Graphics and Games

#WWDC17

SceneKit: What's New

Session 604

Thomas Goossens, SceneKit engineer
Amaury Balliet, SceneKit engineer
Anatole Duprat, SceneKit engineer
Sébastien Métrot, SceneKit engineer

SceneKit

High level API for 3D graphics

Supported on every Apple platform

Related Sessions

What’s New in SceneKit	WWDC 2014
Enhancements to SceneKit	WWDC 2015
Advances in SceneKit Rendering	WWDC 2016

Camera enhancements

Camera enhancements

Tessellation and subdivision surfaces

Camera enhancements

Tessellation and subdivision surfaces

Animation improvements

Camera enhancements

Tessellation and subdivision surfaces

Animation improvements

Developer tools

Camera enhancements

Tessellation and subdivision surfaces

Animation improvements

Developer tools

Related technologies

Demo

Camera Enhancements

Camera Enhancements

Physically Based Camera API

Depth of field

Object motion blur

Screen space ambient occlusion

Camera control

```
//Legacy Camera API

// Move away from legacy projection model
camera.yFov = 60.0
camera.xFov = 60.0
```

✕

NEW

```
//Physically Based Camera

// configure field of view…
camera.fieldOfView = 60.0 //degrees

// …or focal
camera.focalLength = 50.0 //mm
camera.sensorHeight = 24.0 //mm
```

✓

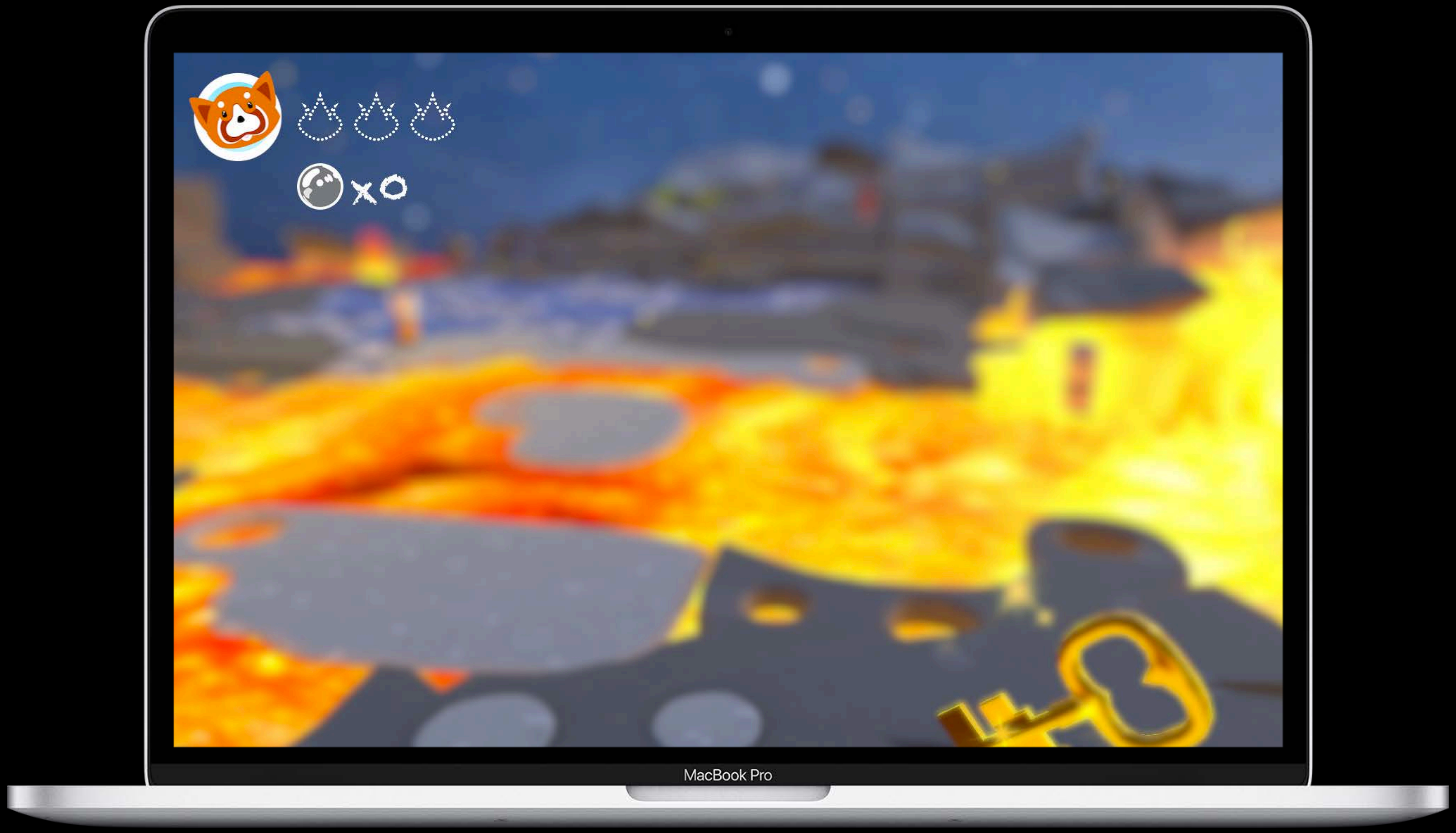
Physically Based Camera

Depth of field

NEW

Approximate physical photo camera

```
// configure the depth of field
camera.wantsDepthOfField = true
camera.focusDistance = 0.8 //meters
camera.fStop = 5.6
```



Physically Based Camera

Bokeh

NEW

Automatic bokeh

Works best with HDR camera

```
// configure the camera for HDR
camera.wantsHDR = true
```

MacBook Pro

Physically Based Camera

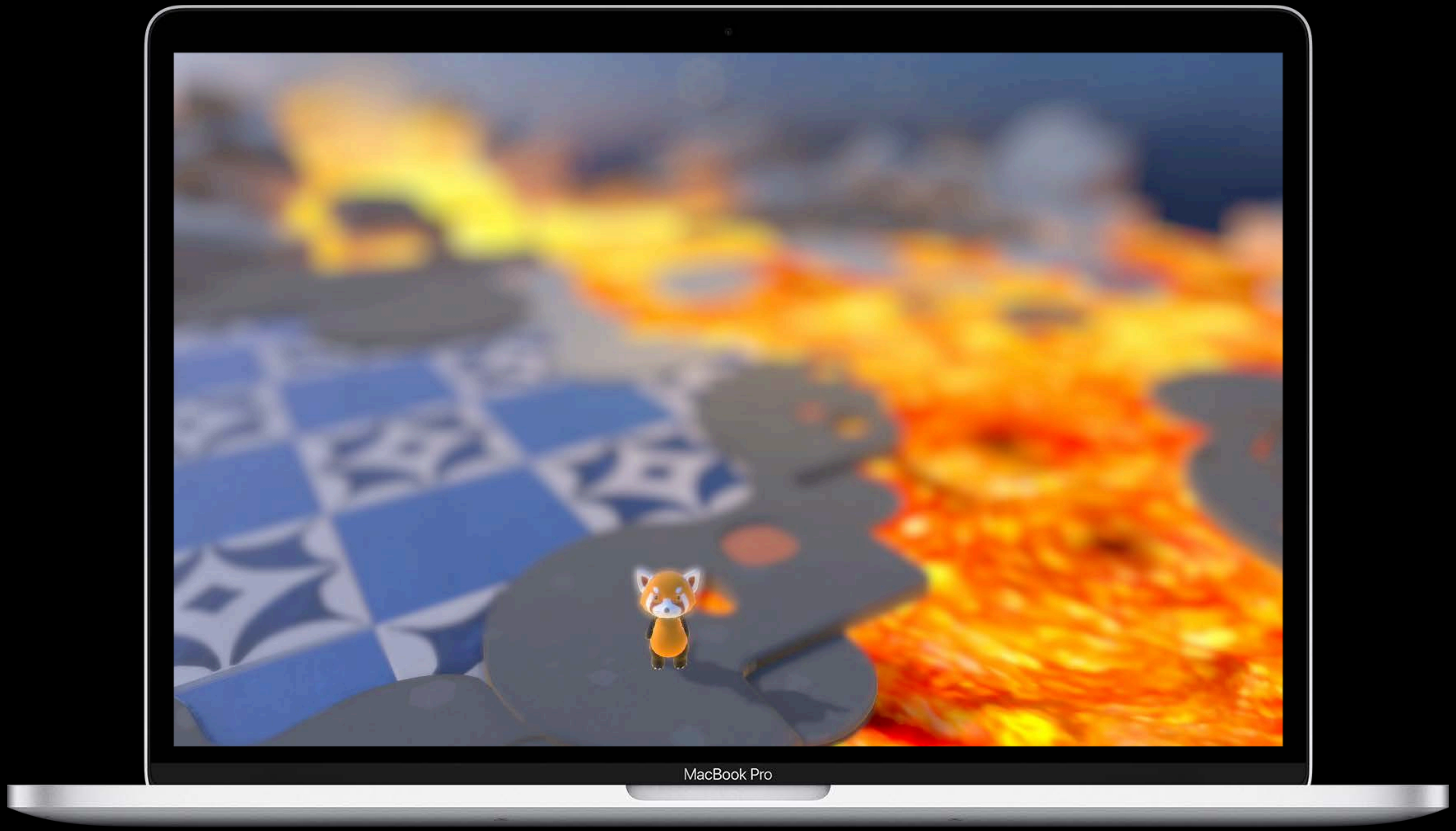
Bokeh

NEW

Automatic bokeh

Works best with HDR camera

```
// configure the camera for HDR
camera.wantsHDR = true
```



Physically Based Camera

Bokeh

NEW

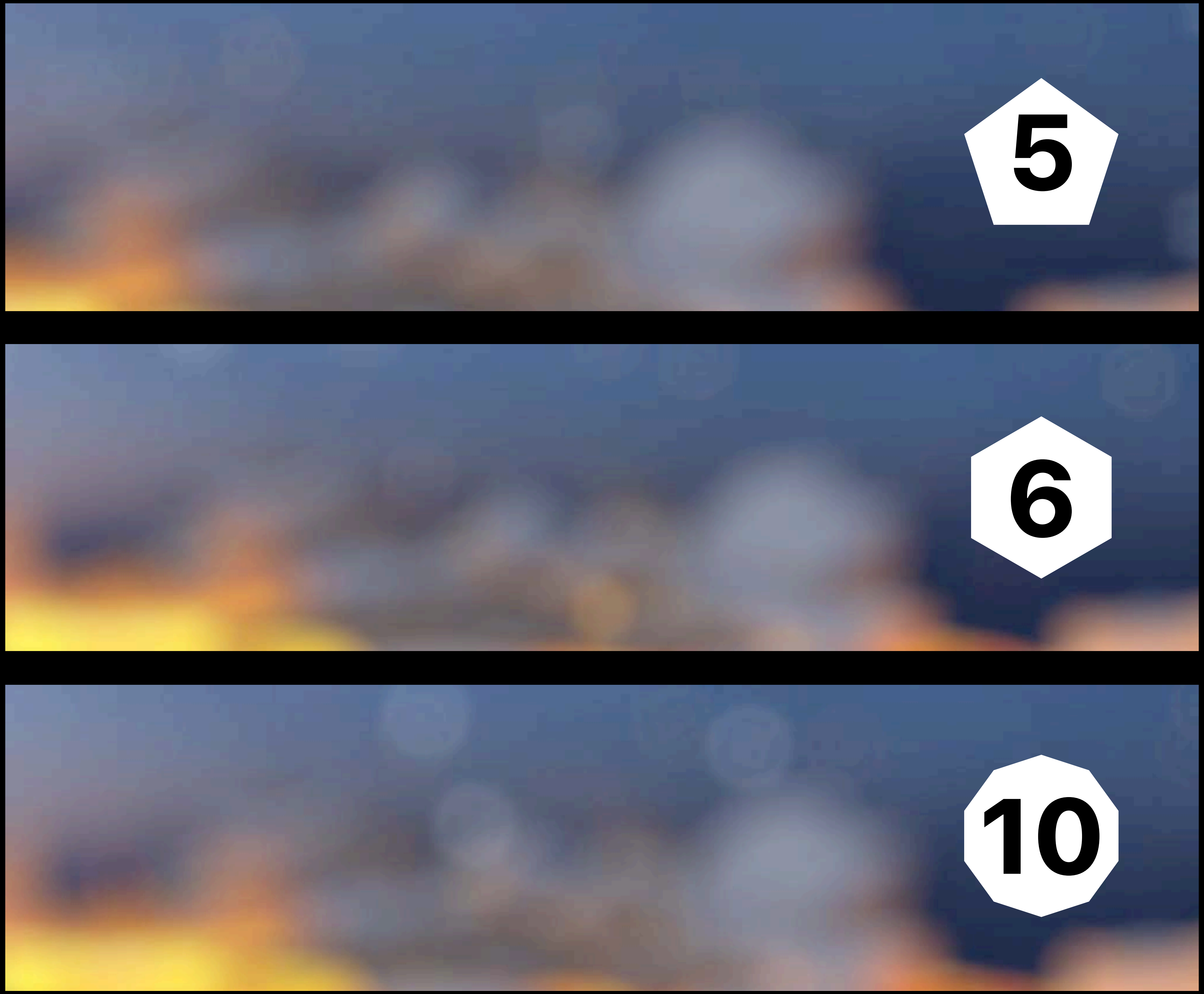
```
// configure the depth of field
camera.apertureBladeCount = 5
```

Physically Based Camera

Bokeh

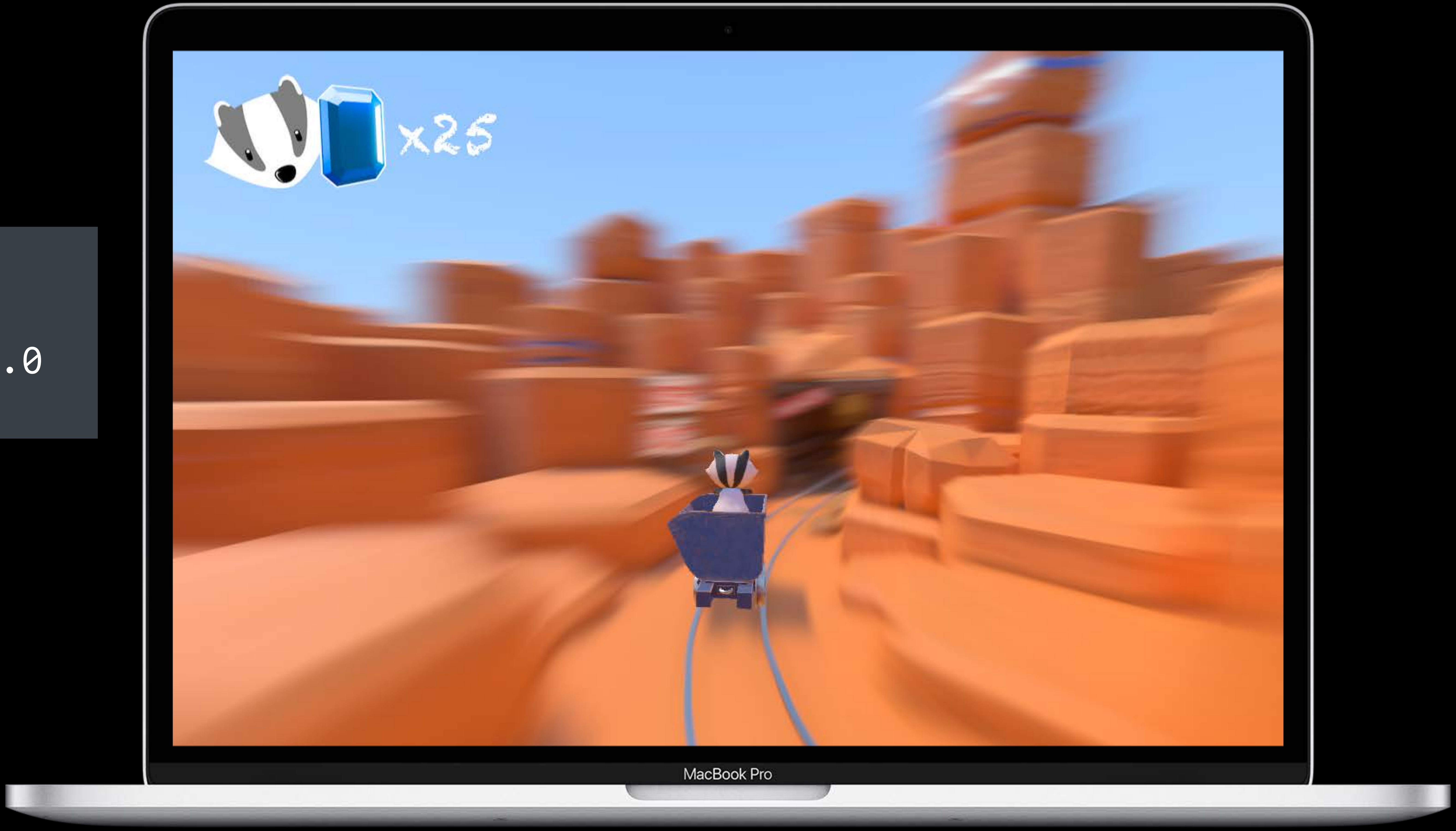
NEW

```
// configure the depth of field
camera.apertureBladeCount = 5
```

