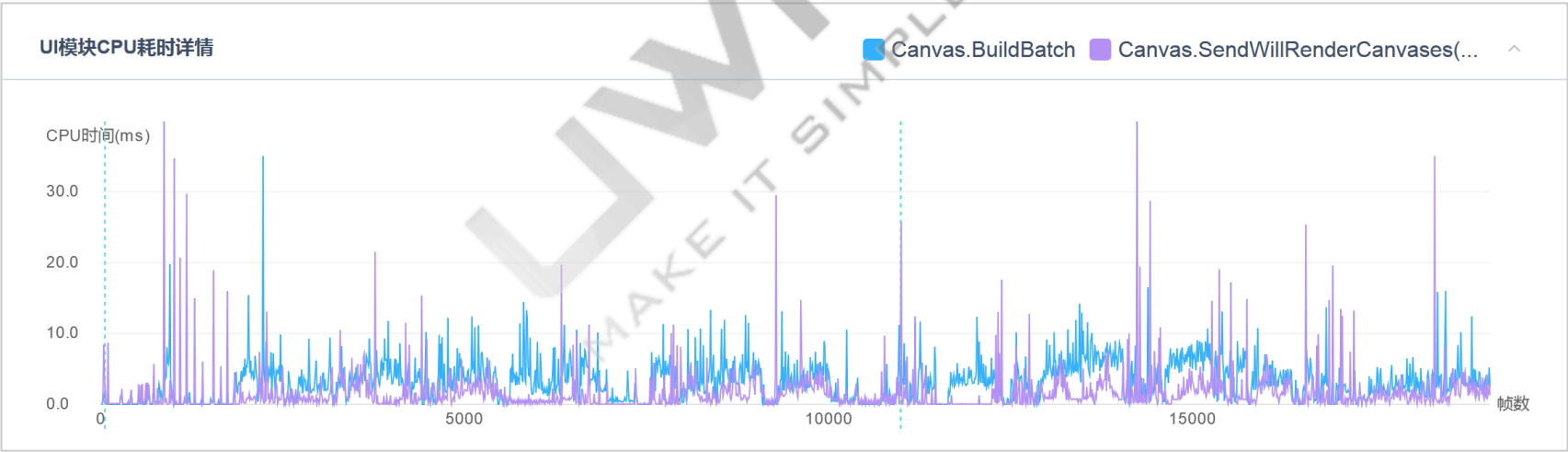
CPU优化

- UI模块
  - NGUI



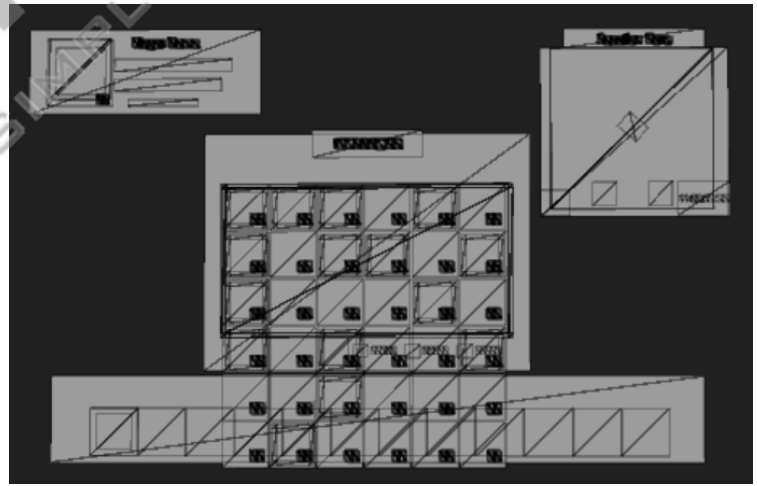
CPU优化

- UI模块
  - UGUI



CPU优化

- UI模块-网格重建
  - NGUI是按Panel进行重建的、UGUI是按Canvas进行重建的



CPU优化

- UI模块-网格重建
  - NGUI是按Panel进行重建的、UGUI是按Canvas进行重建的

Canvas.BuildBatch	21.3%	0.0%	1	0 B	4.22	0.00
Canvas.GenerateBatchedMesh	21.3%	6.6%	1	0 B	4.22	1.32
Canvas.FillBatchMesh	13.6%	1.7%	1	0 B	2.69	0.34
Canvas.FillVerts	10.8%	10.8%	1	0 B	2.14	2.14
Canvas.DoIndicies	0.9%	0.9%	1	0 B	0.19	0.19
Canvas.FillQuads	0.0%	0.0%	1	0 B	0.00	0.00
Canvas.BatchSort	0.9%	0.9%	1	0 B	0.19	0.19
Mesh.AwakeFromLoad	0.0%	0.0%	1	0 B	0.00	0.00

Not Saved (154)	0.7 MB	
Mesh (16)	0.5 MB	
BatchedMesh	489.0 KB	1

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CPU优化

- UI模块-网格重建
  - NGUI是按Panel进行重建的、UGUI是按Canvas进行重建的

资源名称	生命周期(场景数)	内存占用	数量峰值	Vertex数量	Triangles数量	Normal数量	Colors数量	Tangents数量	BoneWeights
[NGUI] NewCom	3	399.4 KB	1	8192	18	0	8192	0	0
[NGUI] NewCom	1	400.2 KB	1	8192	186	0	8192	0	0
[NGUI] light_ball01_add	2	200.6 KB	1	4096	6	0	4096	0	0
[NGUI] Head	2	204.7 KB	1	4096	246	0	4096	0	0
[NGUI] Mesh	5	202.1 KB	1	4096	2	0	4096	0	0
[NGUI] Mesh	5	202.0 KB	1	4096	18	0	4096	0	0
[NGUI] Font Material	2	206.6 KB	1	4096	106	0	4096	0	0
[NGUI] Font Material	1	205.9 KB	1	4096	6	0	4096	0	0
[NGUI] Map_1	2	200.8 KB	1	4096	2	0	4096	0	0
[NGUI] NewLogin	5	200.9 KB	1	4096	2	0	4096	0	0

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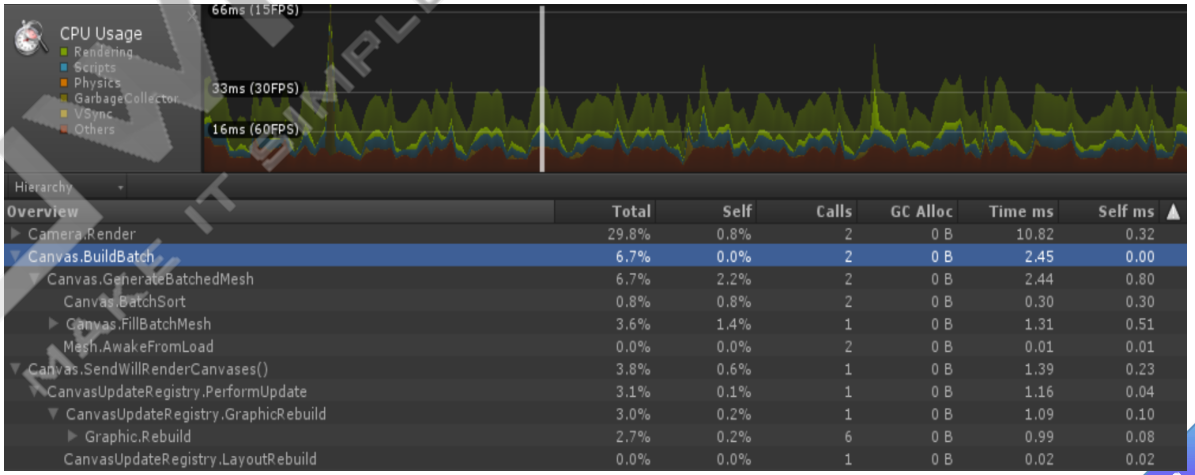
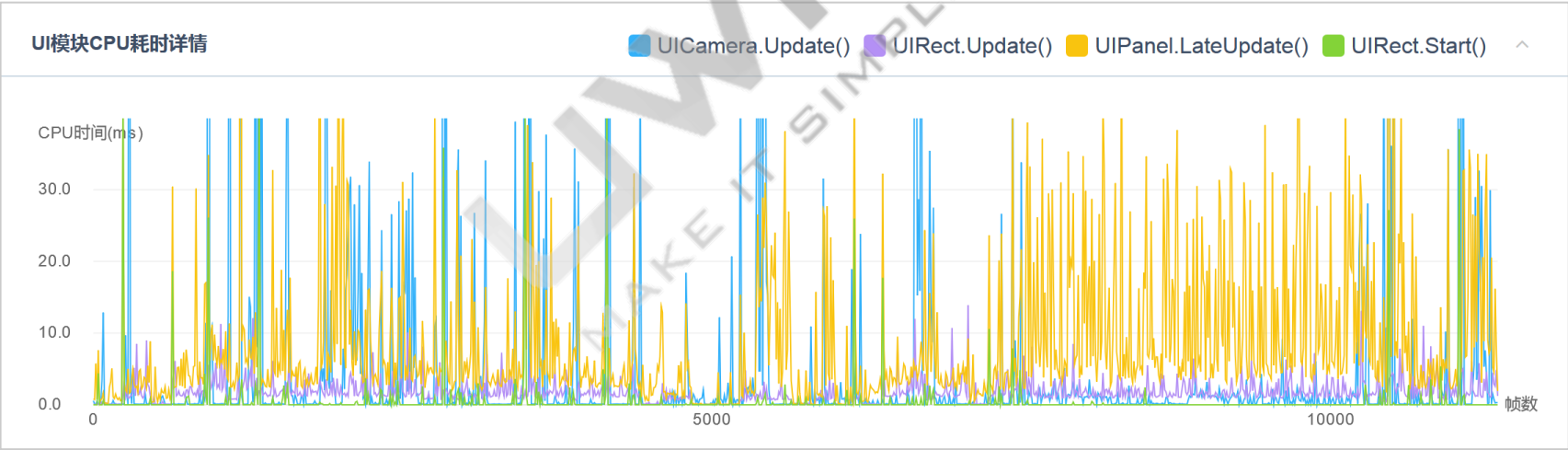
CPU优化