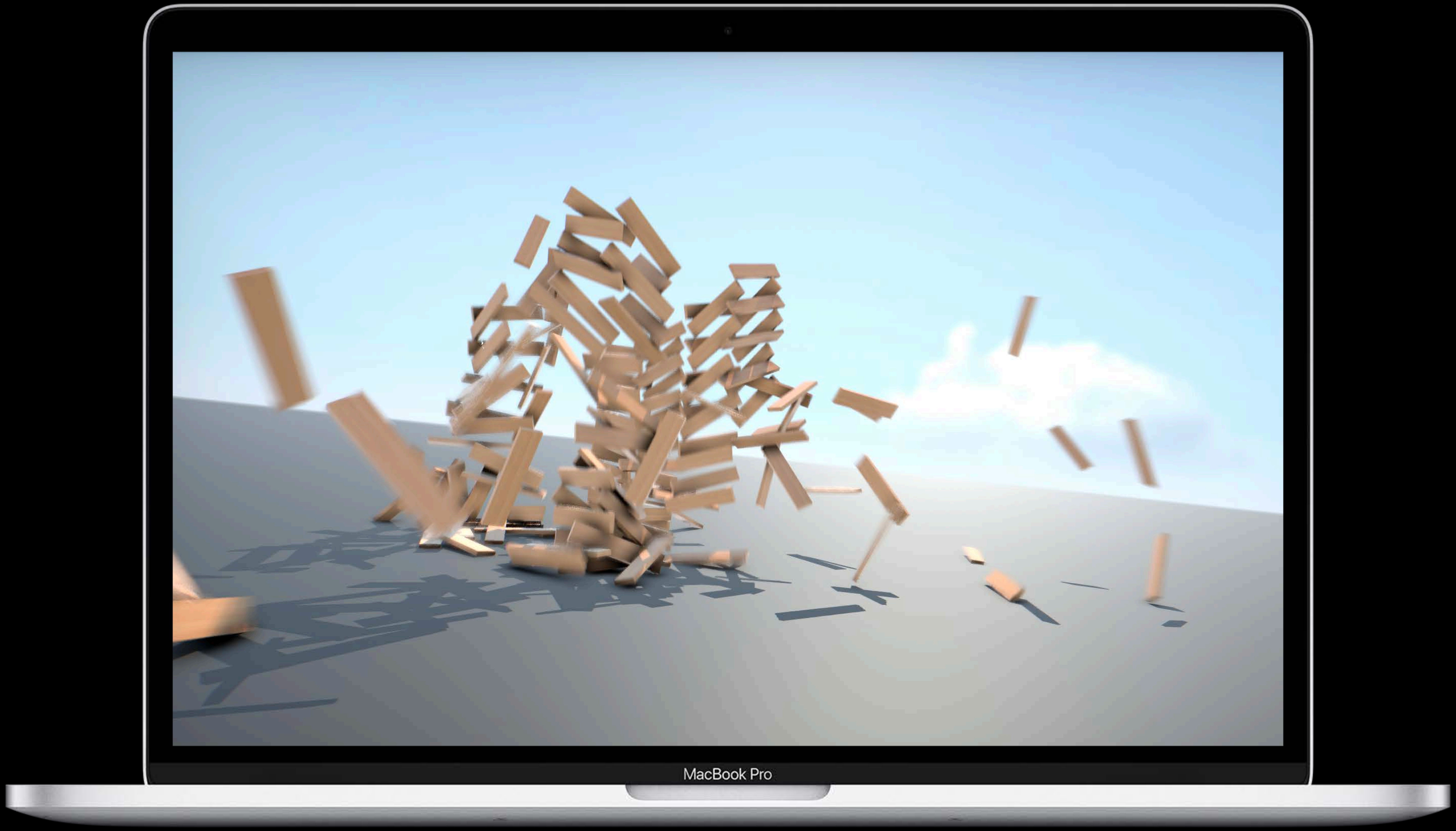


Motion Blur

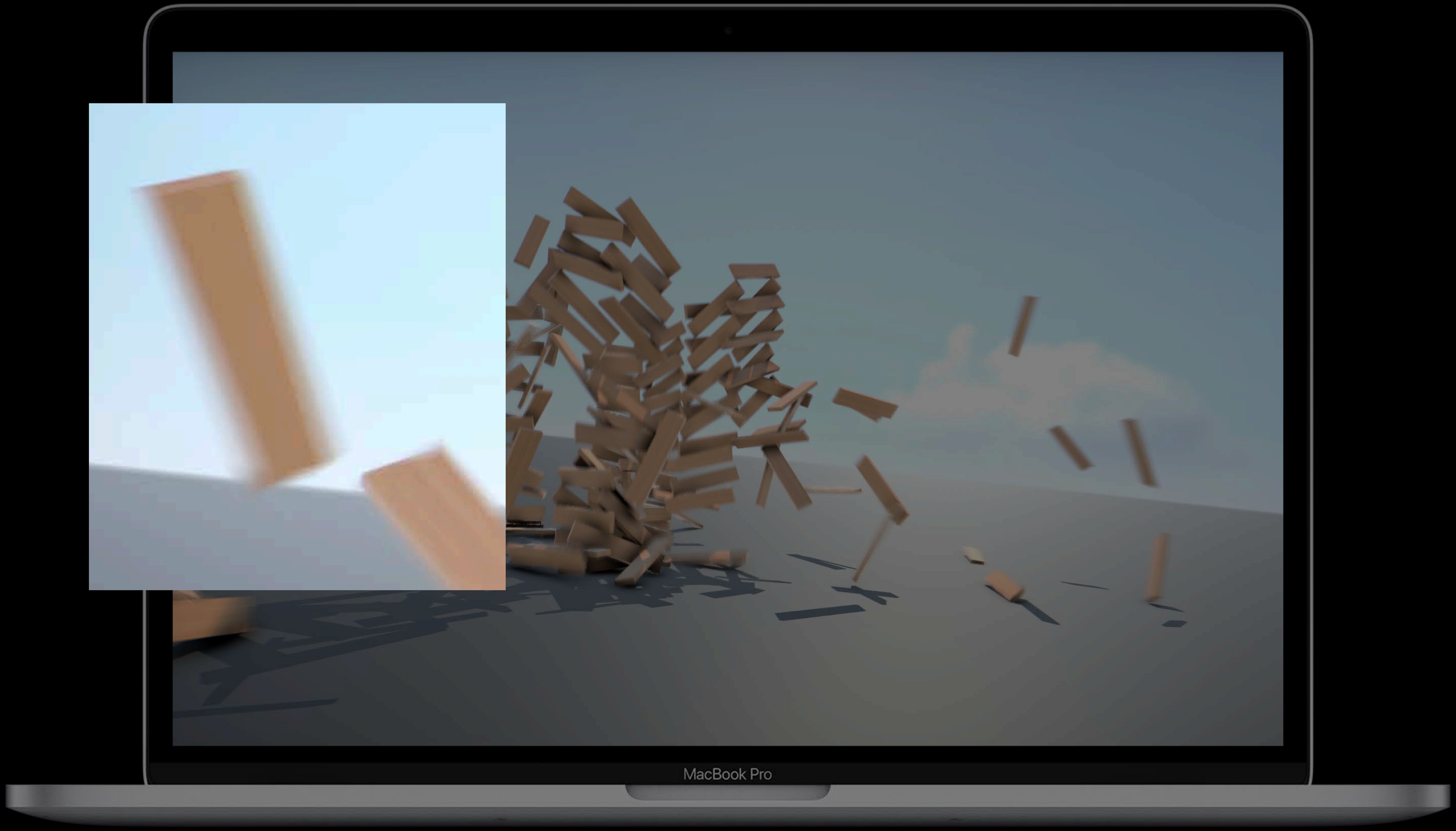
```
// Activate Motion Blur
camera.motionBlurIntensity = 1.0
```