- UI模块-网格重建
  - 动态元素和静态元素分离
    - 坐标、时间
    - HUD 战斗提示
    - 角色头顶信息
    - ……



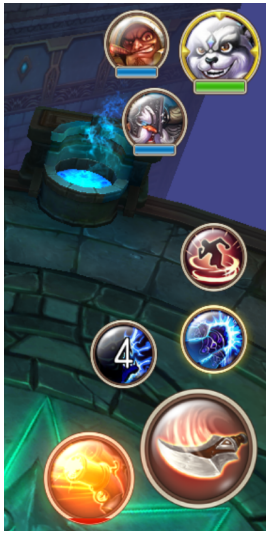
CPU优化

- UI模块-界面切换
  - 不推荐通过Instantiate/Destory或Active/Deactive来频繁切换复杂UI界面



CPU优化

- UI模块-Draw Call
  - 通过UISprite来代替UITexture



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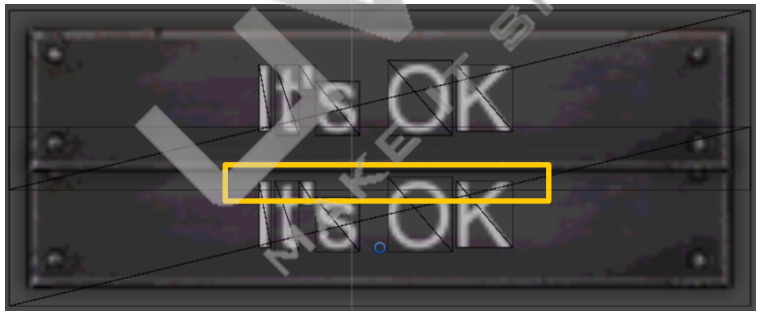
CPU优化

- UI模块-Draw Call
  - 通过UISprite来代替UITexture
  - UI界面避免重叠



UWA MAKE IT SIMPLE

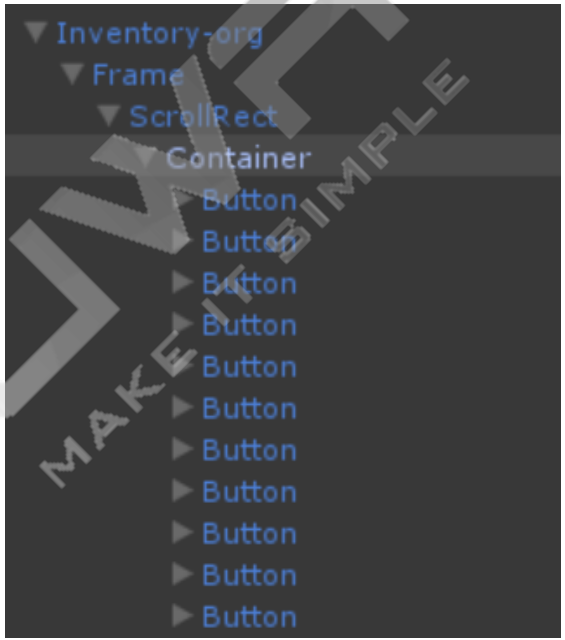
CPU优化

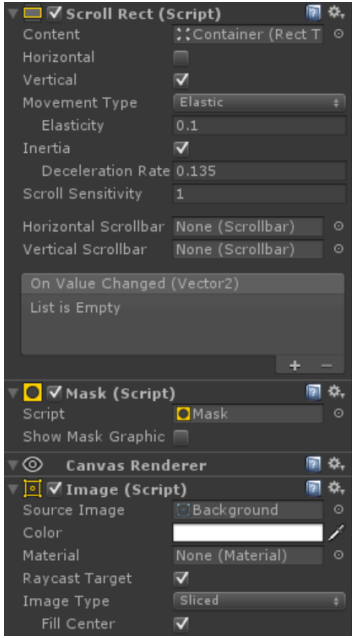
- UI模块-Draw Call
  - 通过UISprite来代替UITexture
  - UI界面避免重叠
  - Z值为0（Unity 5.2+）

UWA MAKE IT SIMPLE

CPU优化

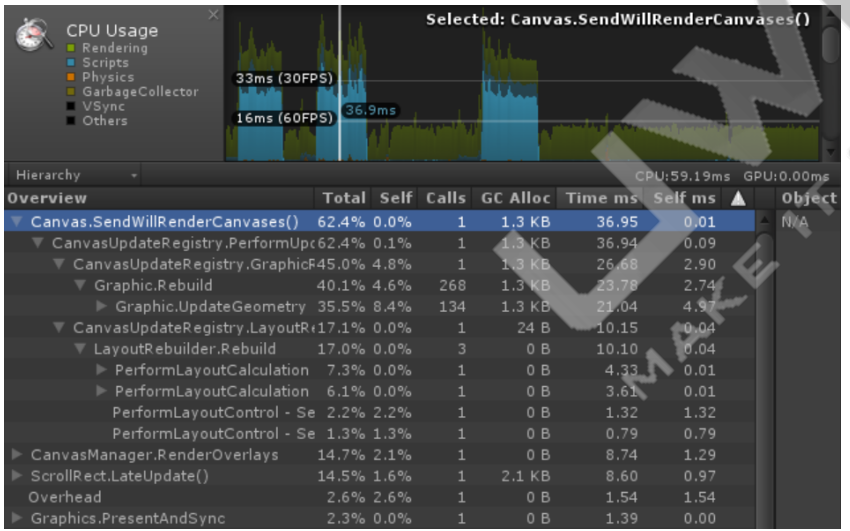
- UI模块-背包界面

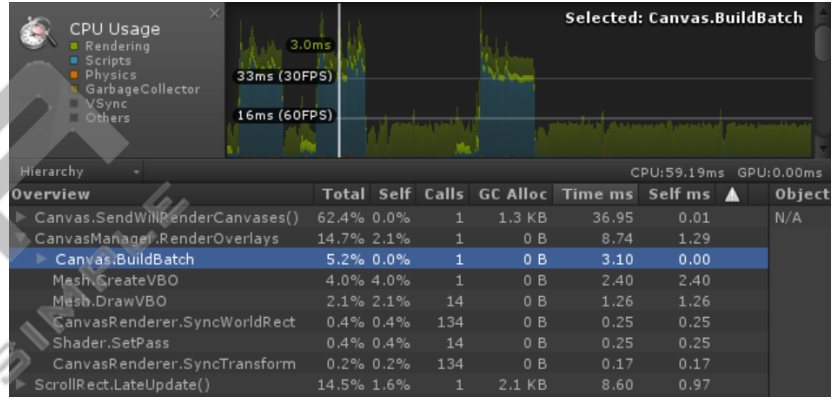


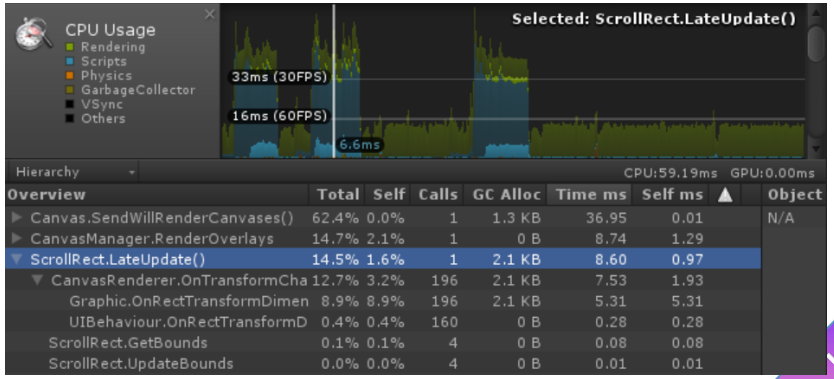


CPU优化

- UI模块-背包界面
  - 拖动开销（59.19ms）



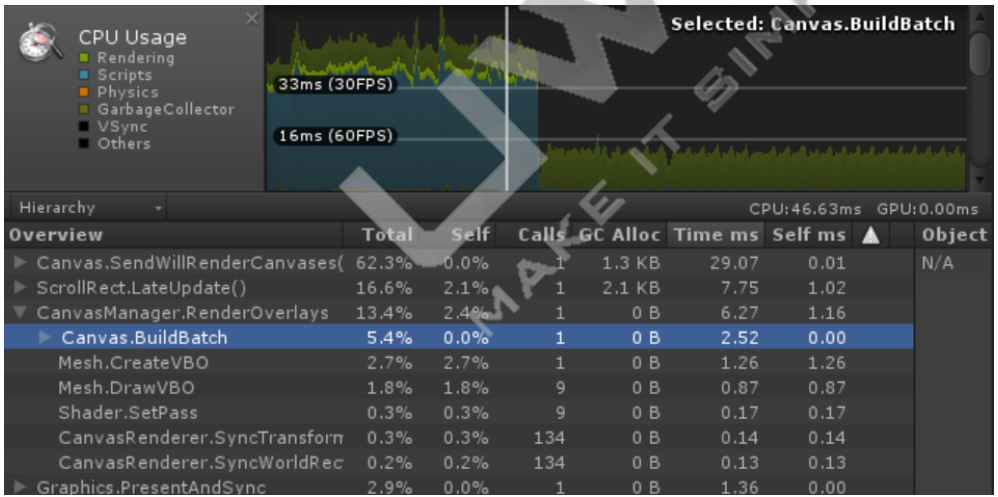


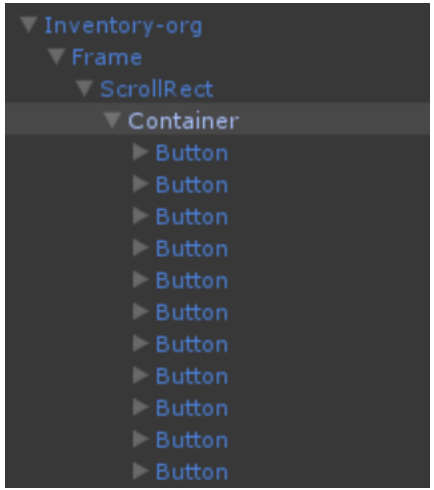


CPU优化

- UI模块-背包界面
  - 拖动开销（46.63ms）

将滚动部分独立成 Canvas，以减小 Canvas.BuildBatch 的范围

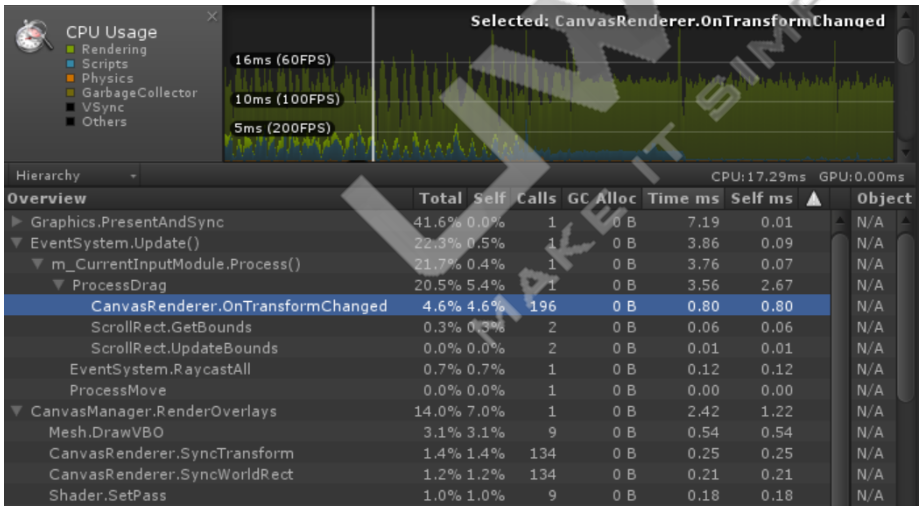




CPU优化

- UI模块-背包界面
  - 拖动开销（17.29ms）

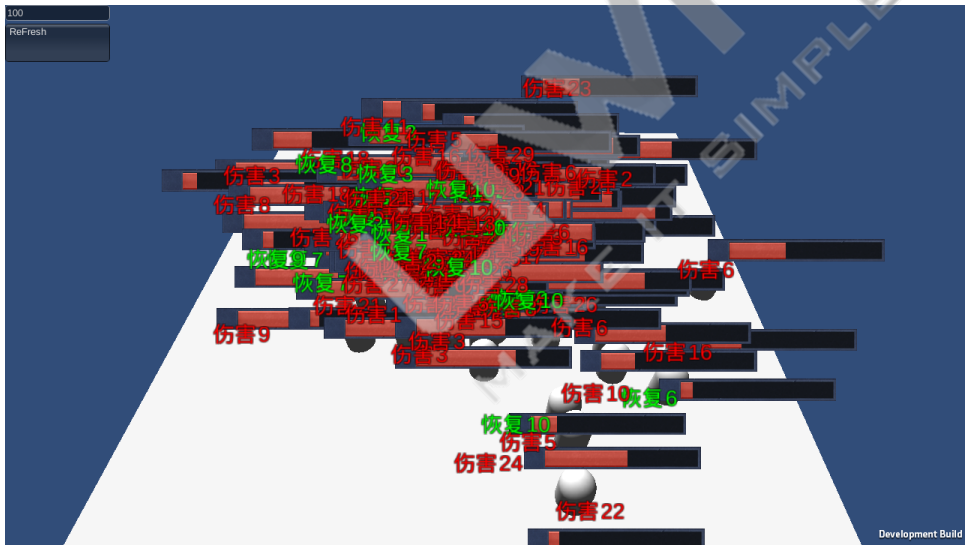
    关闭PixelPerfect，避免 Canvas.SendWillRenderCanvases和Canvas.BuildBatch

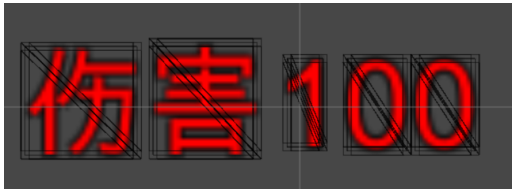


Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms	Object
Graphics.PresentAndSync	41.6%	0.0%	1	0 B	7.19	0.01	N/A
EventSystem.Update()	22.3%	0.5%	1	0 B	3.86	0.09	N/A
m_CurrentInputModule.Process()	21.7%	0.4%	1	0 B	3.76	0.07	N/A
ProcessDrag	20.5%	5.4%	1	0 B	3.56	2.67	N/A
CanvasRenderer.OnTransformChanged	4.6%	4.6%	196	0 B	0.80	0.80	N/A
ScrollRect.GetBounds	0.3%	0.3%	2	0 B	0.06	0.06	N/A
ScrollRect.UpdateBounds	0.0%	0.0%	2	0 B	0.01	0.01	N/A
EventSystem.RaycastAll	0.7%	0.7%	1	0 B	0.12	0.12	N/A
ProcessMove	0.0%	0.0%	1	0 B	0.00	0.00	N/A
CanvasManager.RenderOverlays	14.0%	7.0%	1	0 B	2.42	1.22	N/A
Mesh.DrawVBO	3.1%	3.1%	9	0 B	0.54	0.54	N/A
CanvasRenderer.SyncTransform	1.4%	1.4%	134	0 B	0.25	0.25	N/A
CanvasRenderer.SyncWorldRect	1.2%	1.2%	134	0 B	0.21	0.21	N/A
Shader.SetPass	1.0%	1.0%	9	0 B	0.18	0.18	N/A

CPU优化

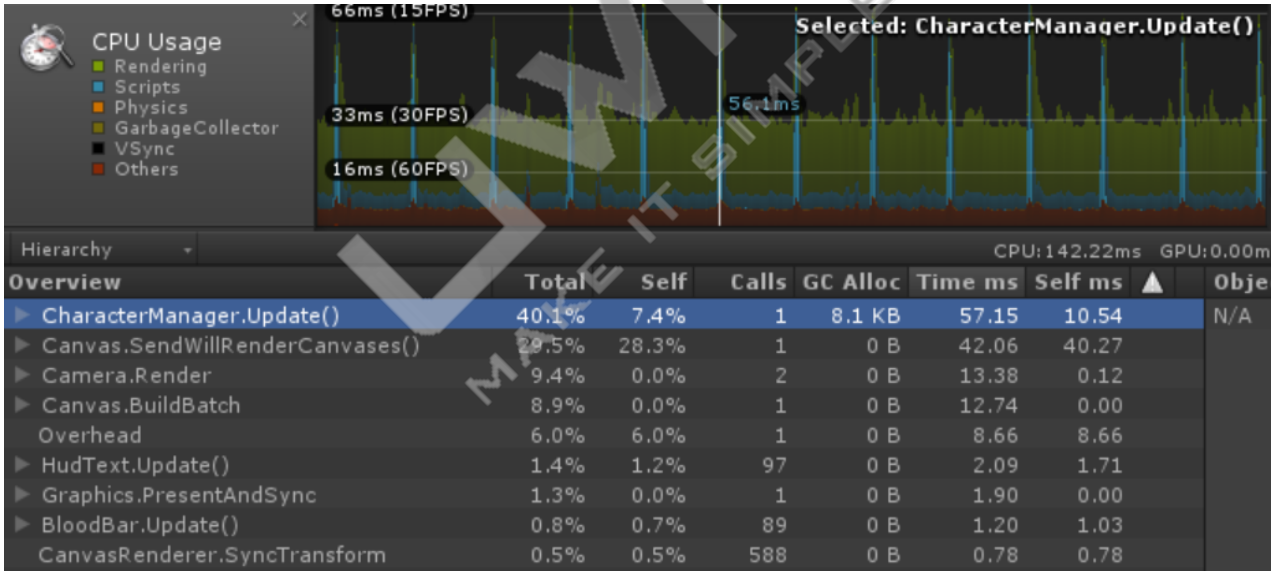
- UI模块-HUD血条优化
  - 同屏文字、血条各100个





CPU优化

- UI模块-HUD血条优化
  - 文字批量出现时CPU占用情况



Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms	Obje
CharacterManager.Update()	40.1%	7.4%	1	8.1 KB	57.15	10.54	N/A
Canvas.SendWillRenderCanvases()	28.5%	28.3%	1	0 B	42.06	40.27	
Camera.Render	9.4%	0.0%	2	0 B	13.38	0.12	
Canvas.BuildBatch	8.9%	0.0%	1	0 B	12.74	0.00	
Overhead	6.0%	6.0%	1	0 B	8.66	8.66	
HudText.Update()	1.4%	1.2%	97	0 B	2.09	1.71	
Graphics.PresentAndSync	1.3%	0.0%	1	0 B	1.90	0.00	
BloodBar.Update()	0.8%	0.7%	89	0 B	1.20	1.03	
CanvasRenderer.SyncTransform	0.5%	0.5%	588	0 B	0.78	0.78	

CPU优化

- UI模块-HUD血条优化
  - 去掉SetParent操作（-9.4ms）

CharacterManager.Update()	41.6%	7.7%	1	8.2 KB	61.64	11.41
GameObject.Activate	28.2%	7.2%	110	312 B	41.82	10.74
Text.OnEnable()	16.4%	16.4%	194	0 B	24.38	24.38
RandomWalker.OnEnable()	1.9%	0.3%	13	312 B	2.93	0.51
GameObject.Activate	1.3%	0.6%	13	156 B	1.97	0.95
MaskableGraphic.OnEnable()	0.4%	0.4%	26	0 B	0.67	0.67
RectTransform.SendReapplyDri	0.1%	0.1%	26	0 B	0.24	0.24
BloodBar.OnEnable()	0.0%	0.0%	13	156 B	0.06	0.06
CanvasRenderer.OnTransformC	0.0%	0.0%	39	0 B	0.03	0.03
Graphic.OnBeforeTransformParent	0.1%	0.1%	26	0 B	0.28	0.28
CanvasRenderer.OnTransformCha	0.0%	0.0%	26	0 B	0.10	0.10
MaskableGraphic.OnTransformPar	0.0%	0.0%	26	0 B	0.06	0.06
RectTransform.SendReapplyDrivenPr	1.4%	1.4%	194	0 B	2.13	2.13
BaseVertexEffect.OnEnable()	0.7%	0.7%	194	0 B	1.09	1.09
HudText.OnEnable()	0.1%	0.1%	97	0 B	0.27	0.27
CanvasRenderer.OnTransformChang	0.1%	0.1%	291	0 B	0.25	0.25
GameObject.Deactivate	1.9%	0.2%	13	0 B	2.92	0.31
RandomWalker.OnDisable()	1.7%	0.2%	13	0 B	2.61	0.34
GameObject.Deactivate	1.5%	0.7%	13	0 B	2.26	1.12
MaskableGraphic.OnDisable()	0.5%	0.5%	26	0 B	0.87	0.87
RectTransform.SendReapplyDri	0.1%	0.1%	26	0 B	0.26	0.26
Graphic.OnBeforeTransformParentChan	1.8%	1.8%	194	0 B	2.78	2.78
Graphic.OnRectTransformDimensionsCh	0.5%	0.5%	58	0 B	0.84	0.84
CanvasRenderer.OnTransformChanged	0.4%	0.4%	498	0 B	0.68	0.68
MaskableGraphic.OnTransformParentCh	0.3%	0.3%	194	0 B	0.45	0.45
UIBehaviour.OnBeforeTransformParent	0.2%	0.2%	194	0 B	0.32	0.32
UIBehaviour.OnTransformParentChange	0.1%	0.1%	194	0 B	0.27	0.27
UIBehaviour.OnRectTransformDimensio	0.0%	0.0%	58	0 B	0.11	0.11