Object Motion Blur



Object Motion Blur



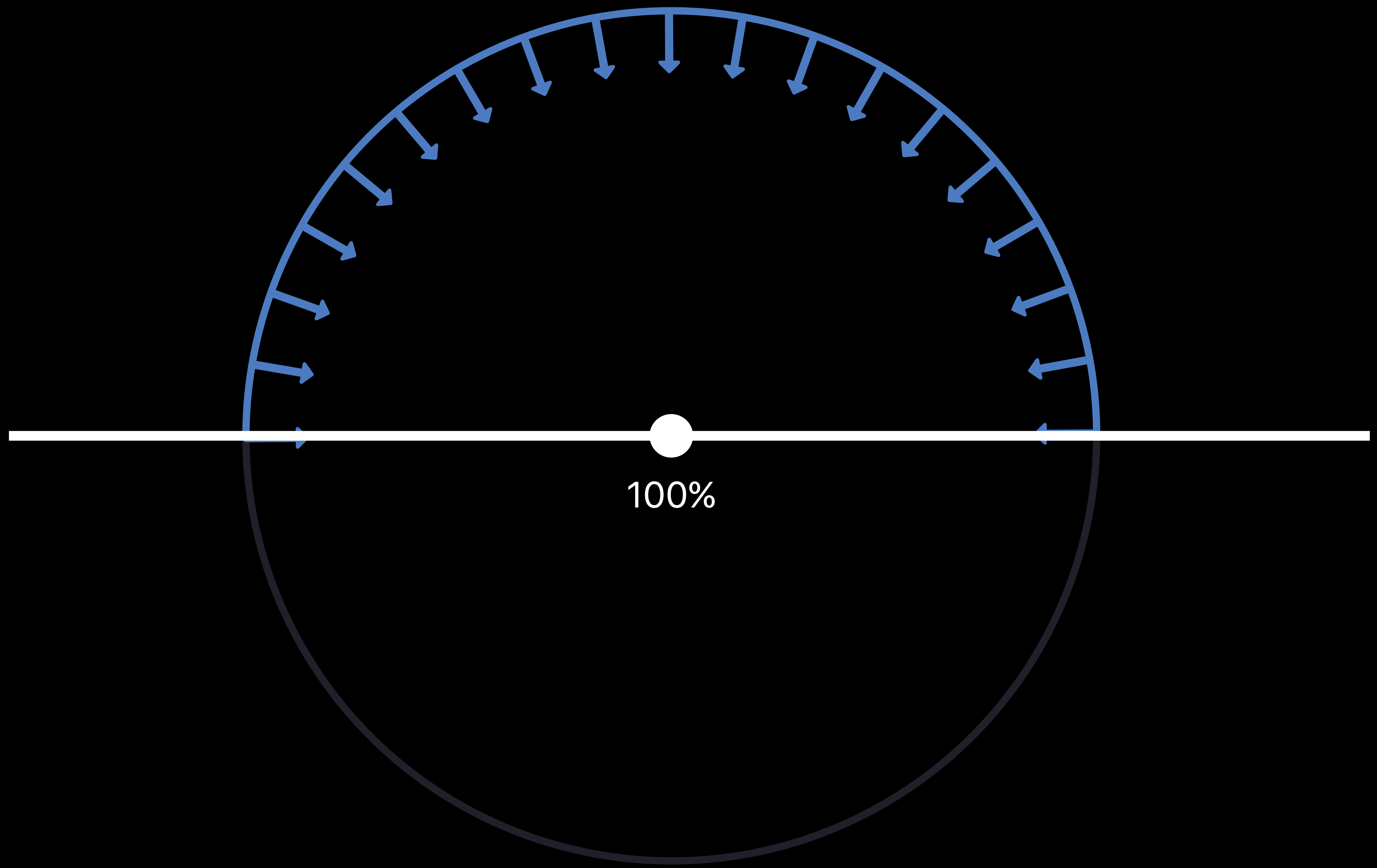
NEW

Ambient Occlusion

Ambient Occlusion

Principle

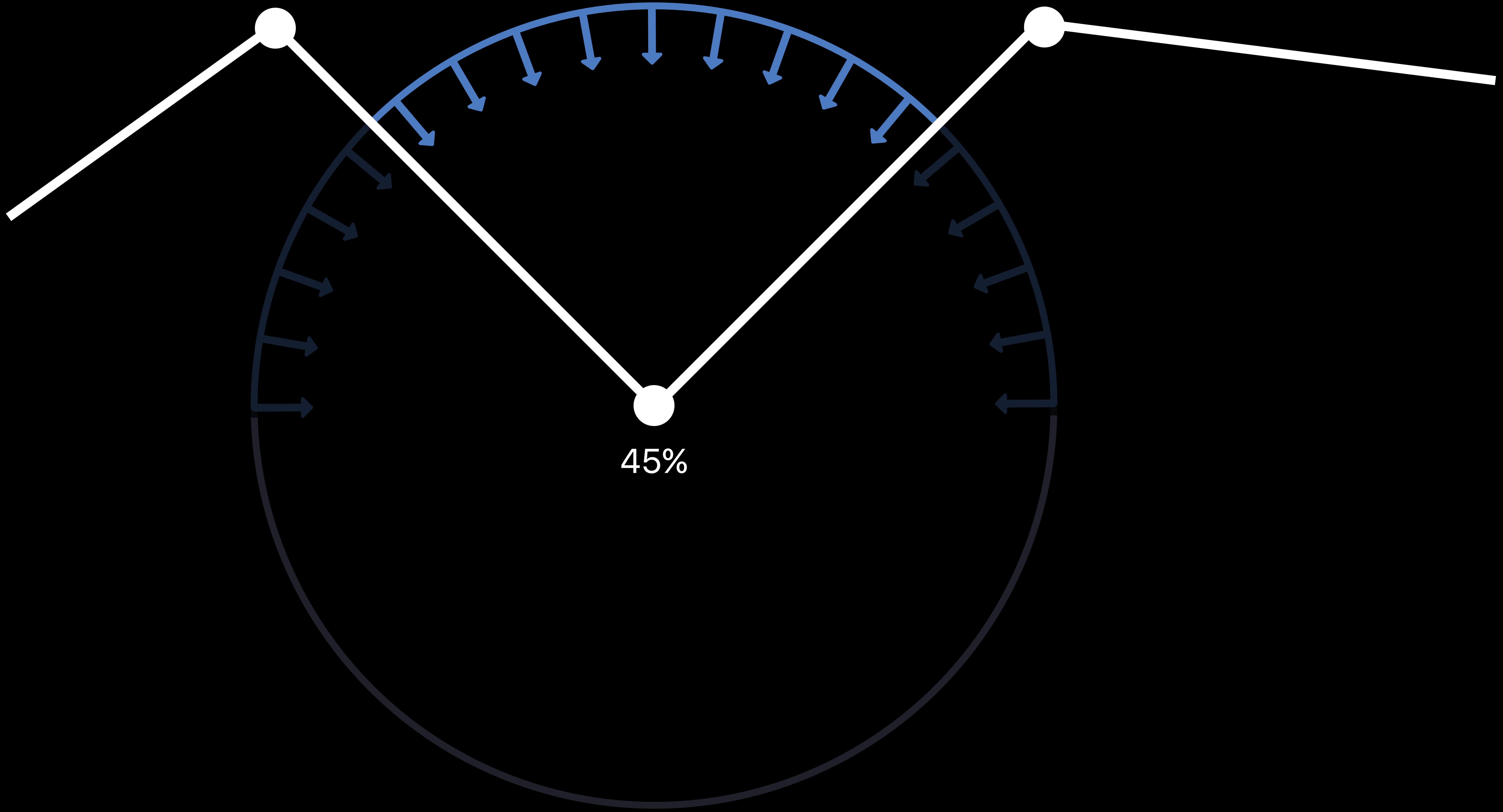
NEW



Ambient Occlusion

Principle

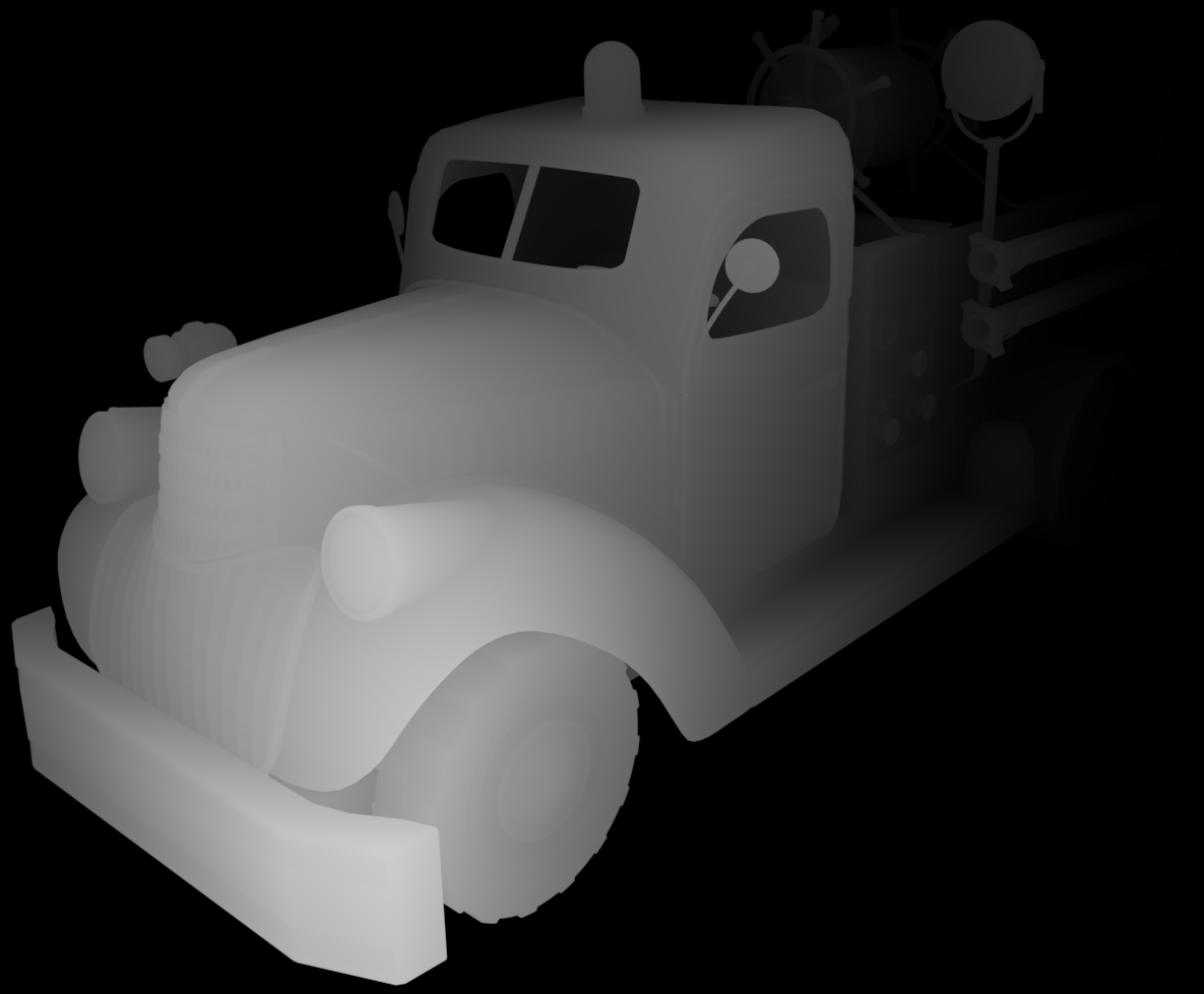
NEW



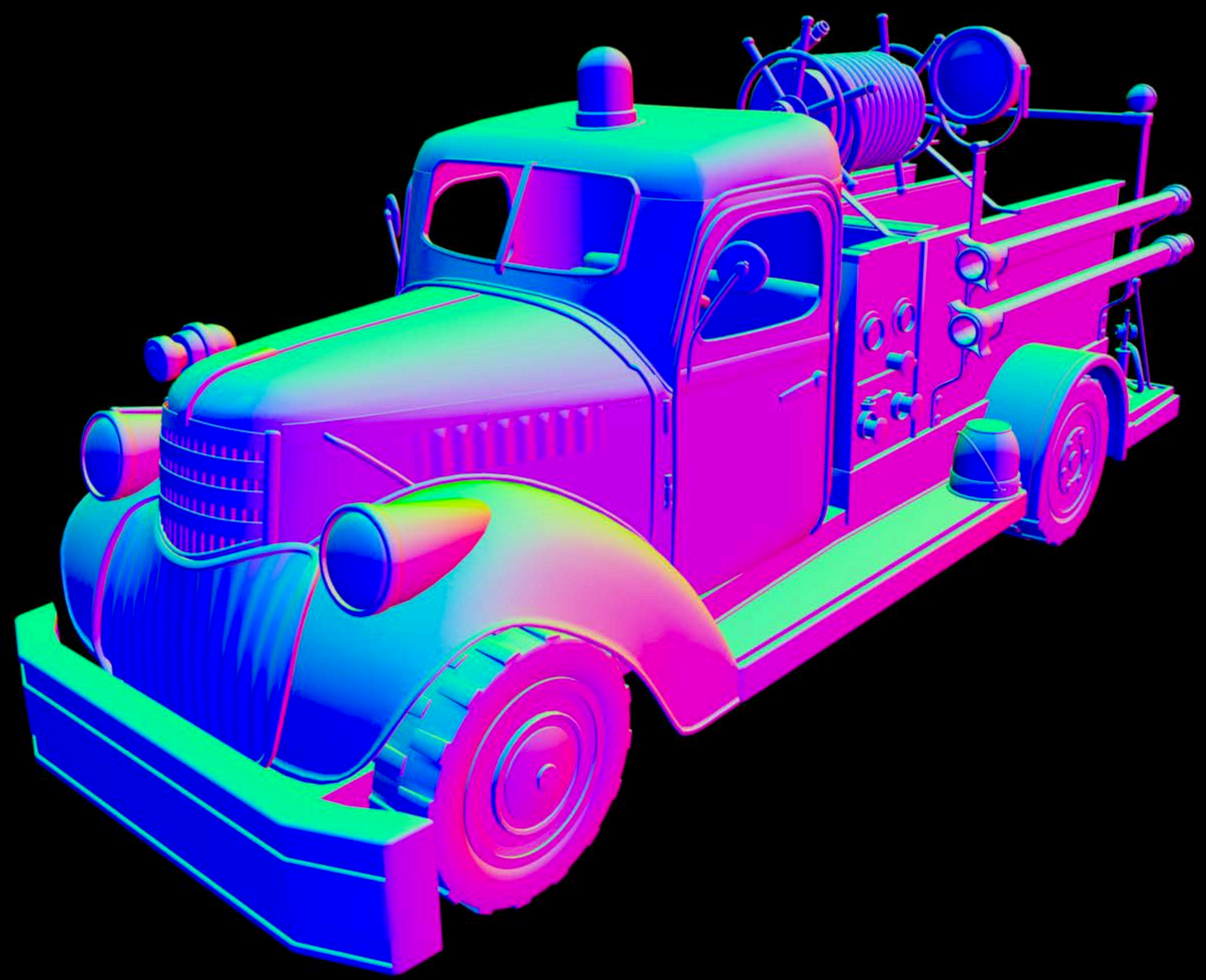
Ambient Occlusion

Screen space ambient occlusion

NEW



depth



normal

Ambient Occlusion

Screen space ambient occlusion

NEW

Ambient Occlusion

Screen space ambient occlusion

NEW

NEW

```
//Ambient Occlusion
//Screen space ambient occlusion

// Activate SSAO
camera.screenSpaceAmbientOcclusionIntensity = 1.0

// Configure SSAO
camera.screenSpaceAmbientOcclusionRadius = 5 //scene units
camera.screenSpaceAmbientOcclusionBias = 0.03 //scene units
camera.screenSpaceAmbientOcclusionDepthThreshold = 0.2 //scene units
camera.screenSpaceAmbientOcclusionNormalThreshold = 0.3
```

Demo

Anatole Duprat, SceneKit engineer

Camera Control

Thomas Goossens, SceneKit engineer

Camera Control

Common challenges

NEW

Object inspection and scene browsing

Camera with a behavior

Camera Control

Object inspection and scene browsing

Previously

- Directly manipulate the camera position, rotation or transform
- For debugging use `allowsCameraControl` API

Camera Control

Object inspection and scene browsing

NEW

Introducing `SCNCameraController`

Built-in support for common controls modes

Default camera controller provided by `SCNView`

```
// turn on camera control
scnView.allowsCameraControl = true

// configure the camera control behaviour
scnView.defaultCameraController.interactionMode = .orbitTurntable
scnView.defaultCameraController.inertiaEnabled = true
scnView.defaultCameraController.maximumVerticalAngle = 45 //degrees
```