CharacterManager.Update()	46.9%	6.8%	1	8.3 KB	52.21	7.61
GameObject.Activate	37.2%	9.0%	109	216 B	41.42	10.05
Text.OnEnable()	23.5%	23.5%	200	0 B	26.17	26.17
RectTransform.SendReapplyDrivenProper	2.0%	2.0%	200	0 B	2.29	2.29
RandomWalker.OnEnable()	1.3%	0.1%	9	216 B	1.54	0.12
GameObject.Activate	1.2%	0.6%	9	108 B	1.42	0.67
MaskableGraphic.OnEnable()	0.4%	0.4%	18	0 B	0.48	0.48
RectTransform.SendReapplyDrivenI	0.1%	0.1%	18	0 B	0.17	0.17
BloodBar.OnEnable()	0.0%	0.0%	9	108 B	0.05	0.05
CanvasRenderer.OnTransformChan	0.0%	0.0%	27	0 B	0.03	0.03
CanvasRenderer.OnTransformChanged	1.0%	1.0%	300	0 B	1.11	1.11
HudText.OnEnable()	0.2%	0.2%	100	0 B	0.24	0.24
GameObject.Deactivate	1.6%	0.1%	9	0 B	1.84	0.16
Graphic.OnRectTransformDimensionsChang	0.6%	0.6%	46	0 B	0.75	0.75
CanvasRenderer.OnTransformChanged	0.4%	0.4%	324	0 B	0.46	0.46
UIBehaviour.OnRectTransformDimensionsCl	0.0%	0.0%	46	0 B	0.11	0.11

UWA MAKE IT SIMPLE

CPU优化

- UI模块-HUD血条优化
  - 去掉Outline效果

Canvas.SendWillRenderCanvases()	40.4%	0.0%	1	0 B	160.49	0.00
CanvasUpdateRegistry.PerformUpdate()	40.4%	0.5%	1	0 B	160.49	2.29
Graphic.Rebuild()	39.4%	0.1%	602	0 B	156.69	0.41
Text.UpdateGeometry()	32.9%	0.1%	194	0 B	130.63	0.44
Graphic.UpdateGeometry()	32.7%	0.6%	194	0 B	130.16	2.68
Outline.ModifyVertices()	23.4%	0.7%	194	0 B	93.15	2.92
Text.OnFillVBO()	7.5%	3.1%	194	0 B	30.05	12.66
ComponentListPool.Release()	0.2%	0.0%	194	0 B	1.04	0.09
CanvasRenderer.SetVertices()	0.2%	0.0%	194	0 B	0.90	0.17
ObjectPool`1.Release()	0.2%	0.0%	194	0 B	0.86	0.39

UWA MAKE IT SIMPLE

CPU优化

- UI模块-HUD血条优化
  - 去掉Outline效果（-10.5ms）

Canvas.SendWillRenderCanvases()	29.5%	28.2%	1	0 B	41.02	39.28
Font.CacheFontForText	1.2%	1.2%	380	0 B	1.73	1.73

Canvas.SendWillRenderCanvases()	27.4%	25.7%	1	24 B	30.49	28.63
Font.CacheFontForText	1.6%	1.6%	400	0 B	1.86	1.86

UWA MAKE IT SIMPLE

CPU优化

- UI模块-HUD血条优化
  - 去掉SetParent操作 & Outline效果（-6.4ms）

Camera.Render	9.5%	0.0%	2	0 B	13.31	0.12
Drawing	9.2%	0.0%	2	0 B	12.79	0.02
Render.TransparentGeometry	6.2%	0.0%	2	0 B	8.72	0.02
RenderForwardAlpha.Render	6.2%	0.0%	2	0 B	8.68	0.09
Mesh.CreateVBO	4.0%	4.0%	1	0 B	5.69	5.69
Mesh.DrawVBO	2.0%	2.0%	3	0 B	2.83	2.83
Shader.SetPass	0.0%	0.0%	3	0 B	0.06	0.06
RenderForwardAlpha.Prepare	0.0%	0.0%	2	0 B	0.01	0.01
RenderForwardAlpha.Sort	0.0%	0.0%	2	0 B	0.00	0.00
Render.OpaqueGeometry	2.8%	0.0%	2	0 B	3.97	0.02
Render.Prepare	0.0%	0.0%	2	0 B	0.06	0.06
Camera.ImageEffects	0.0%	0.0%	2	0 B	0.00	0.00
Culling	0.2%	0.1%	2	0 B	0.38	0.22
RenderTexture.SetActive	0.0%	0.0%	2	0 B	0.00	0.00
Camera.ImageEffects	0.0%	0.0%	2	0 B	0.00	0.00

Camera.Render	6.4%	0.1%	2	0 B	6.89	0.12
Drawing	5.9%	0.0%	2	0 B	6.36	0.03
Render.OpaqueGeometry	3.7%	0.0%	2	0 B	3.96	0.02
Render.TransparentGeometry	2.1%	0.0%	2	0 B	2.28	0.02
RenderForwardAlpha.Render	2.0%	0.0%	2	0 B	2.24	0.08
Mesh.CreateVBO	1.3%	1.3%	1	0 B	1.48	1.48
Mesh.DrawVBO	0.5%	0.5%	3	0 B	0.61	0.61
Shader.SetPass	0.0%	0.0%	3	0 B	0.06	0.06
RenderForwardAlpha.Prepare	0.0%	0.0%	2	0 B	0.01	0.01
RenderForwardAlpha.Sort	0.0%	0.0%	2	0 B	0.00	0.00
Render.Prepare	0.0%	0.0%	2	0 B	0.06	0.06
Camera.ImageEffects	0.0%	0.0%	2	0 B	0.00	0.00
Culling	0.3%	0.1%	2	0 B	0.39	0.20
RenderTexture.SetActive	0.0%	0.0%	2	0 B	0.00	0.00
Camera.ImageEffects	0.0%	0.0%	2	0 B	0.00	0.00

CPU优化

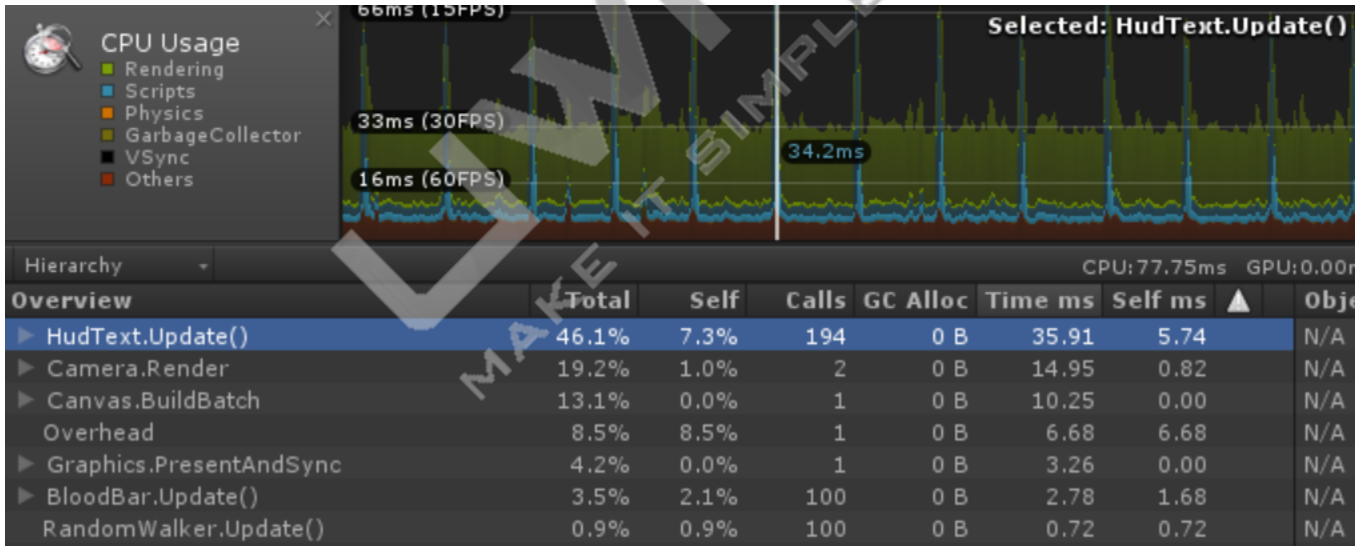
- UI模块-HUD血条优化
  - 去掉SetParent操作 & Outline效果（-6.0ms）

Canvas.BuildBatch	9.3%	0.0%	1	0 B	12.92	0.00
Canvas.GenerateBatchedMesh	9.2%	0.5%	1	0 B	12.92	0.81
Canvas.FillBatchMesh	5.9%	1.1%	1	0 B	8.32	1.55
Canvas.FillVerts	4.4%	4.4%	1	0 B	6.23	6.23
Canvas.DoIndicies	0.3%	0.3%	1	0 B	0.49	0.49
Canvas.FillQuads	0.0%	0.0%	1	0 B	0.04	0.04
Canvas.BatchSort	2.7%	2.7%	1	0 B	3.78	3.78
Mesh.AwakeFromLoad	0.0%	0.0%	1	0 B	0.00	0.00

Canvas.BuildBatch	5.9%	0.0%	1	0 B	6.34	0.00
Canvas.GenerateBatchedMesh	5.9%	0.4%	1	0 B	6.33	0.51
Canvas.BatchSort	3.2%	3.2%	1	0 B	3.53	3.53
Canvas.FillBatchMesh	2.1%	0.4%	1	0 B	2.29	0.43
Canvas.FillVerts	1.6%	1.6%	1	0 B	1.73	1.73
Canvas.DoIndicies	0.1%	0.1%	1	0 B	0.11	0.11
Canvas.FillQuads	0.0%	0.0%	1	0 B	0.01	0.01
Mesh.AwakeFromLoad	0.0%	0.0%	1	0 B	0.00	0.00

CPU优化

- UI模块-HUD血条优化
  - 文字批量消失时CPU占用情况



CPU优化

- UI模块-HUD血条优化
  - 文字批量消失时CPU占用情况（-5ms）

HudText.Update()	43.7%	5.6%	193	0 B	30.96	4.01
GameObject.Deactivate	36.7%	15.5%	192	0 B	26.01	10.98
Text.OnDisable()	15.0%	15.0%	192	0 B	10.67	10.67
RectTransform.SendReapplyDrivenPr	4.3%	4.3%	192	0 B	3.09	3.09
BaseVertexEffect.OnDisable()	1.3%	1.3%	192	0 B	0.98	0.98
HudText.OnDisable()	0.3%	0.3%	96	0 B	0.26	0.26
CanvasRenderer.OnTransformChanged	1.3%	1.3%	388	0 B	0.94	0.94

UWA MAKE IT SIMPLE

CPU优化

- UI模块-HUD血条优化
  - Text.OnEnable/OnDisable

CharacterManager.Update()	46.9%	6.8%	1	8.3 KB	52.21	7.61
GameObject.Activate	37.2%	9.0%	109	216 B	41.42	10.05
Text.OnEnable()	23.5%	23.5%	200	0 B	26.17	26.17
RectTransform.SendReapplyDrivenPropei	2.0%	2.0%	200	0 B	2.29	2.29
RandomWalker.OnEnable()	1.3%	0.1%	9	216 B	1.54	0.12
GameObject.Activate	1.2%	0.6%	9	108 B	1.42	0.67
MaskableGraphic.OnEnable()	0.4%	0.4%	18	0 B	0.48	0.48
RectTransform.SendReapplyDrivenI	0.1%	0.1%	18	0 B	0.17	0.17
BloodBar.OnEnable()	0.0%	0.0%	9	108 B	0.05	0.05
CanvasRenderer.OnTransformChan	0.0%	0.0%	27	0 B	0.03	0.03
CanvasRenderer.OnTransformChanged	1.0%	1.0%	300	0 B	1.11	1.11
HudText.OnEnable()	0.2%	0.2%	100	0 B	0.24	0.24
GameObject.Deactivate	1.6%	0.1%	9	0 B	1.84	0.16
Graphic.OnRectTransformDimensionsChang	0.6%	0.6%	46	0 B	0.75	0.75
CanvasRenderer.OnTransformChanged	0.4%	0.4%	324	0 B	0.46	0.46
UIBehaviour.OnRectTransformDimensionsCl	0.0%	0.0%	46	0 B	0.11	0.11

HudText.Update()	43.7%	5.6%	193	0 B	30.96	4.01
GameObject.Deactivate	36.7%	15.5%	192	0 B	26.01	10.98
Text.OnDisable()	15.0%	15.0%	192	0 B	10.67	10.67
RectTransform.SendReapplyDrivenPr	4.3%	4.3%	192	0 B	3.09	3.09
BaseVertexEffect.OnDisable()	1.3%	1.3%	192	0 B	0.98	0.98
HudText.OnDisable()	0.3%	0.3%	96	0 B	0.26	0.26
CanvasRenderer.OnTransformChanged	1.3%	1.3%	388	0 B	0.94	0.94

CPU优化

- UI模块-HUD血条优化
  - 通过设置.text=“xxx”来代替
    - 52.2ms -> 15.1ms

CharacterManager.Update()	23.3%	12.7%	1	8.2 KB	15.05	8.22
GameObject.Deactivate	3.5%	0.2%	10	0 B	2.30	0.14
RandomWalker.OnDisable()	3.3%	0.4%	10	0 B	2.16	0.27
GameObject.Activate	3.5%	0.3%	10	240 B	2.29	0.25
RandomWalker.OnEnable()	3.1%	0.2%	10	240 B	2.04	0.16
CanvasRenderer.OnTransformChanged	1.6%	1.6%	293	0 B	1.03	1.03
Graphic.OnRectTransformDimensionsChai	1.2%	1.2%	49	0 B	0.81	0.81
HudText.OnEnable()	0.4%	0.4%	98	0 B	0.28	0.28
UIBehaviour.OnRectTransformDimensions	0.1%	0.1%	49	0 B	0.09	0.09

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CPU优化

- UI模块-HUD血条优化
  - 通过设置.text=“xxx”来代替
    - 31ms -> 5.5ms

HudText.Update()	12.0%	7.5%	198	0 B	5.53	3.45
CanvasRenderer.OnTransformChanged	2.5%	2.5%	392	0 B	1.17	1.17
HudText.OnDisable()	1.9%	1.9%	100	0 B	0.90	0.90

UWA MAKE IT SIMPLE

CPU优化

- 动画模块

Animation.Update/Animator.Update 耗时: 0.5 ~ 3.5 ms，均值：1.1ms；

UWA推荐：＜3ms，达标率: 55.1%。

MeshSkinning.Update 耗时: 0.2 ~ 1.9 ms；

UWA推荐：＜3ms，达标率: 80.1%。

UWA MAKE IT SIMPLE

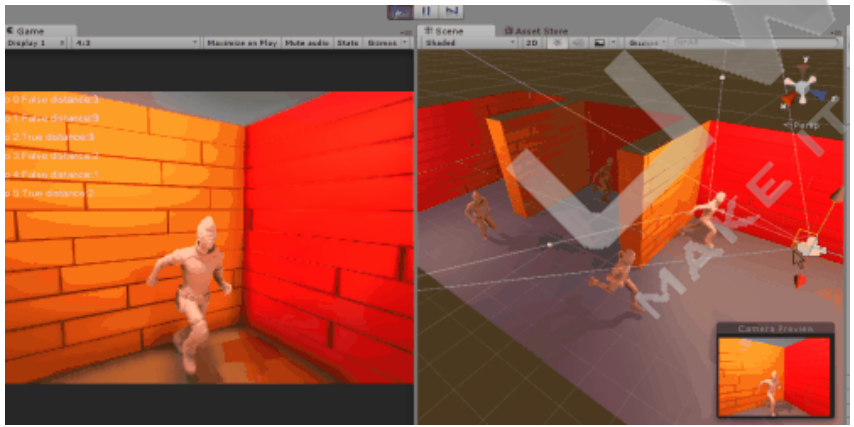
CPU优化

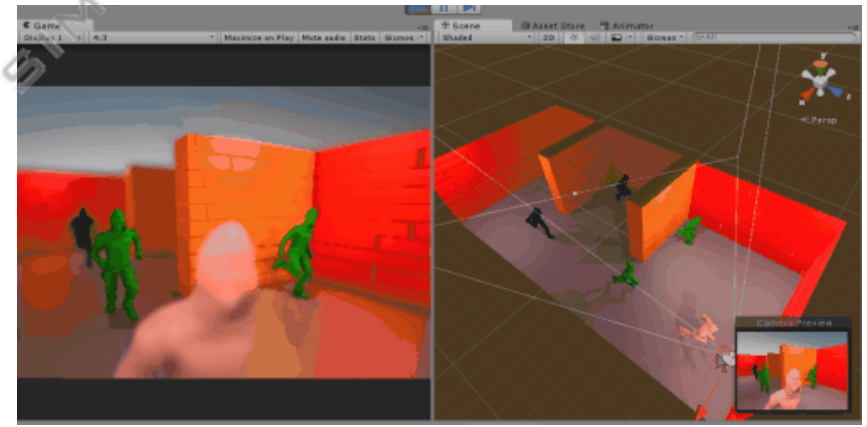
- 动画模块
  - 控制SkinnedMesh的骨骼数、动画曲线等
  - 控制Animator.Update更新模式
    - Always Animated/Cull Update Transfrom/Cull Complete
    - CullingGroup

UWA MAKE IT SIMPLE

CPU优化

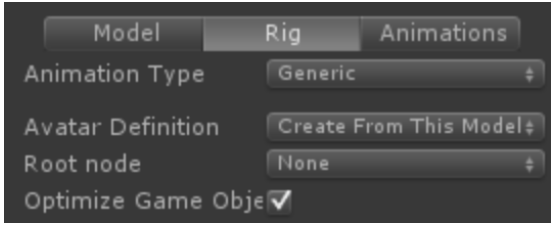
- 动画模块
  - CullingGroup功能

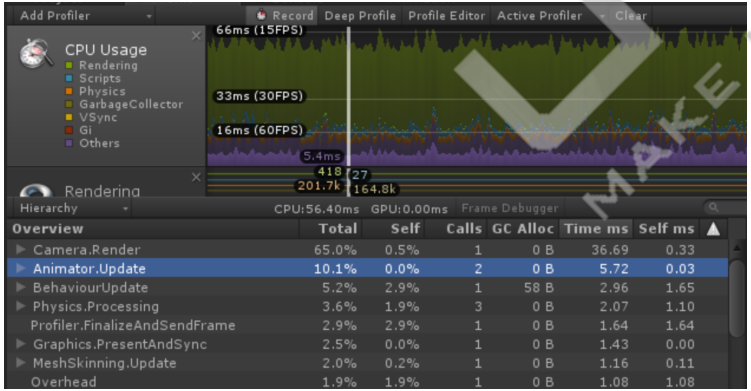


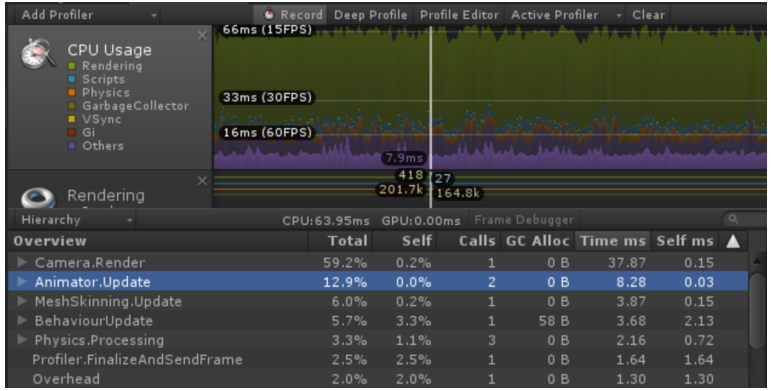


CPU优化

- 动画模块
  - Optimize GameObject
    - Animator.Update 5.72 : 8.28 70%
    - MeshSkinning.Update 1.16 : 3.87 30%