Camera Control

SCNCameraController

Orbit Turntable

Orbit Arcball

Orbit Angle Mapping

Fly

Pan

Roll

Frame nodes

Dolly

Inertia

Truck

Camera Control

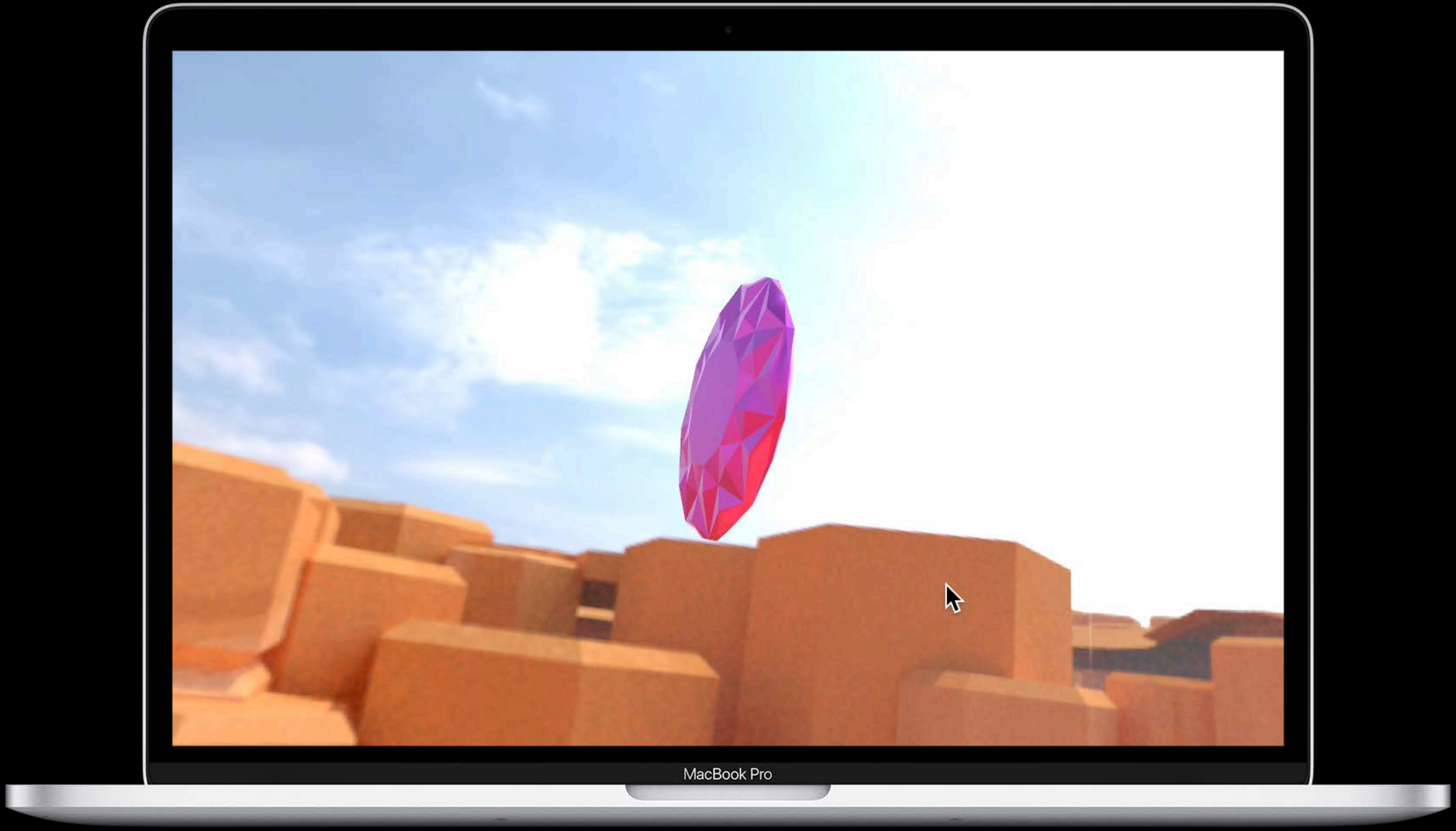
SCNCameraController examples

Orbit Turntable

Camera Control

SCNCameraController examples

Orbit Arcball



Camera Control

SCNCameraController examples

Fly

Camera Control

Common challenges

Object inspection and scene browsing

Camera with a behavior

Camera Control

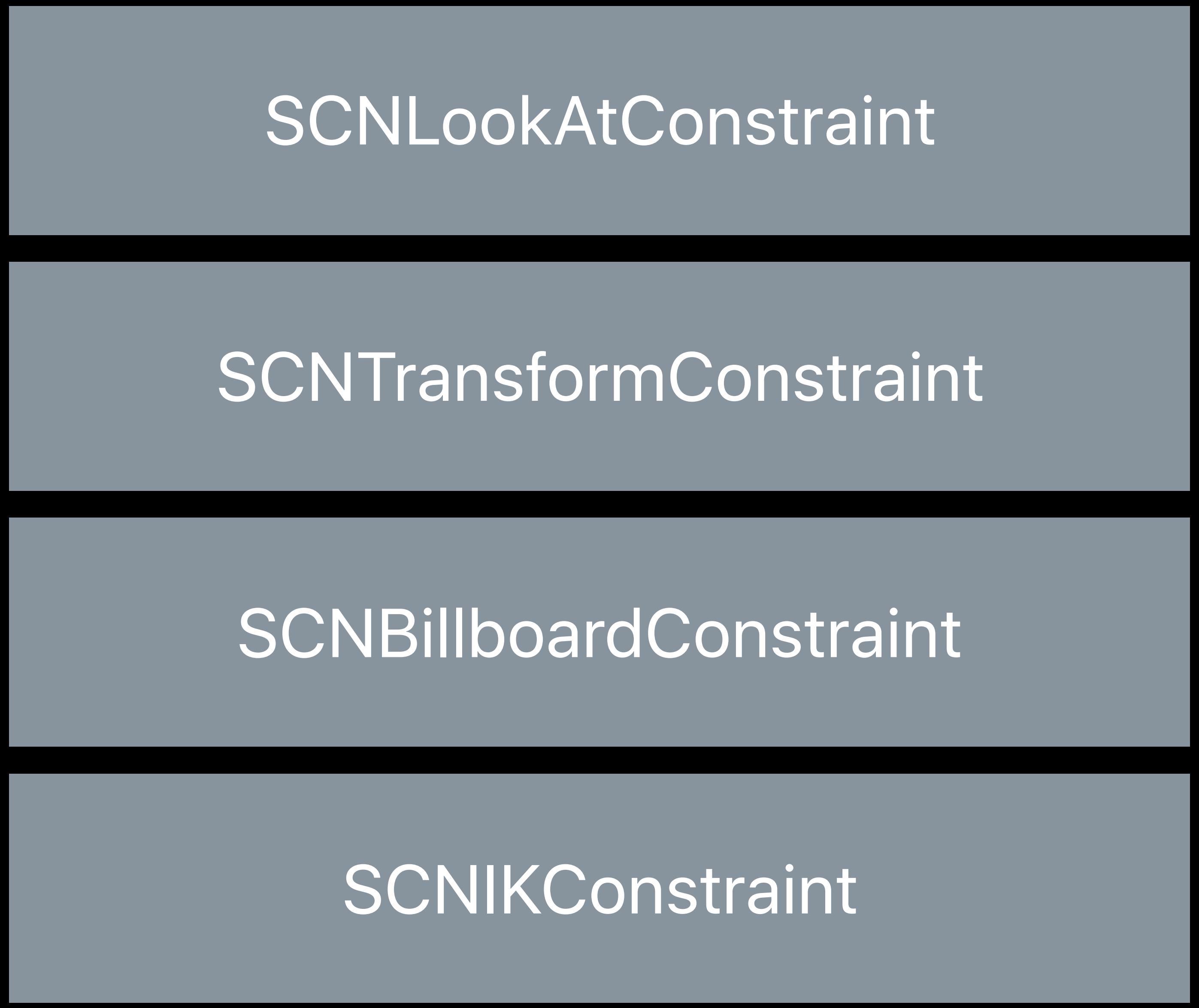
Constraints

Chain `SCNConstraint` objects to define a camera behavior

Camera Control

Constraints

Chain `SCNConstraint` objects to define a camera behavior



SCNLookAtConstraint

SCNTransformConstraint

SCNBillboardConstraint

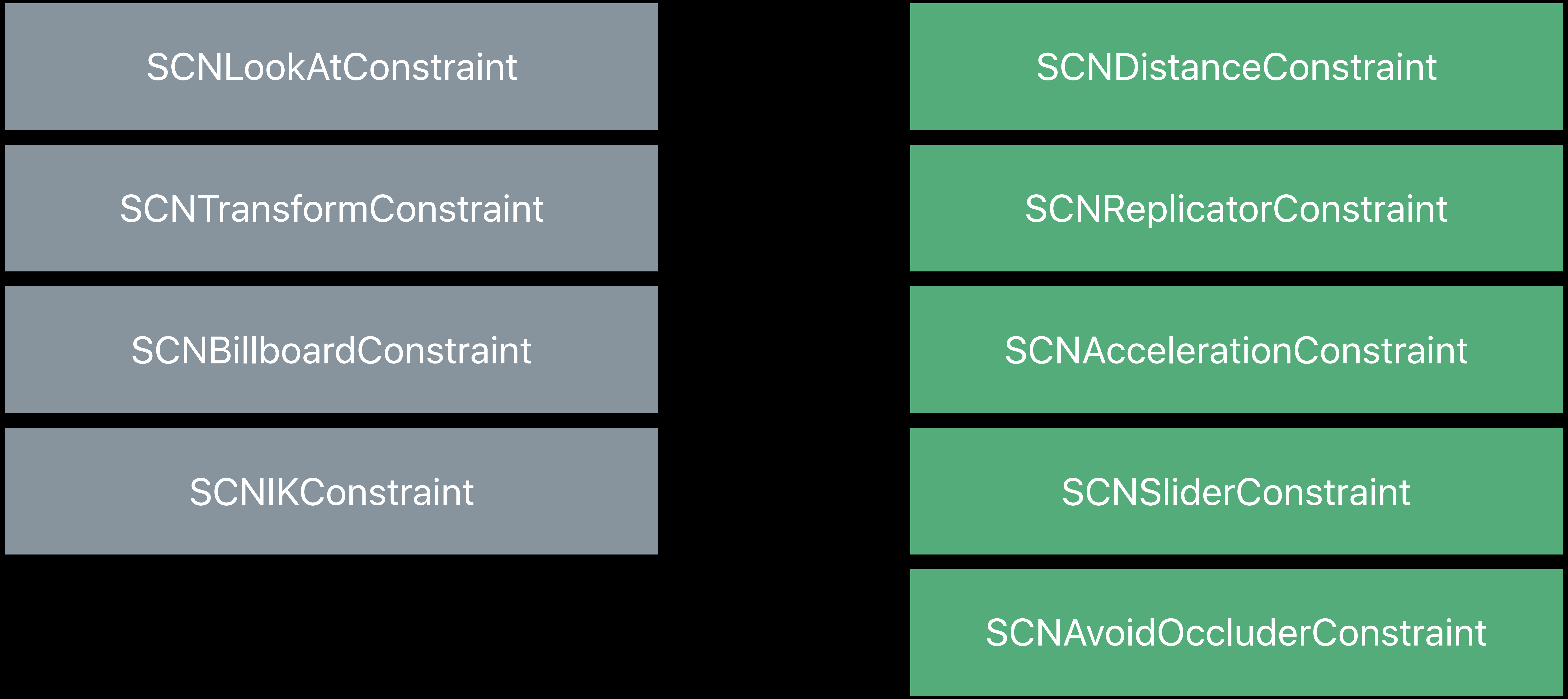
SCNIKConstraint

Camera Control

Constraints

NEW

Chain `SCNConstraint` objects to define a camera behavior



SCNLookAtConstraint

SCNTransformConstraint

SCNBillboardConstraint