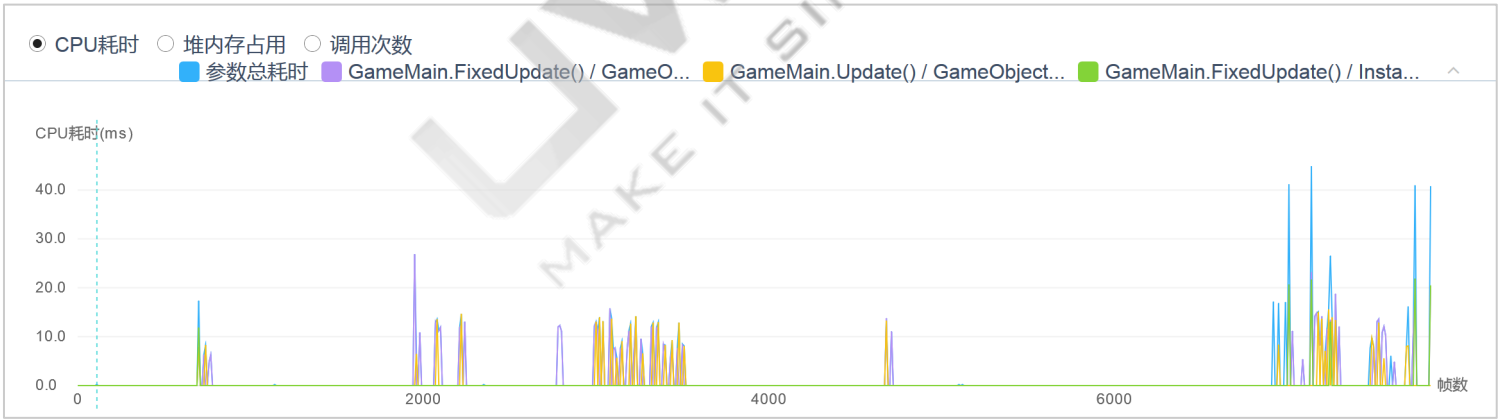




CPU优化

- 动画模块
  - Animator.Initialize

    触发于GameObject的Instantiate和Active



CPU优化

- 动画模块
  - Animator.Initialize

    触发于GameObject的Instantiate和Active

Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms
AC without Line	9.9%	0.0%	1	0 B	0.18	0.00
GameObject.Activate	9.9%	2.8%	1	0 B	0.18	0.05
Animator.Initialize	6.4%	3.0%	1	0 B	0.12	0.05
Animator.SetupAvatarDataSet	1.9%	1.9%	1	0 B	0.03	0.03
Animator.SetupControllerDataSet	1.2%	1.2%	1	0 B	0.02	0.02
AnimatorControllerPlayable.PrepareFrame	0.2%	0.2%	1	0 B	0.00	0.00

Overview	Total	Self	Calls	GC Alloc	Time ms	Self ms
AC without Line	1.0%	0.6%	1	0 B	0.02	0.01
AnimatorControllerPlayable.PrepareFrame	0.4%	0.4%	1	0 B	0.00	0.00

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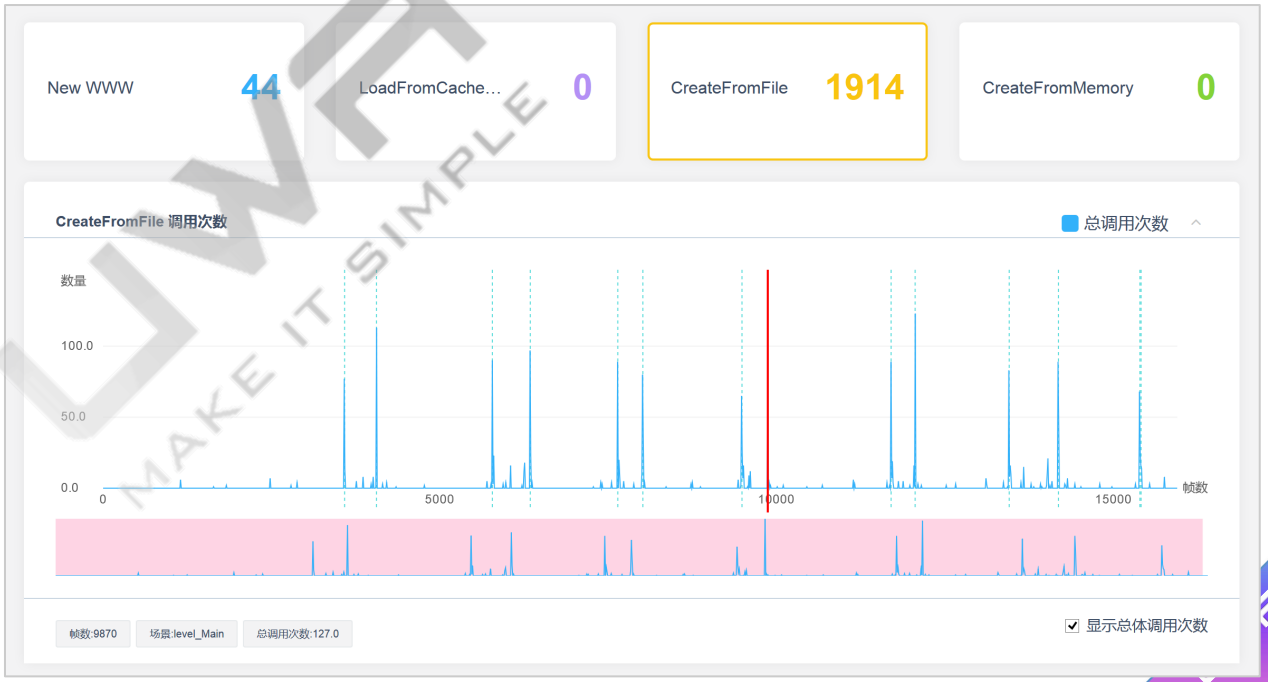
资源管理

- AssetBundle加载/卸载
- 具体AssetBundle使用情况
- 资源加载/卸载
- GameObject实例化与激活

UWA MAKE IT SIMPLE

资源管理

- AssetBundle管理
  - 加载方式



资源管理

- AssetBundle管理
  - 加载方式
  - 加载具体信息

CreateFromFile 资源列表 (所有资源)

查看所有资源 | 查看所选场景资源列表 | 查看所选帧资源列表

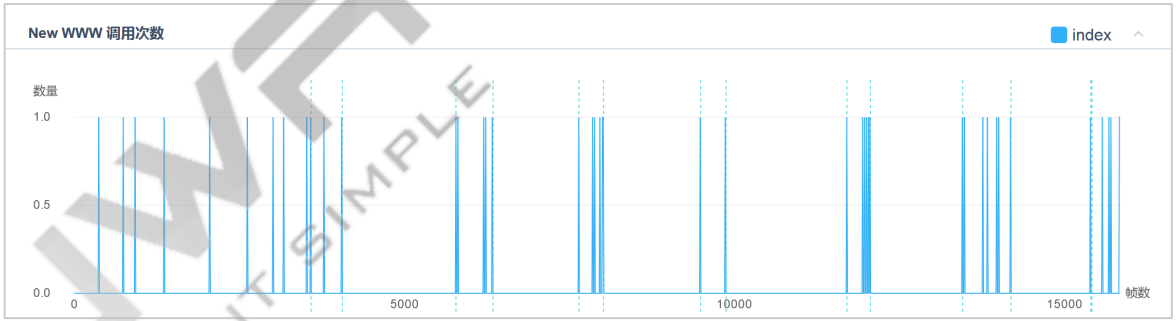
输入资源名称关键字

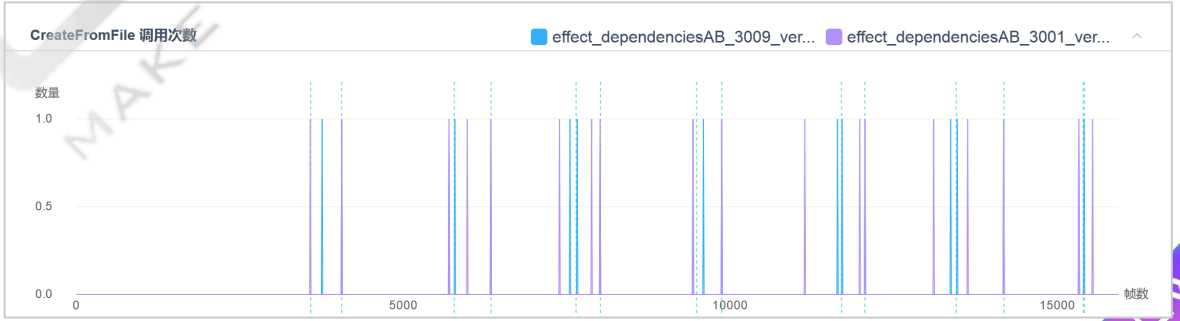
资源名称	类型	文件位置	加载方式	加载次数
actormats_dependenciesAB_1082_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/actormats/actormats_dependenciesAB_1082_ver666.unity3d	AssetBundle.CreateFromFile	26
actormats_dependenciesAB_1000_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/actormats/actormats_dependenciesAB_1000_ver666.unity3d	AssetBundle.CreateFromFile	26
actormats_dependenciesAB_1006_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/actormats/actormats_dependenciesAB_1006_ver666.unity3d	AssetBundle.CreateFromFile	22
effect_dependenciesAB_4062_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/effect/effect_dependenciesAB_4062_ver666.unity3d	AssetBundle.CreateFromFile	20
effect_dependenciesAB_3000_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/effect/effect_dependenciesAB_3000_ver666.unity3d	AssetBundle.CreateFromFile	20
level_other_6195_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/level/level_other_6195_ver666.unity3d	AssetBundle.CreateFromFile	20
effect_dependenciesAB_3034_ver666.unity3d	AssetBundle	/storage/emulated/0/Android/data/com.sixwaves.heroesofskyrealm/files/effect/effect_dependenciesAB_3034_ver666.unity3d	AssetBundle.CreateFromFile	20