SCNIKConstraint

SCNDistanceConstraint

SCNReplicatorConstraint

SCNAccelerationConstraint

SCNSliderConstraint

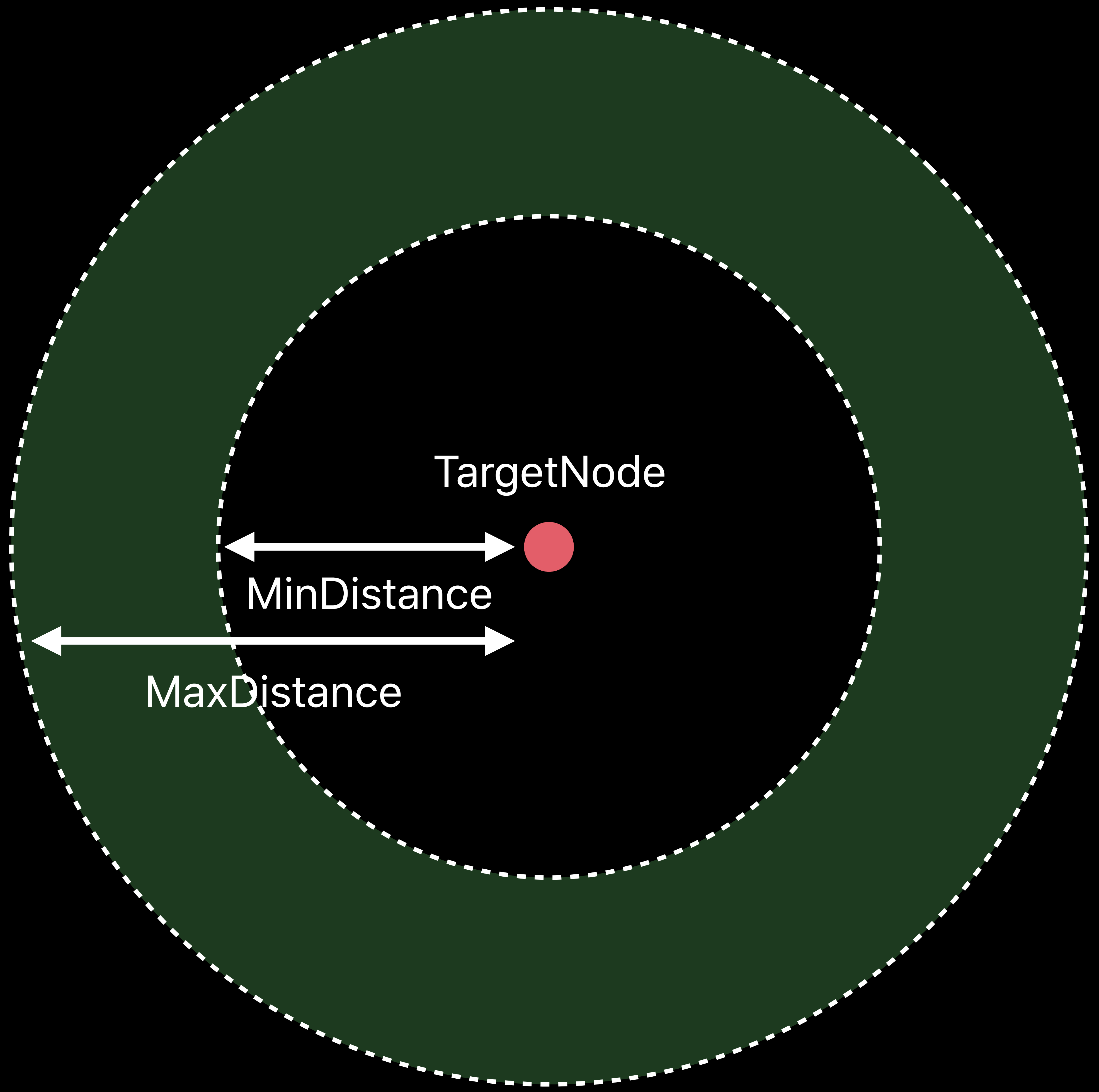
SCNAvoidOccluderConstraint

Camera Control

Constraints

NEW

SCNDistanceConstraint

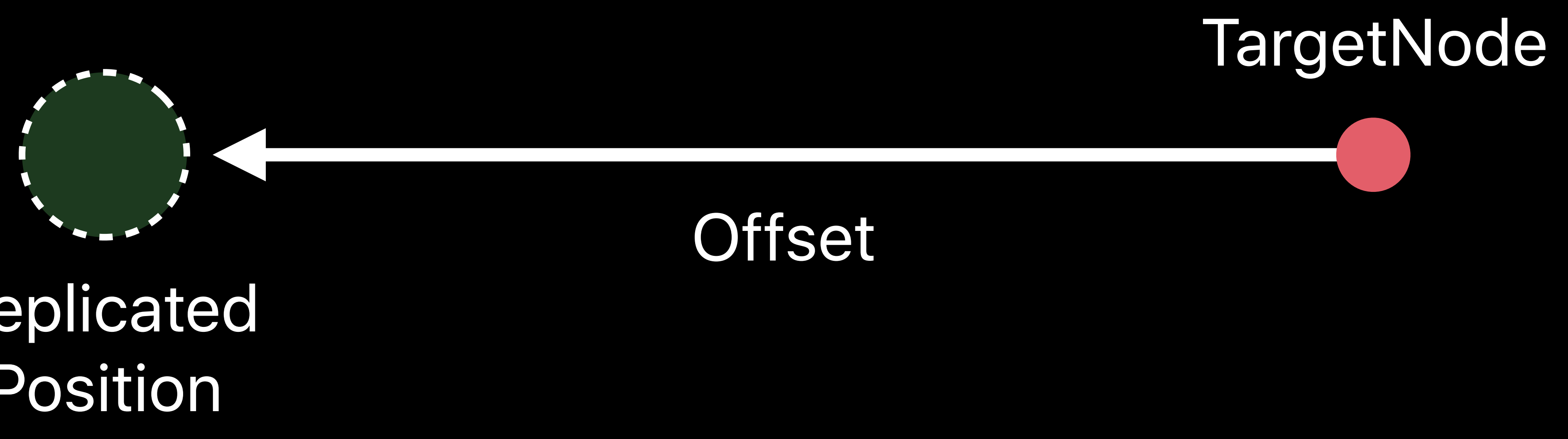


Camera Control

Constraints

NEW

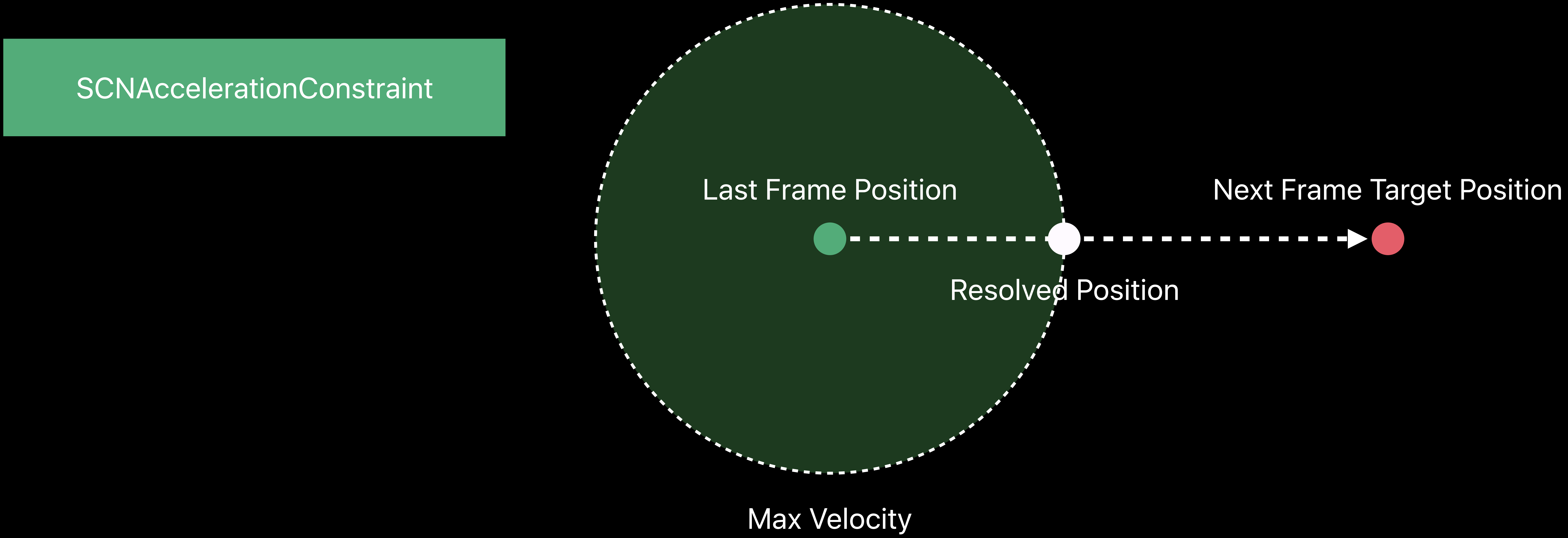
SCNReplicatorConstraint



Camera Control

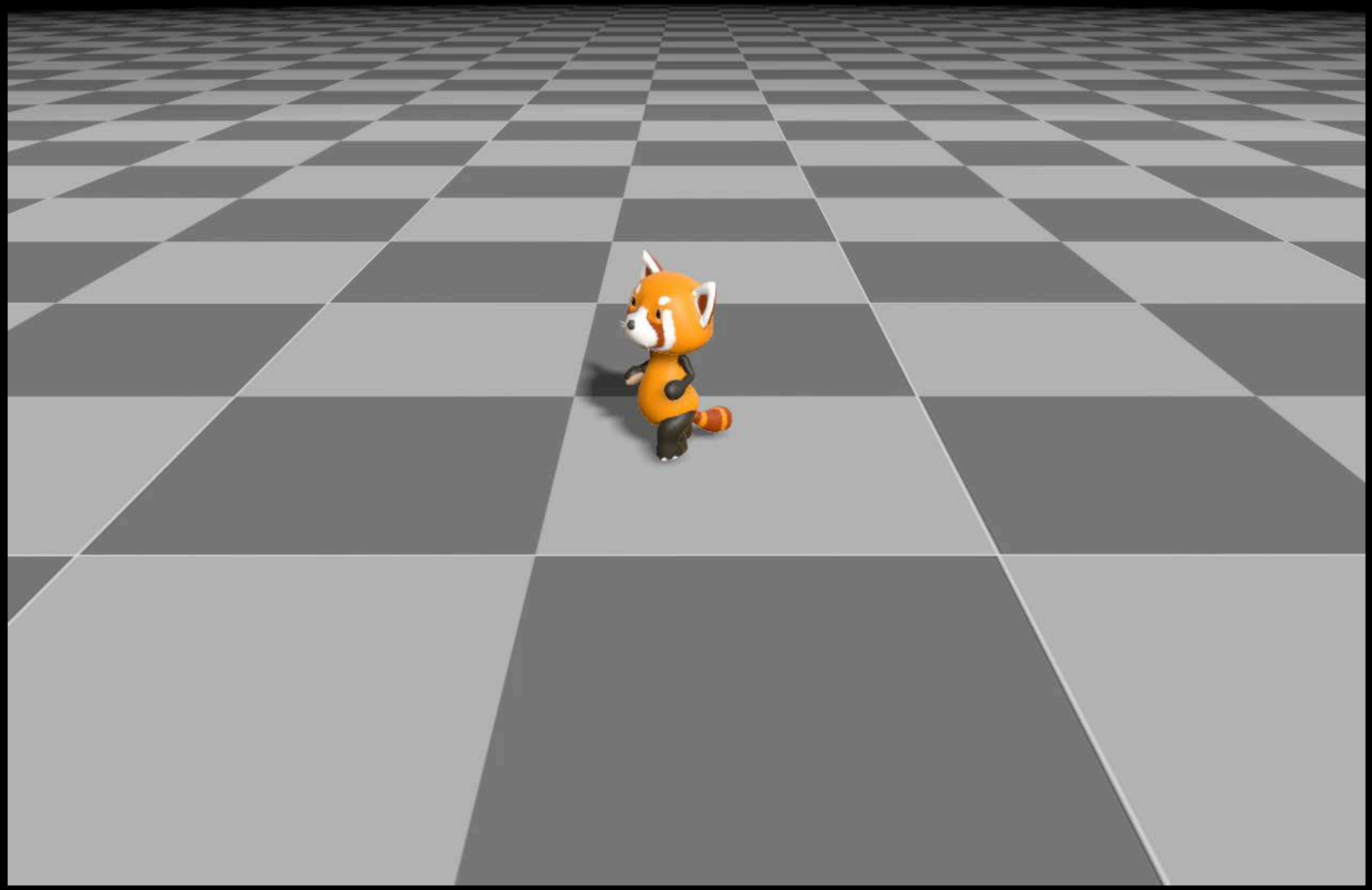
Constraints

NEW



Camera Control

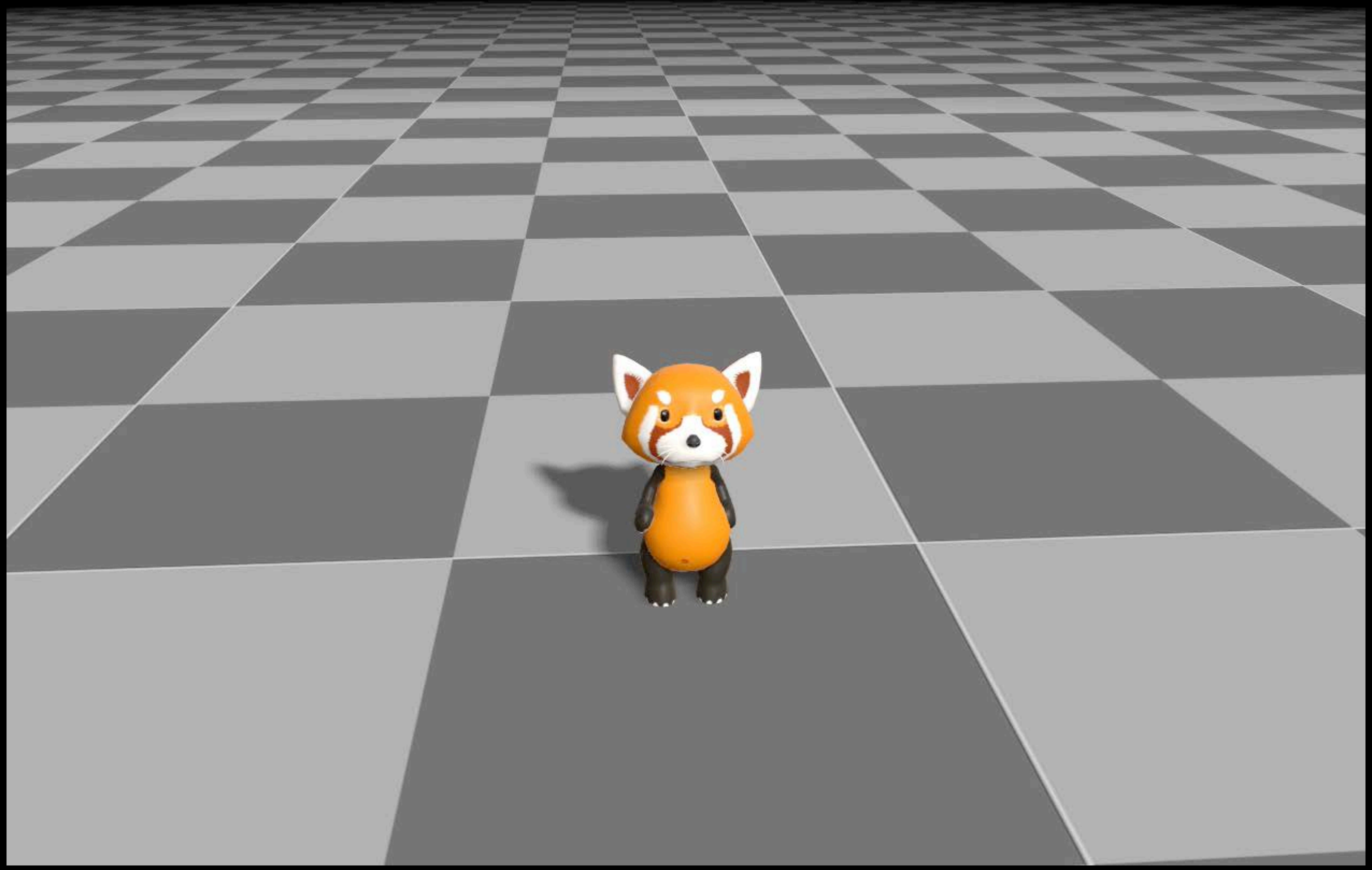
Building a behavior from constraints



Camera Control

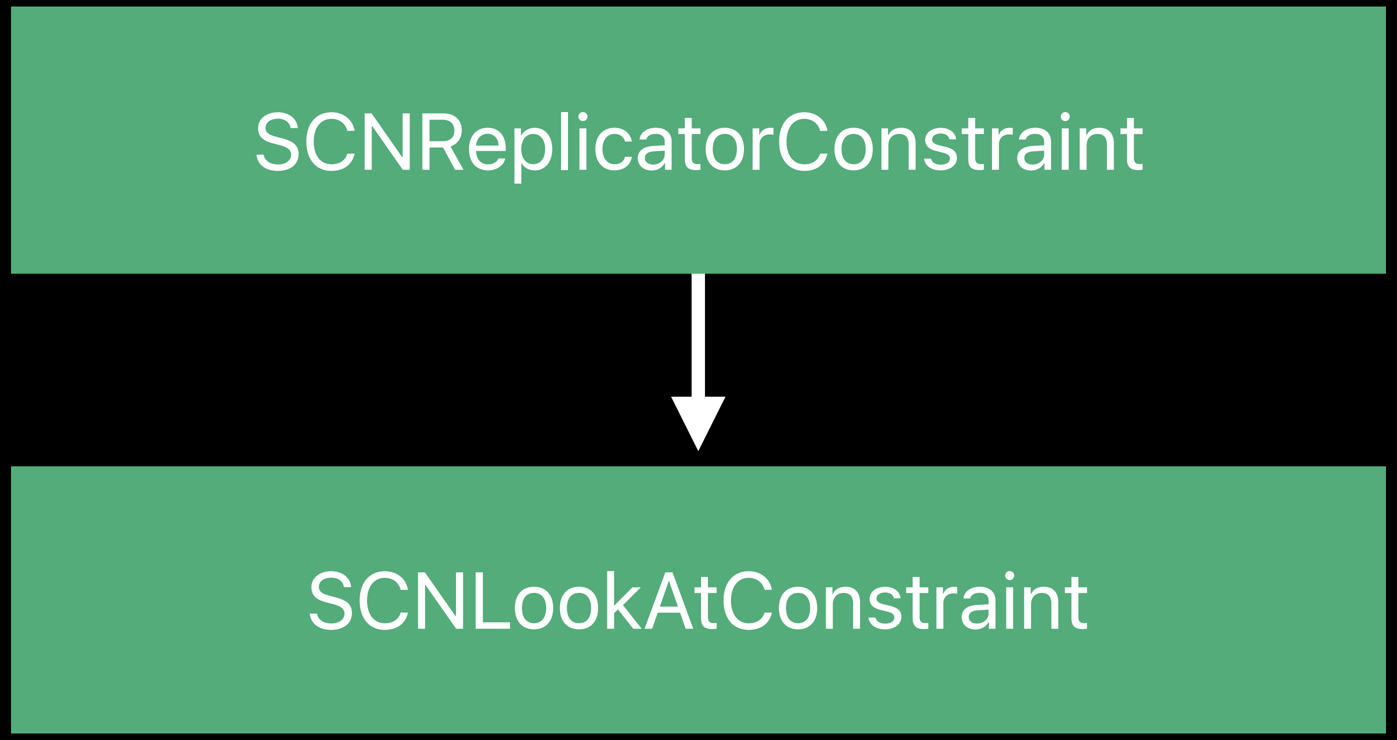
Building a behavior from constraints

SCNLookAtConstraint



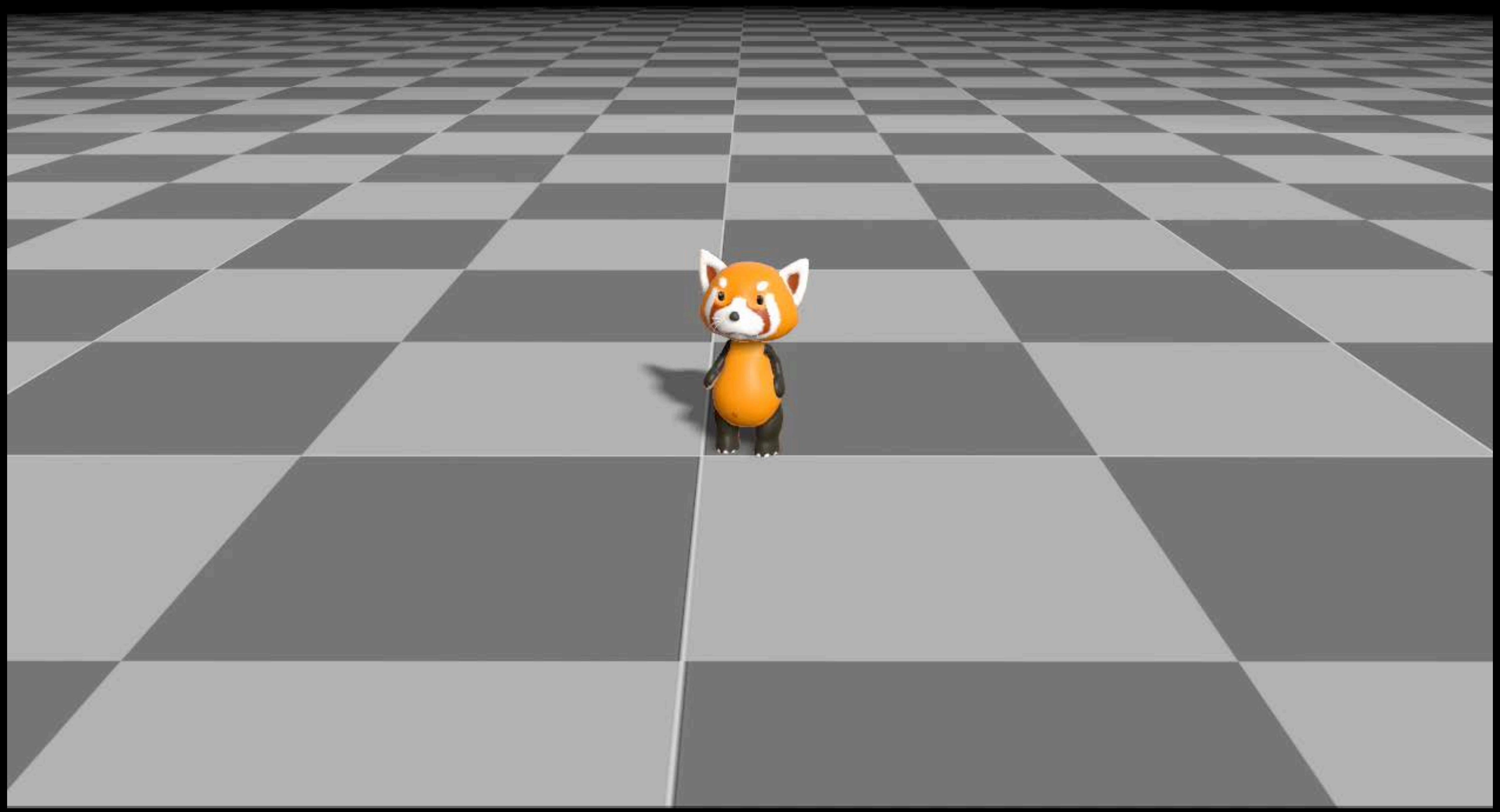
Camera Control

Building a behavior from constraints



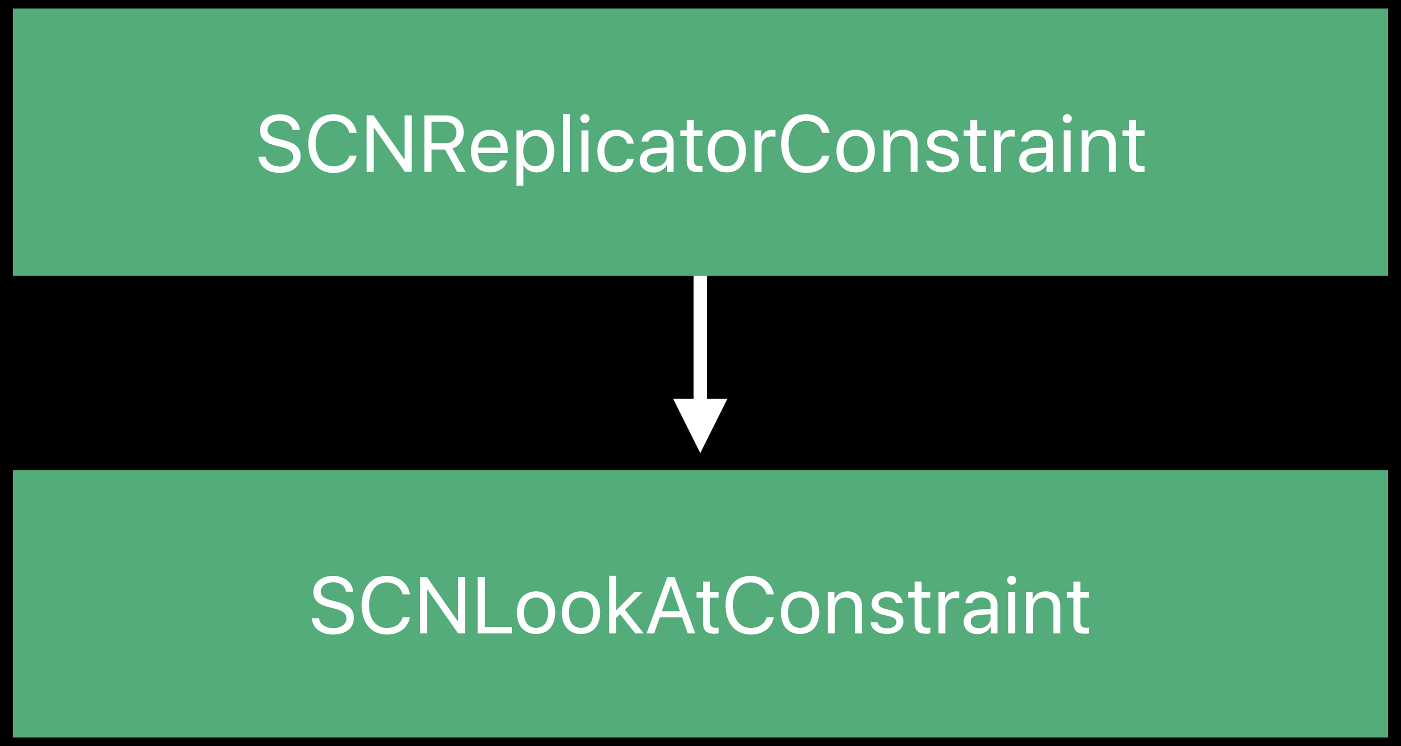
SCNReplicatorConstraint

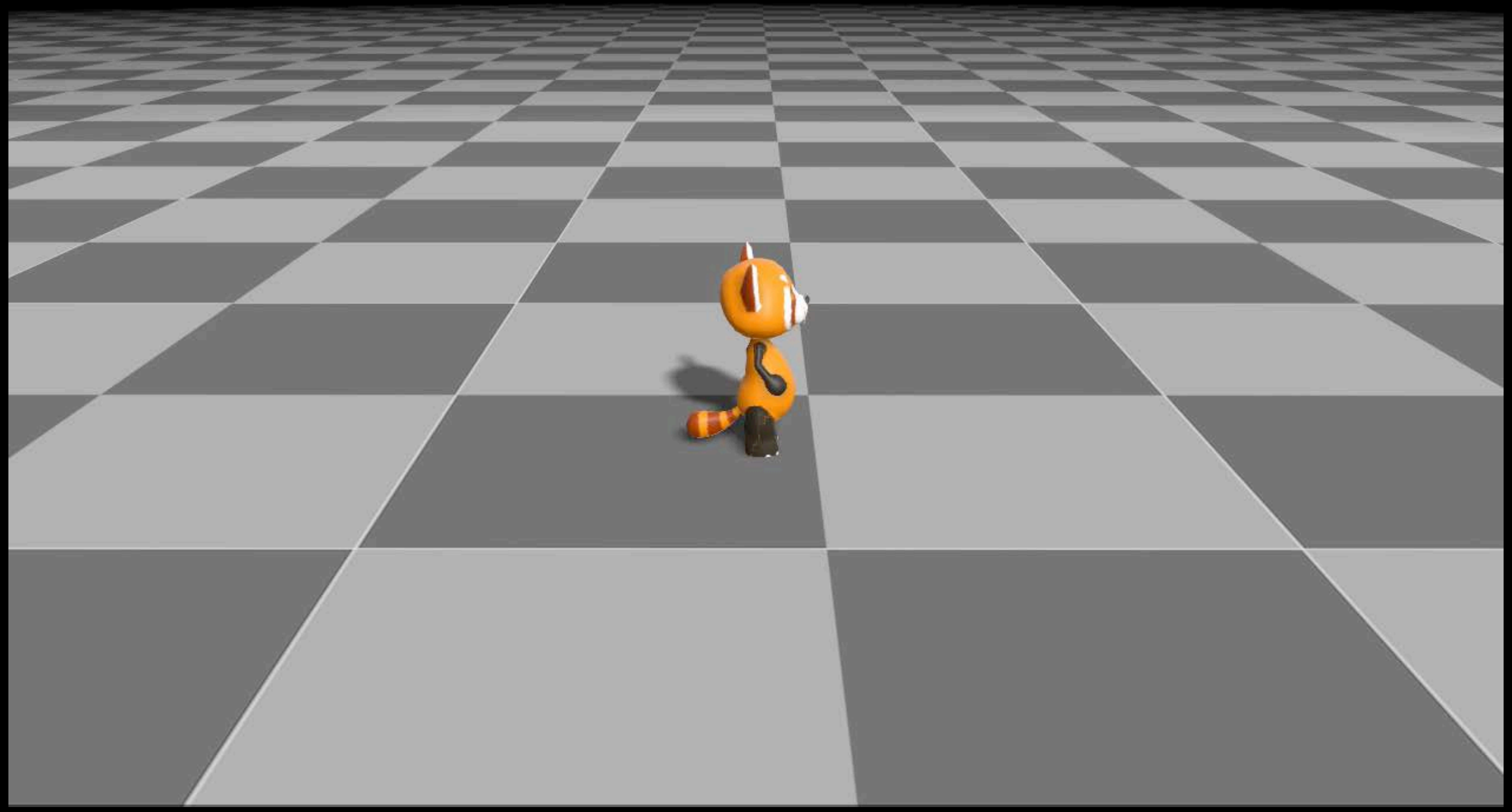
SCNLookAtConstraint



Camera Control

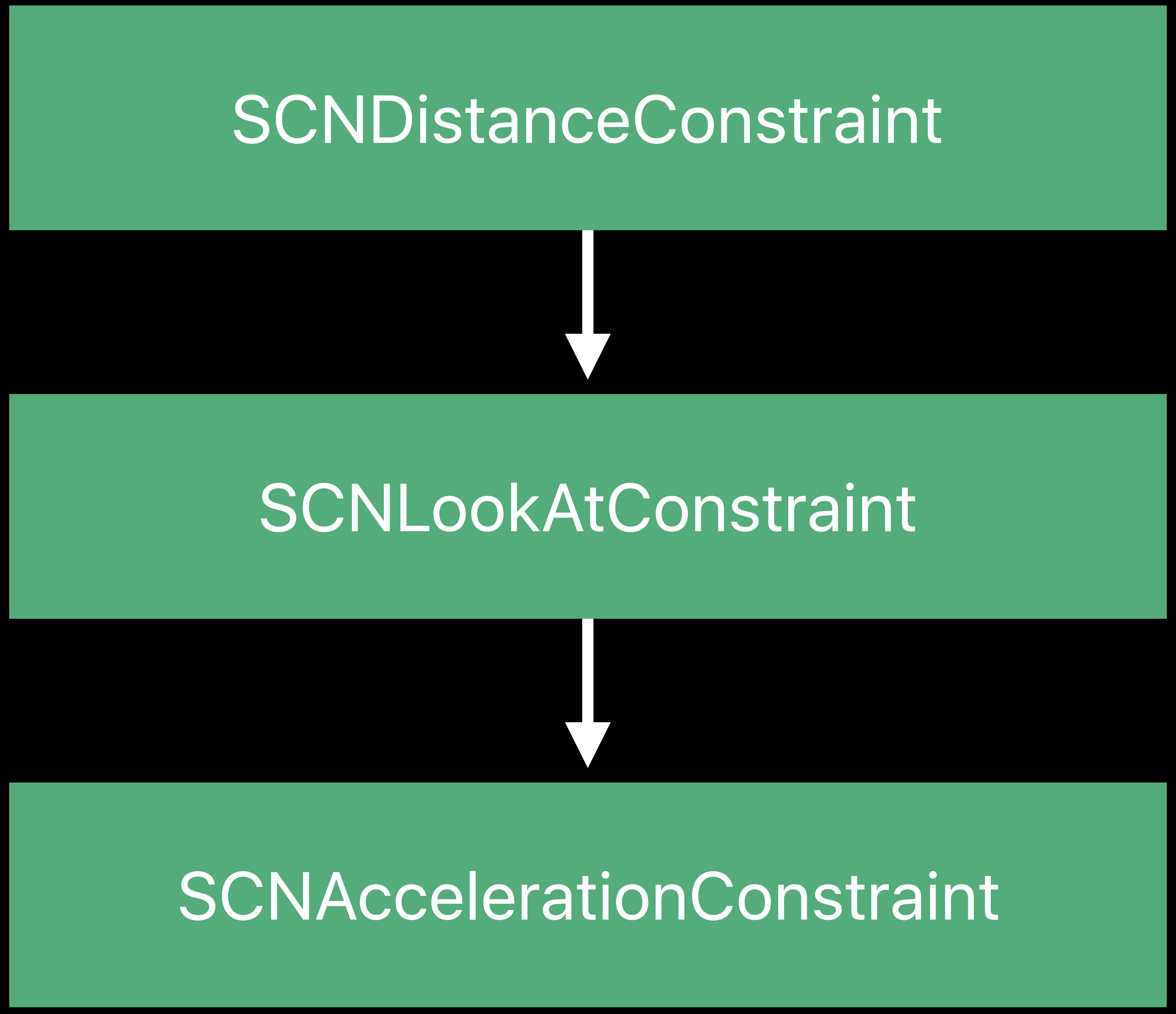
Building a behavior from constraints

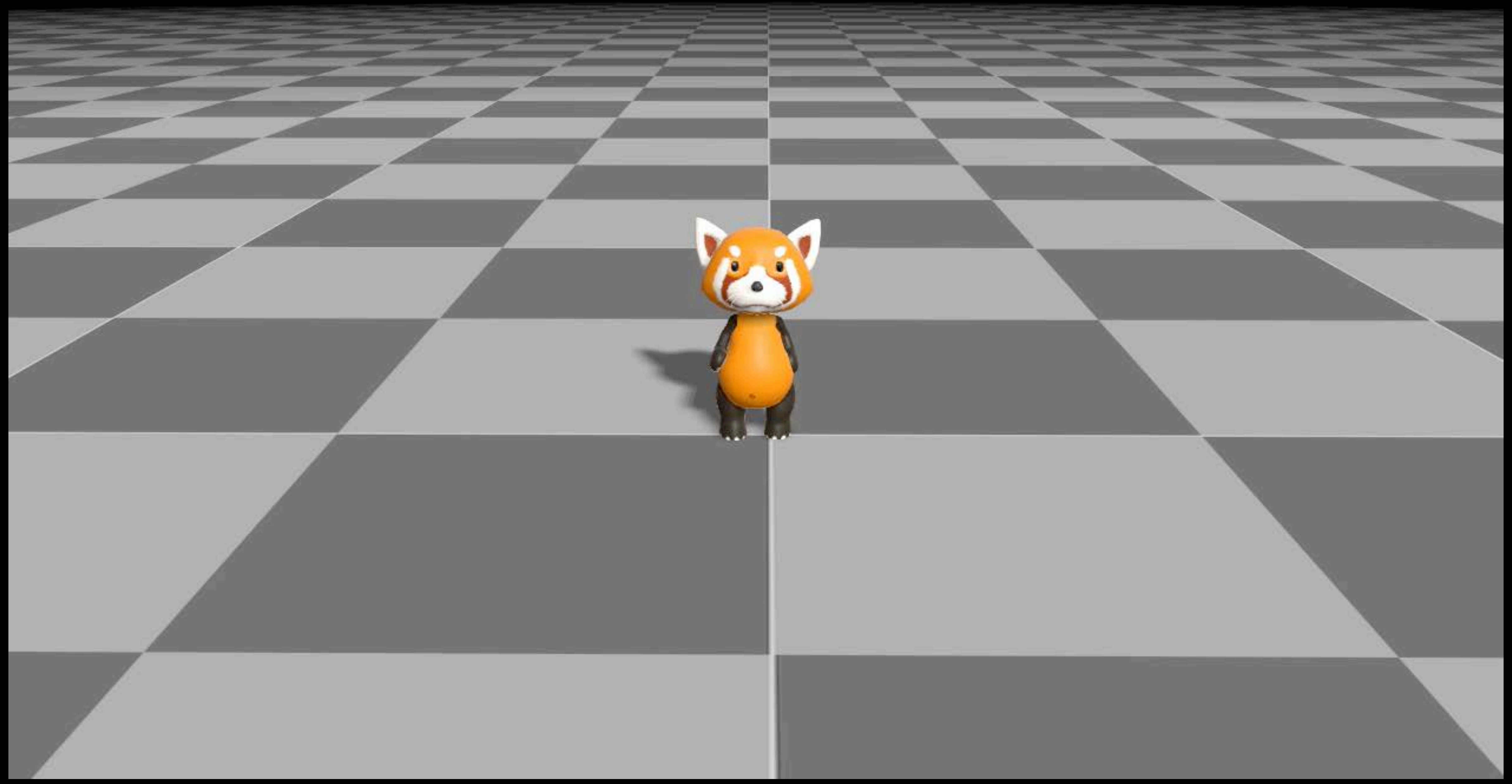




Camera Control

Building a behavior from constraints





Camera Control

In the «Fox 2» demo

Camera Control

Node manipulation helpers

NEW

Math helpers on `SCNNode` for common transformations

Vector conversion from node to node

`SCNNode` transforms properties available as SIMD types

```
// Working with SIMD
aNode.simdPosition += aNode.simdTransform * anotherNode.simdPosition
```

Tessellation and Subdivision Surfaces

Amaury Balliet, SceneKit engineer

Tessellation and Subdivision Surfaces

How tessellation works

New features based on tessellation

Subdivision surfaces

Tessellation

Motivation

Asset comes as a low-resolution model (coarse mesh)

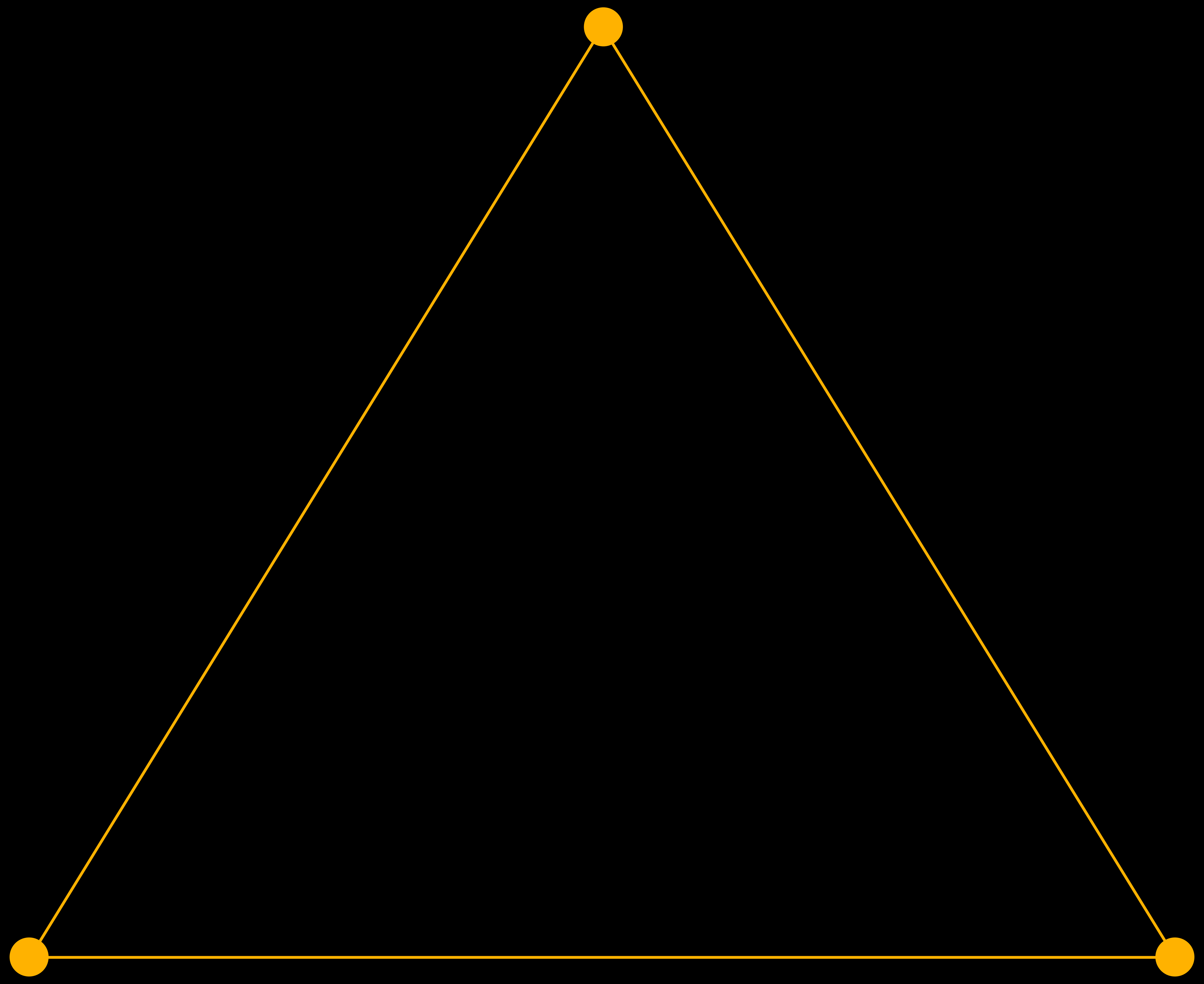
Decreased memory bandwidth

High resolution model generated from the coarser model

- High resolution model not stored in memory
- Generated on-the-fly by the GPU
- Control over the amount of detail generated