UWA MAKE IT SIMPLE

资源管理

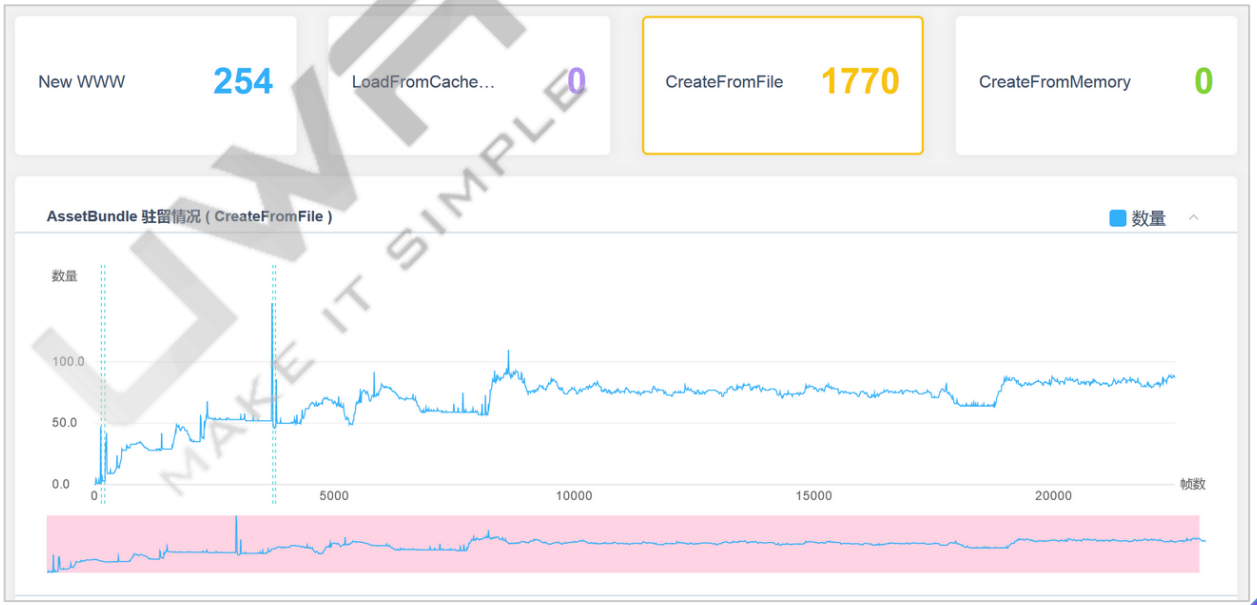
- AssetBundle管理
  - 加载方式
  - 加载具体信息
  - 特定AB查看





资源管理

- 具体AssetBundle使用情况
  - 驻留情况



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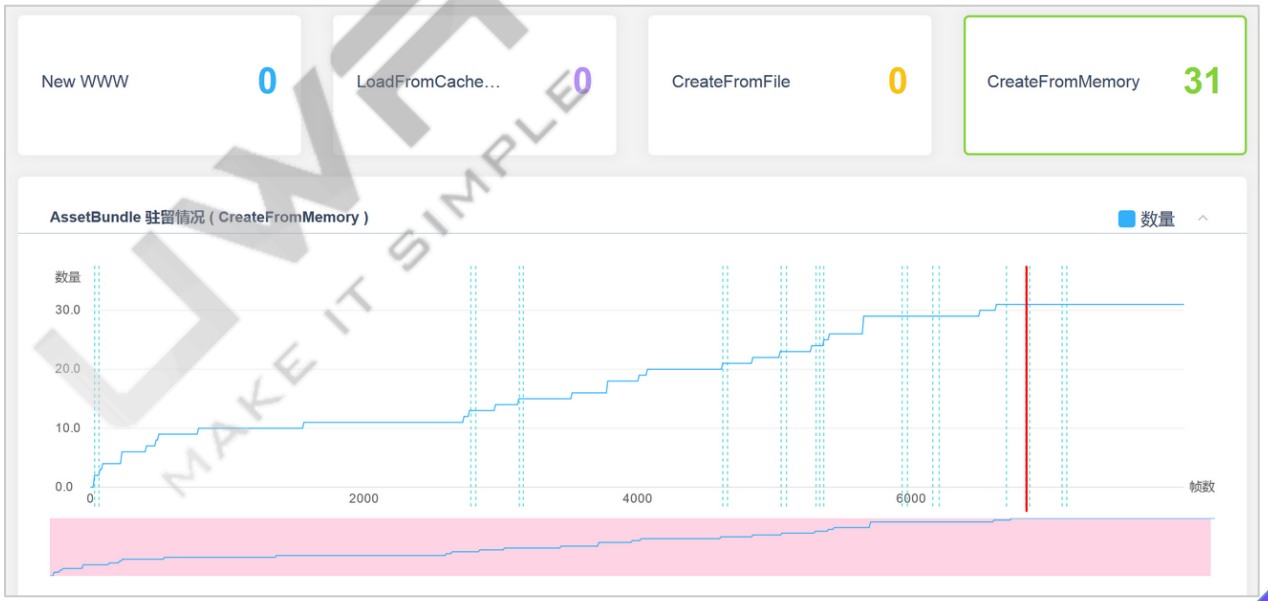
资源管理

- 具体AssetBundle使用情况
  - 驻留情况
  - 泄露情况



UWA MAKE IT SIMPLE

资源管理

- 具体AssetBundle使用情况
  - 驻留情况
  - 泄露情况
  - 使用情况

New WWW 资源列表 (所有资源)

查看所有资源 | 查看所选场景资源列表 | 查看所选帧资源列表

输入资源名称关键字

资源名称	文件位置	加载方式	驻留帧数	资源数量
assets.shaders.transparent.fx.simple.simple_uvanim.shader.ab	jar:file://data/app/com.mayday-1/base.apk/assets/AssetBundles/assets.shaders.transparent.fx.simple.simple_uvanim.shader.ab	New WWW	999	0
assets.shaders.transparent.fx.simple.simple_normal.shader.ab	jar:file://data/app/com.mayday-1/base.apk/assets/AssetBundles/assets.shaders.transparent.fx.simple.simple_normal.shader.ab	New WWW	3326	0
assets.artists.effect.newtextures.glow.glow_019.png.ab	jar:file://data/app/com.mayday-1/base.apk/assets/AssetBundles/assets.artists.effect.newtextures.glow.glow_019.png.ab	New WWW	245	0
assets.artists.effect.newtextures.glow.materials.guangqiu_3_add.mat.ab	jar:file://data/app/com.mayday-1/base.apk/assets/AssetBundles/assets.artists.effect.newtextures.glow.materials.guangqiu_3_add.mat.ab	New WWW	999	0

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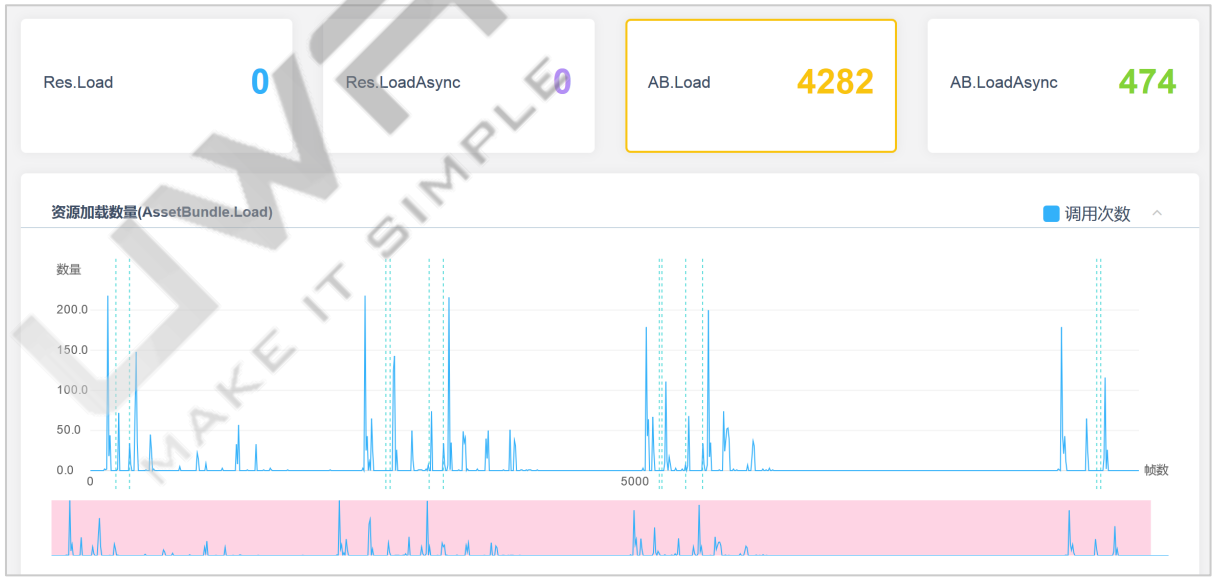
资源管理

- 资源管理
  - 加载方式



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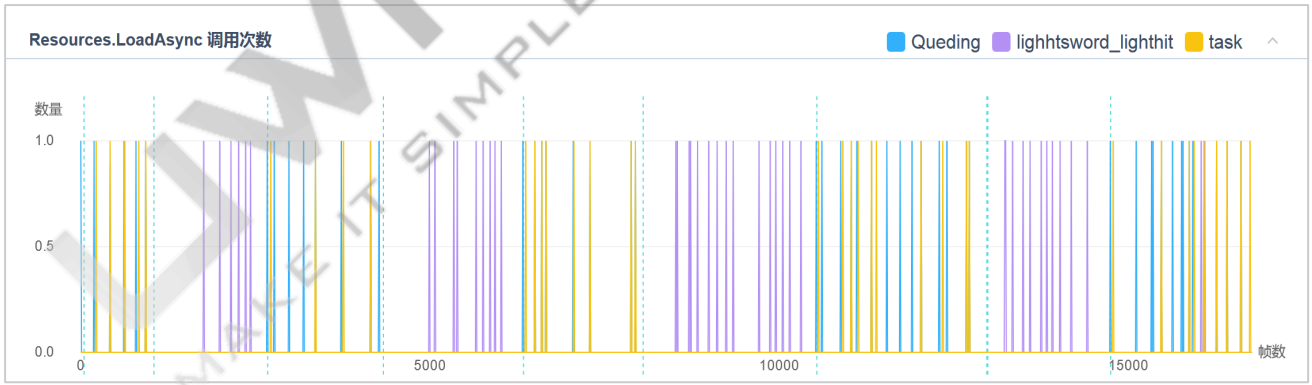
资源管理