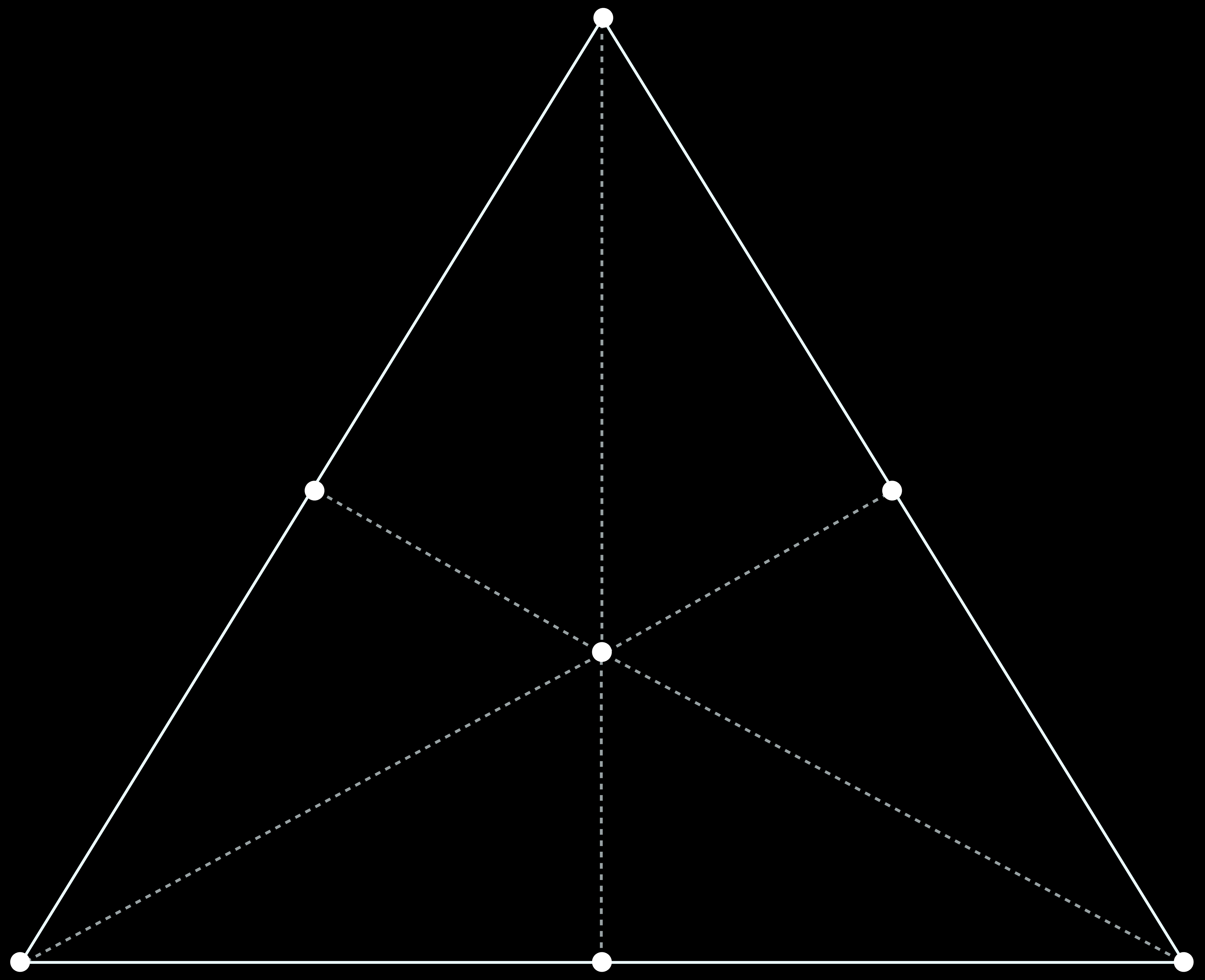
Tessellation

Tessellation factors



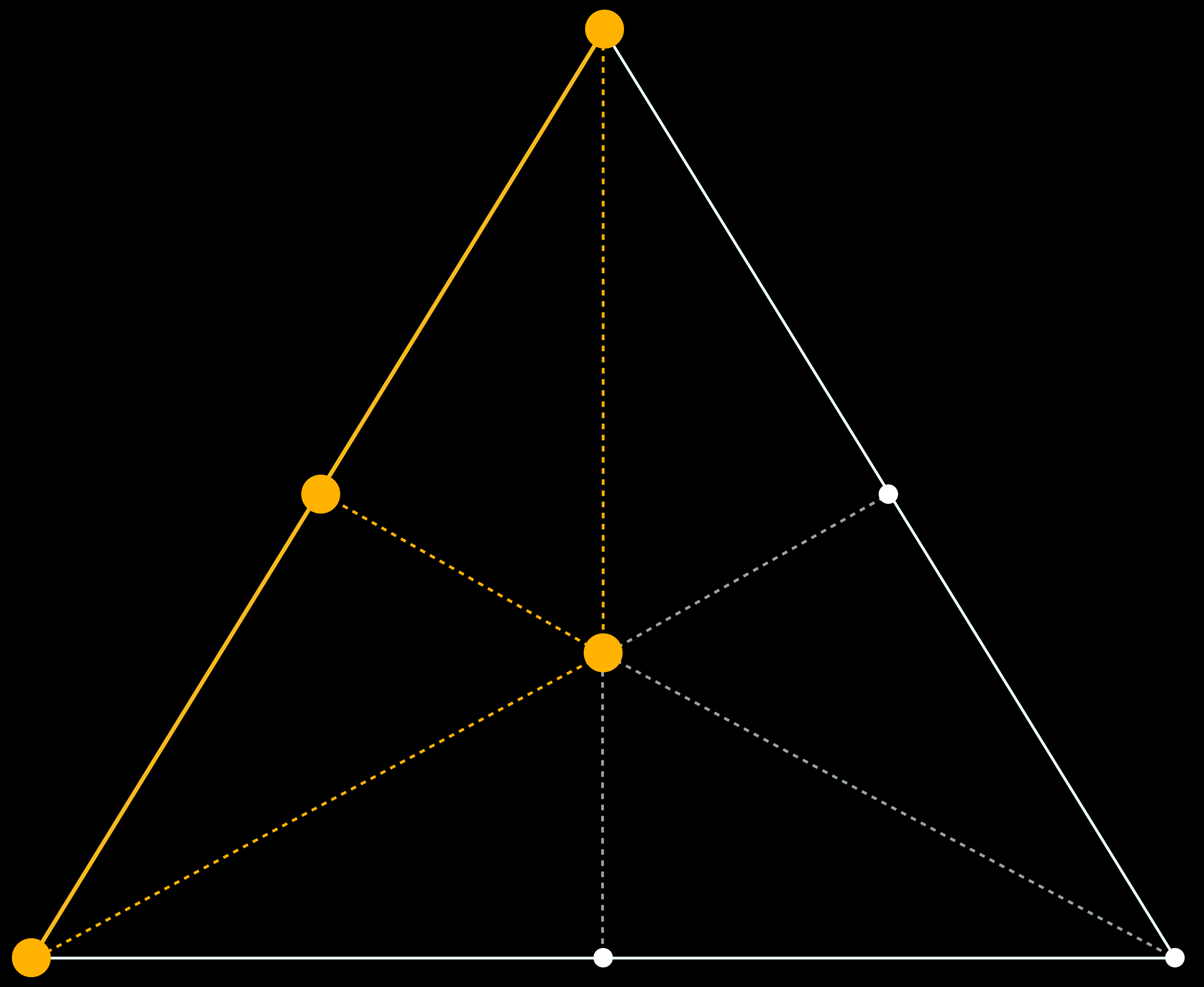
Tessellation

Tessellation factors



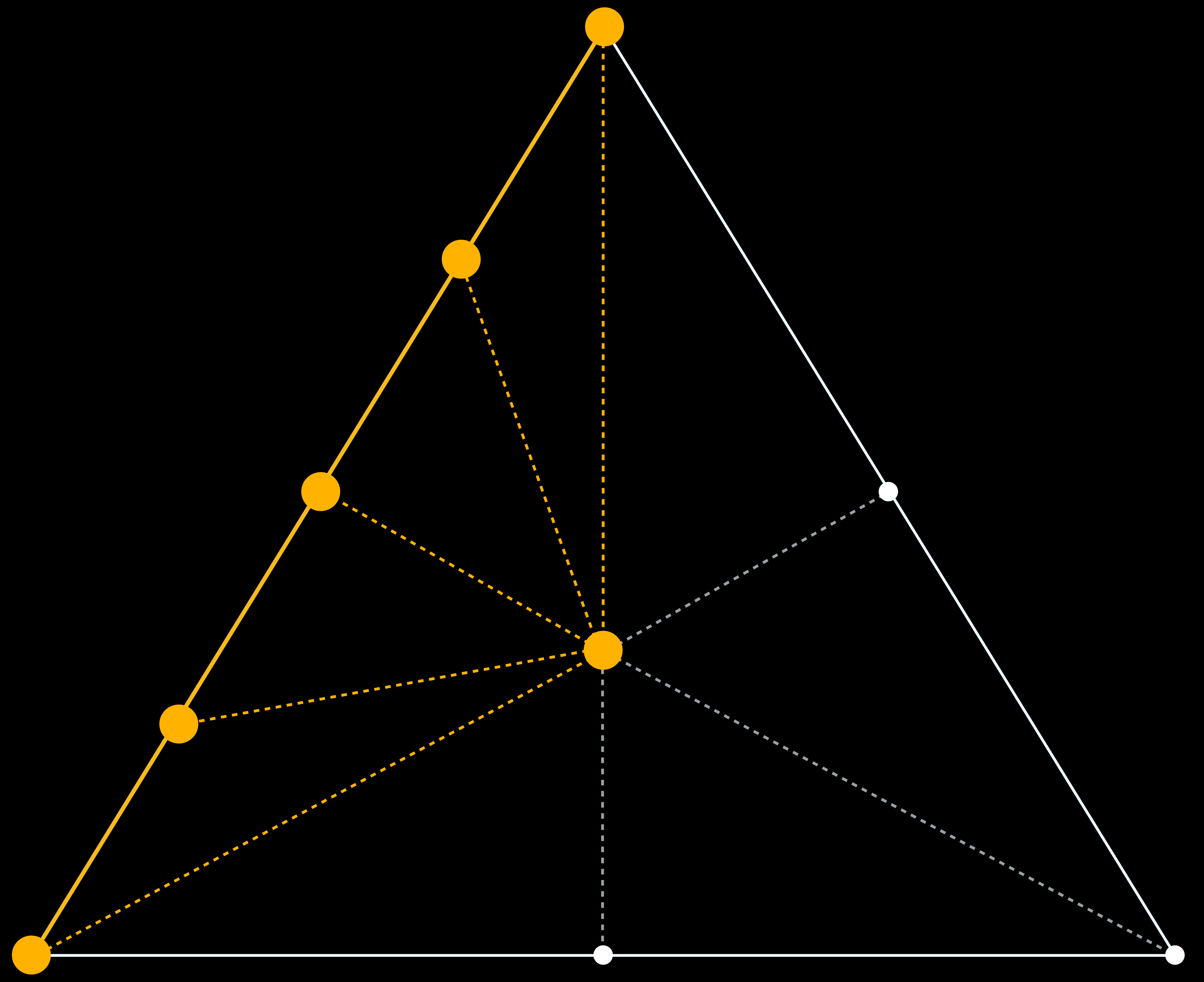
Tessellation

Tessellation factors



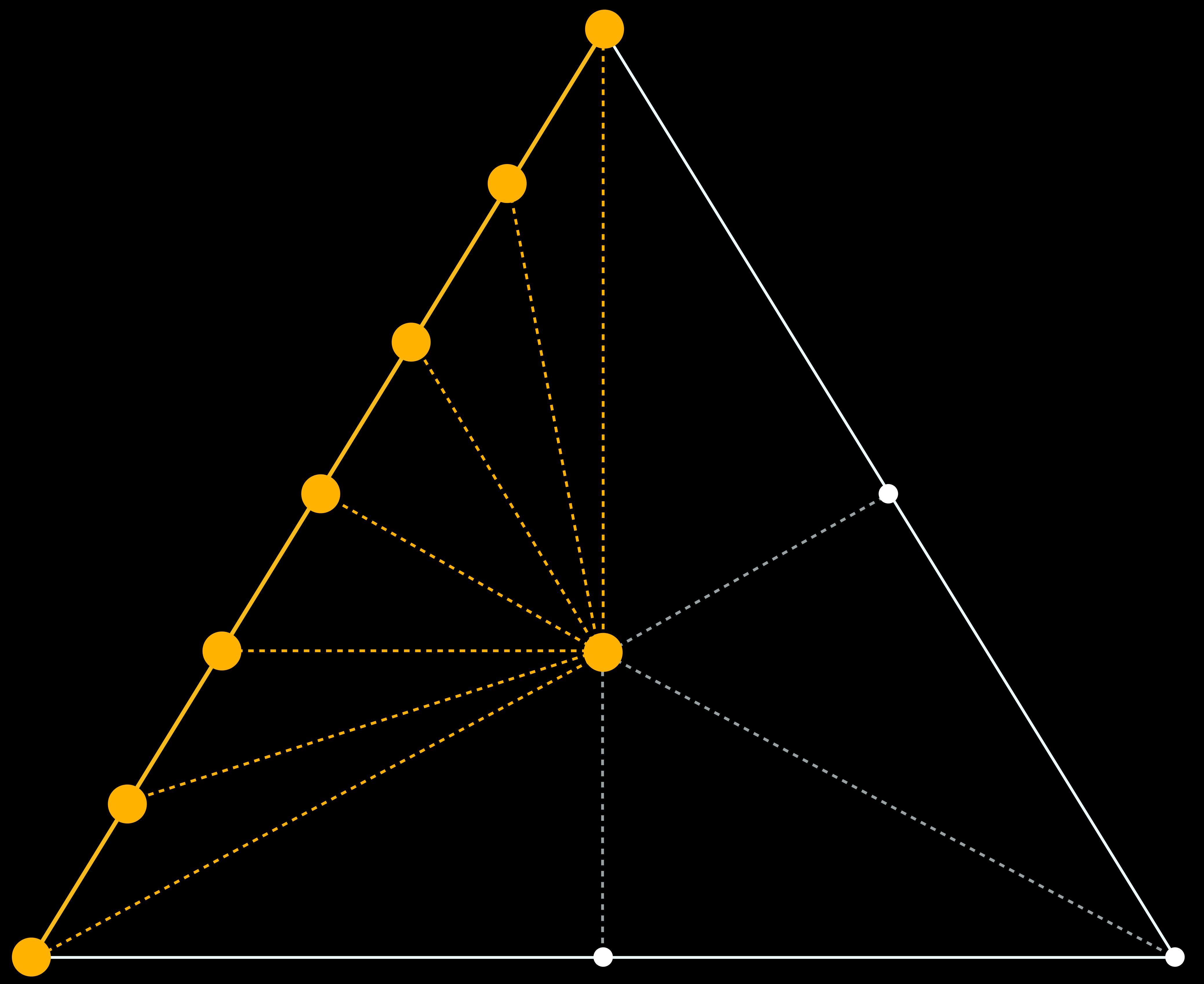
Tessellation

Tessellation factors