- 资源管理
  - 加载方式
  - 资源信息



MAKE IT SIMPLE

资源管理

- 资源管理
  - 加载方式
  - 资源信息

Resources.Load 资源列表 (所有资源)

查看所有资源 | 查看所选场景资源列表 | 查看所选帧资源列表

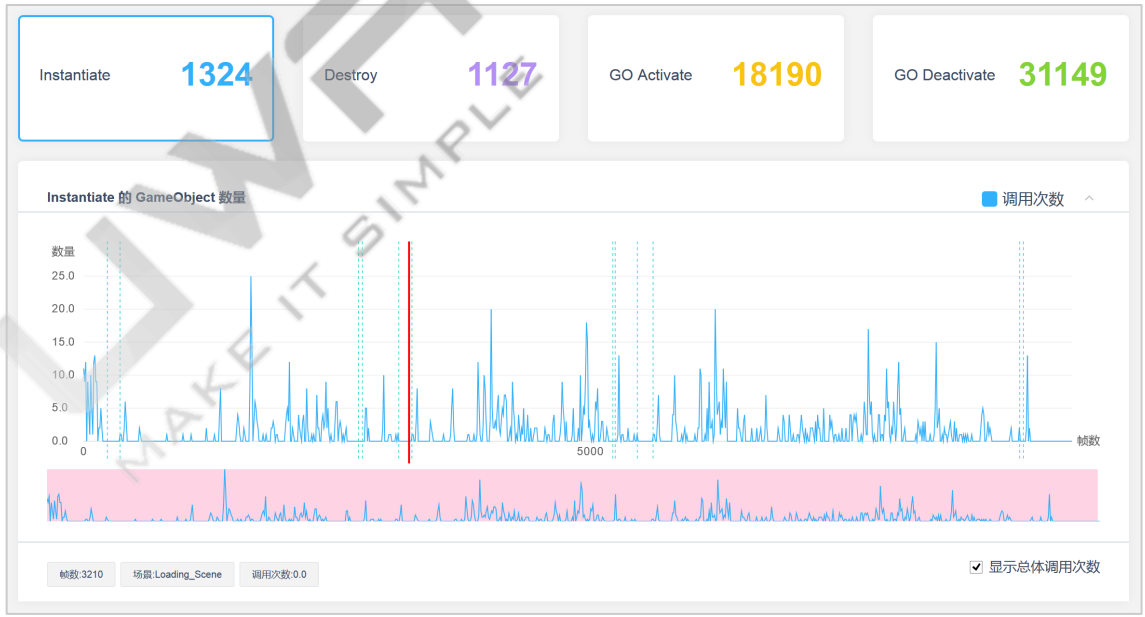
输入资源名称关键字

资源名称		文件位置	加载方式	加载次数
AssaultSpeedCurve		Curves/AssaultSpeedCurve	Resources.Load	207
Linear		Curves/Linear	Resources.Load	23
KnockFlySpeedCurve_202		Curves/KnockFlySpeedCurve_202	Resources.Load	6
KnockBackSpeedCurve_1		Curves/KnockBackSpeedCurve_1	Resources.Load	3
Race_113	不存在	game/mob/Race_113	Resources.Load	3
Race_111	不存在	game/mob/Race_111	Resources.Load	3
HitEffectCurve		Curves/HitEffectCurve	Resources.Load	3
Race_110	不存在	game/mob/Race_110	Resources.Load	2
Race_203	不存在	game/mob/Race_203	Resources.Load	2
Race_202	不存在	game/mob/Race_202	Resources.Load	2

UWA MAKE IT SIMPLE

资源管理

- GameObject实例化与激活
  - Instantiate



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资源管理

- GameObject实例化与激活
  - Instantiate

Instantiate 资源列表 (所有资源)

查看所有资源 | 查看所选场景资源列表 | 查看所选帧资源列表

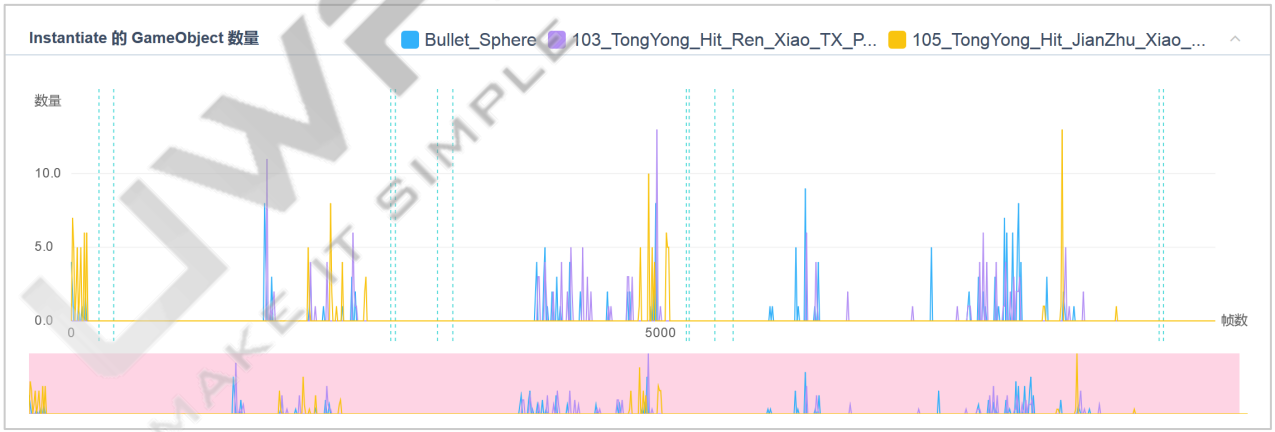
输入资源名称关键字

资源名称	类型	操作方式	操作次数
Bullet_Sphere	GameObject	GameObject.Instantiate	164
103_TongYong_Hit_Ren_Xiao_TX_Prefab	GameObject	GameObject.Instantiate	162
105_TongYong_Hit_JianZhu_Xiao_TX_Prefab	GameObject	GameObject.Instantiate	122
1000_JiQiangBing_Attack01_Bullet_TX_Prefab	GameObject	GameObject.Instantiate	103
1000_JiQiangBing_Prefab	GameObject	GameObject.Instantiate	88
Soldier_O	GameObject	GameObject.Instantiate	84
Soldier_E	GameObject	GameObject.Instantiate	69
PlayCardItem	GameObject	GameObject.Instantiate	58
1000_JiQiangBing_Attack01_TX_Prefab	GameObject	GameObject.Instantiate	57
UI_A_PuTongAnJian1	GameObject	GameObject.Instantiate	35

UWA MAKE IT SIMPLE

资源管理

- GameObject实例化与激活
  - Instantiate



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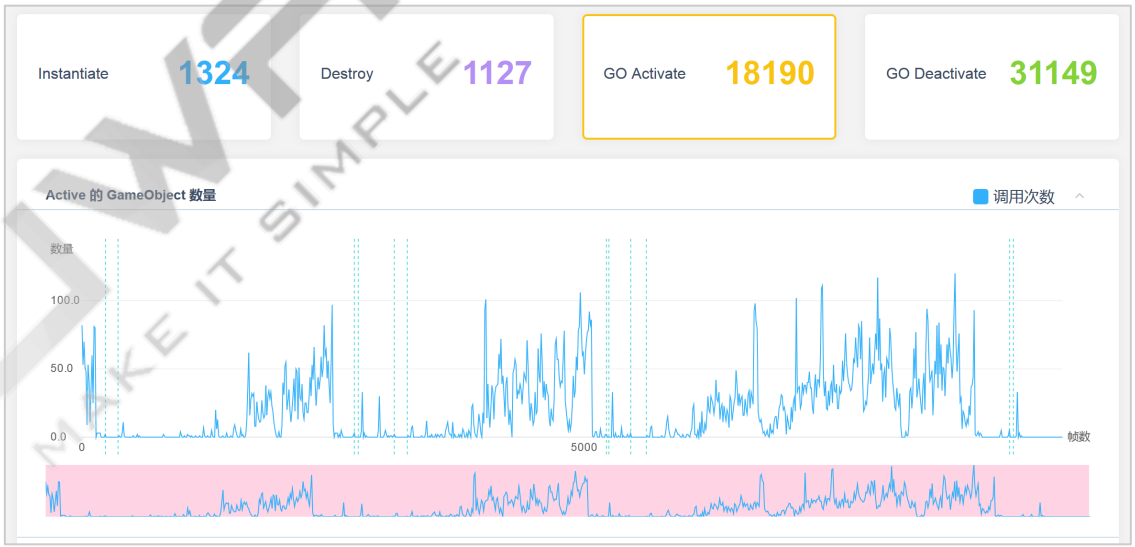
资源管理

- GameObject实例化与激活
  - Active/Deactive



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资源管理

- GameObject实例化与激活
  - Active/Deactive

GO Activate 资源列表 (所有资源)

查看所有资源 | 查看所选场景资源列表 | 查看所选帧资源列表

输入资源名称关键字

资源名称	类型	操作方式	操作次数
Bullet_Sphere(Clone)	GameObject	GameObject.SetActive(True)	4161
1000_JiQiangBing_Attack01_Bullet_TX_Prefab(Clone)	GameObject	GameObject.SetActive(True)	2964
103_TongYong_Hit_Ren_Xiao_TX_Prefab(Clone)	GameObject	GameObject.SetActive(True)	2445
1000_JiQiangBing_Attack01_TX_Prefab(Clone)	GameObject	GameObject.SetActive(True)	1519
1000_JiQiangBing_P_Audio_Prefab(Clone)	GameObject	GameObject.SetActive(True)	1328
2020_ZhongZhuangBuBing_Attack01_Hit_01_TX_Prefab(Clone)	GameObject	GameObject.SetActive(True)	673
105_TongYong_Hit_JianZhu_Xiao_TX_Prefab(Clone)	GameObject	GameObject.SetActive(True)	575
Obstacle-1000_JiQiangBing_Prefab(Clone)	GameObject	GameObject.SetActive(True)	418
Normal	GameObject	GameObject.SetActive(True)	345
2020_ZhongZhuangBuBing_P1_1_Audio_Prefab(Clone)	GameObject	GameObject.SetActive(True)	247

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总结

- 具体的优化经验其实并不重要，两年前的经验不适合于今天，今天的经验也不适合于两年后…
- 真正想让大家看到的是**研究问题的方式**和**厚积薄发的态度**，这才是以后能帮到大家的东西！
- 这是我们做UWA的真正原因。

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