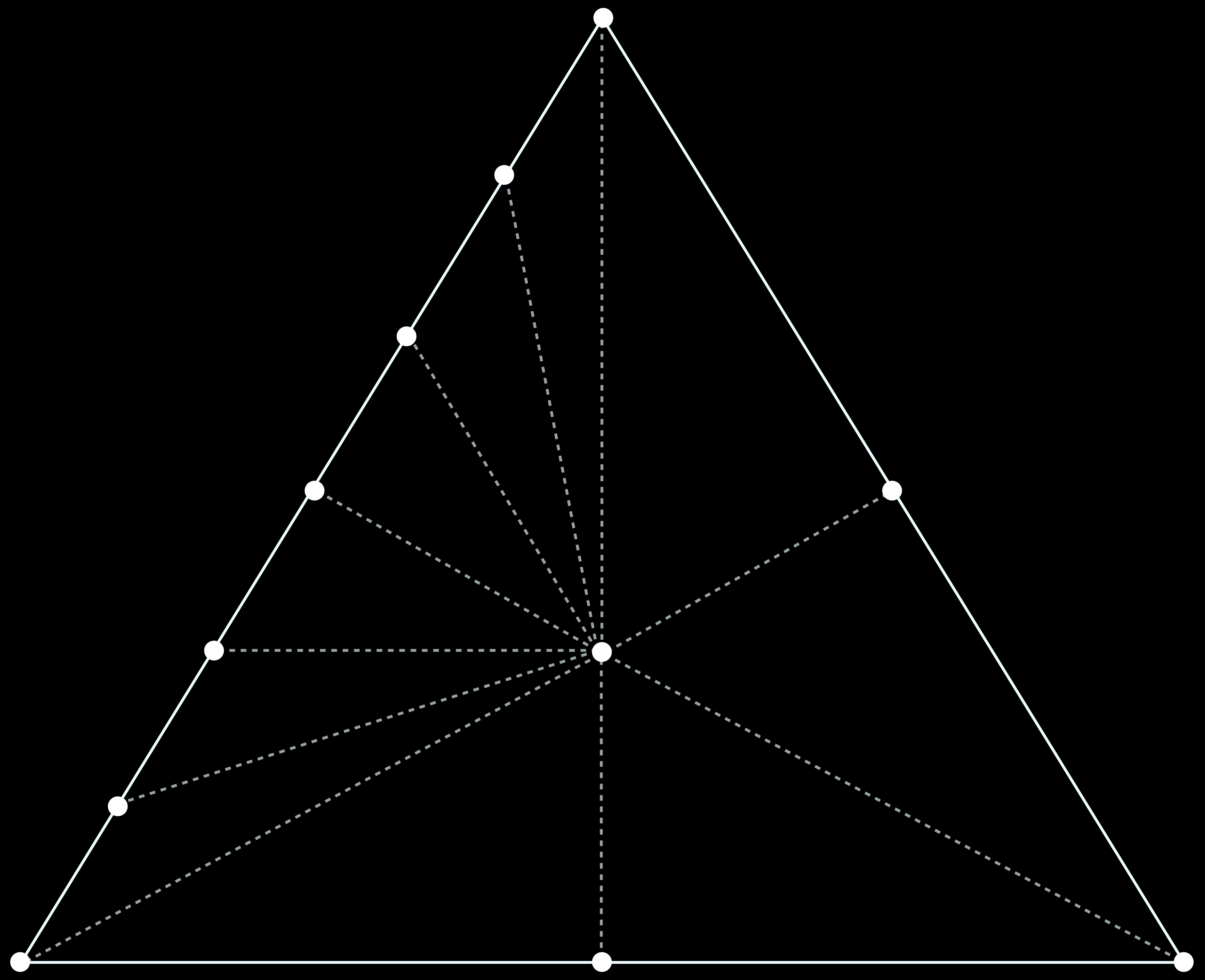
Tessellation

Tessellation factors



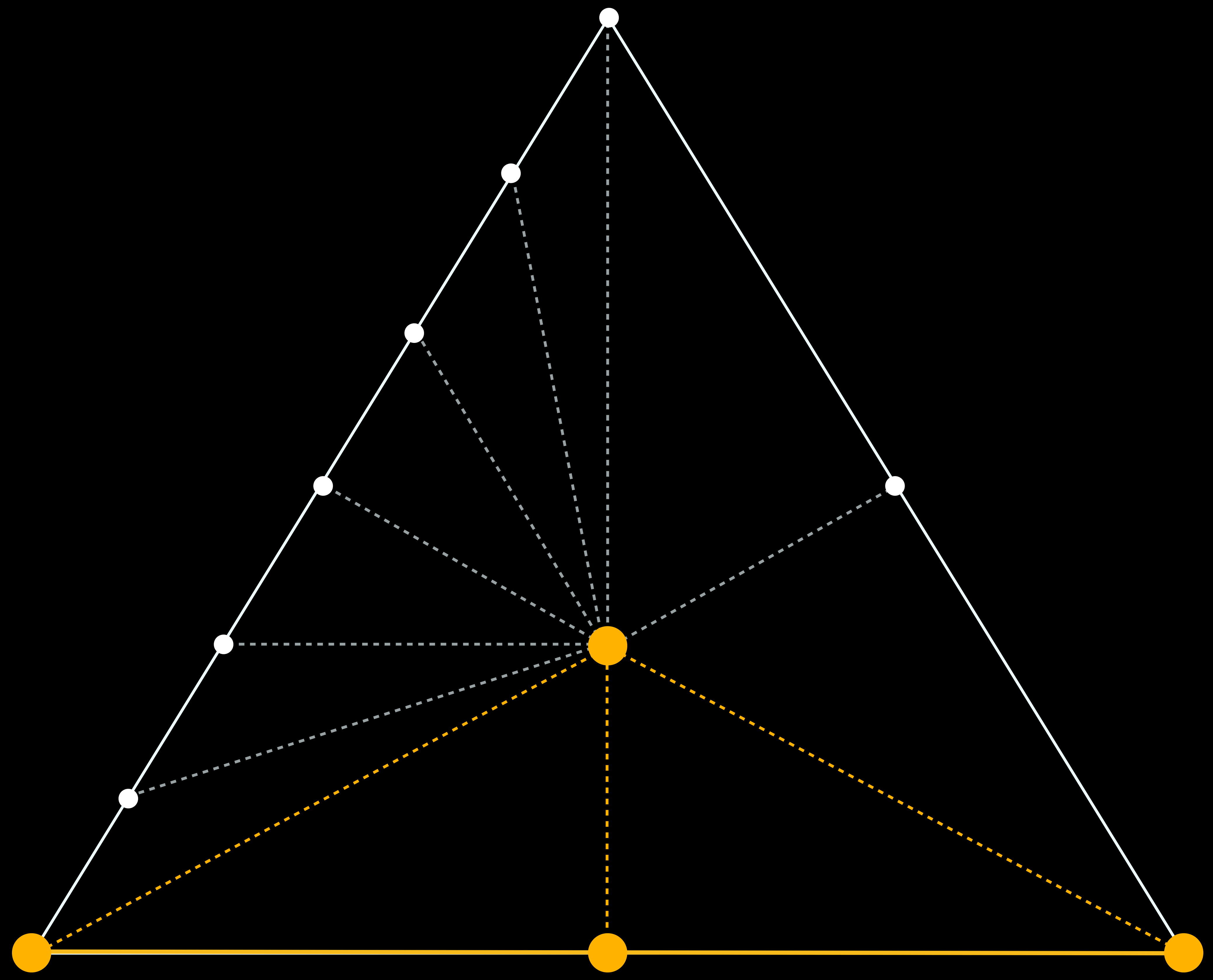
Tessellation

Tessellation factors



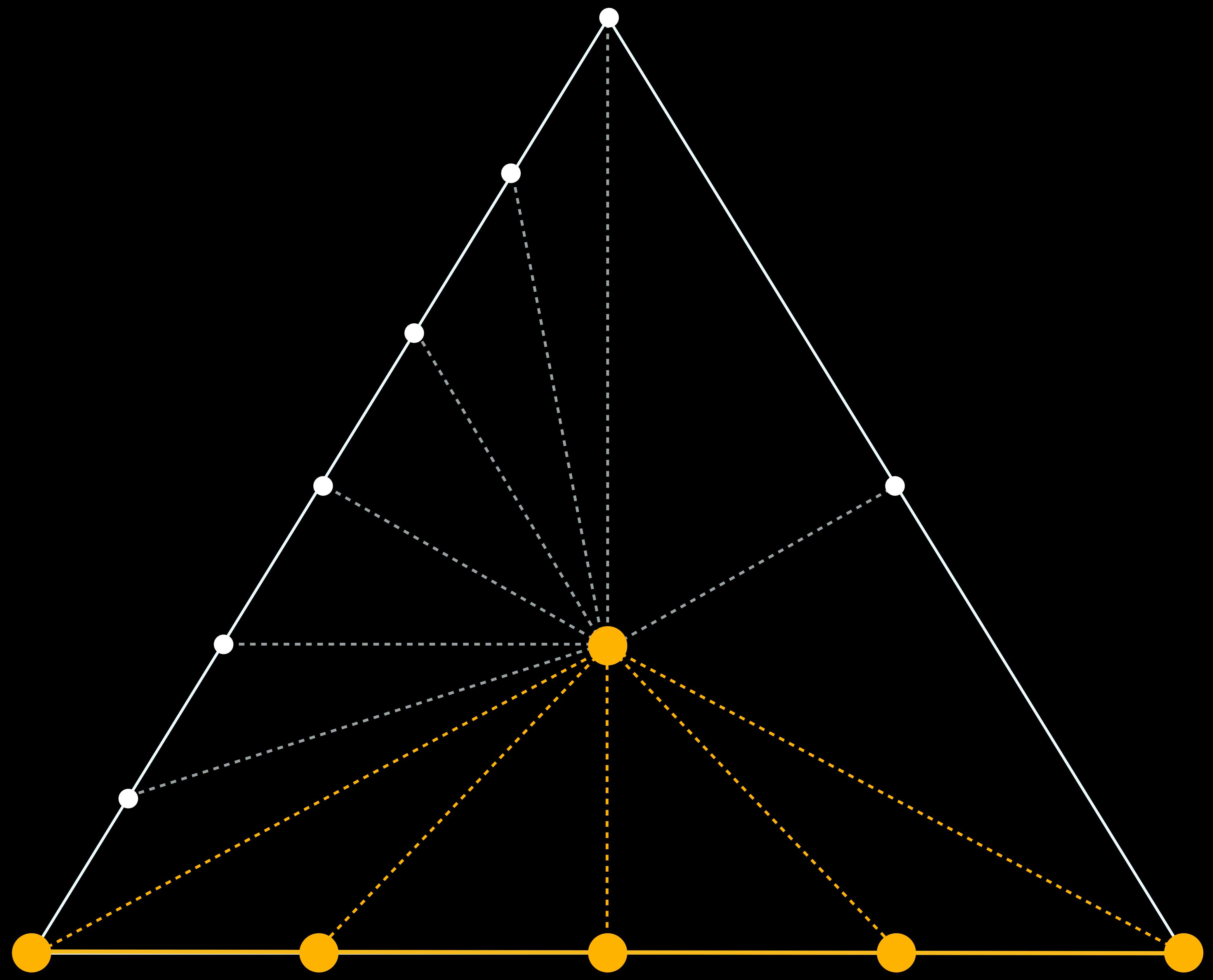
Tessellation

Tessellation factors



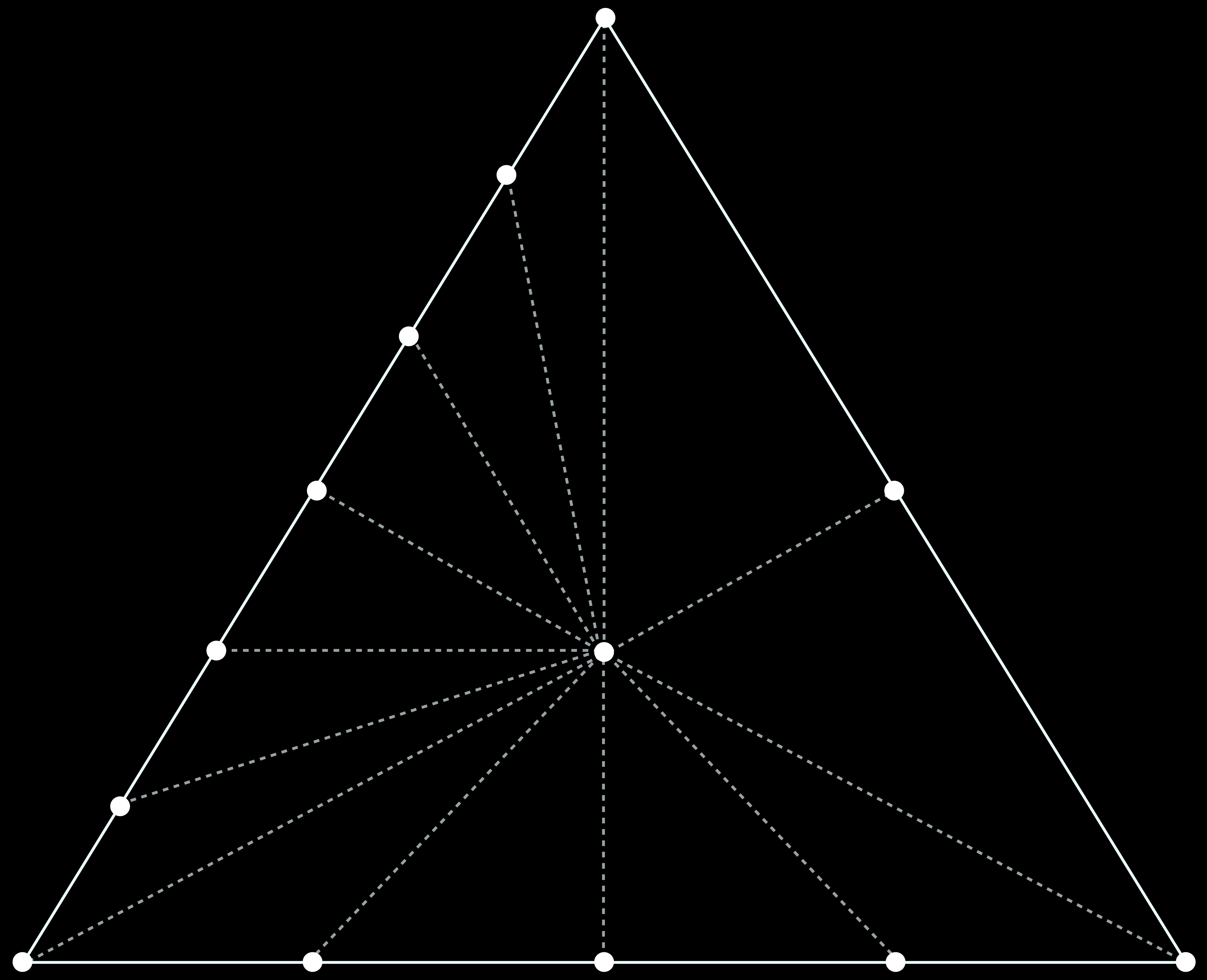
Tessellation

Tessellation factors



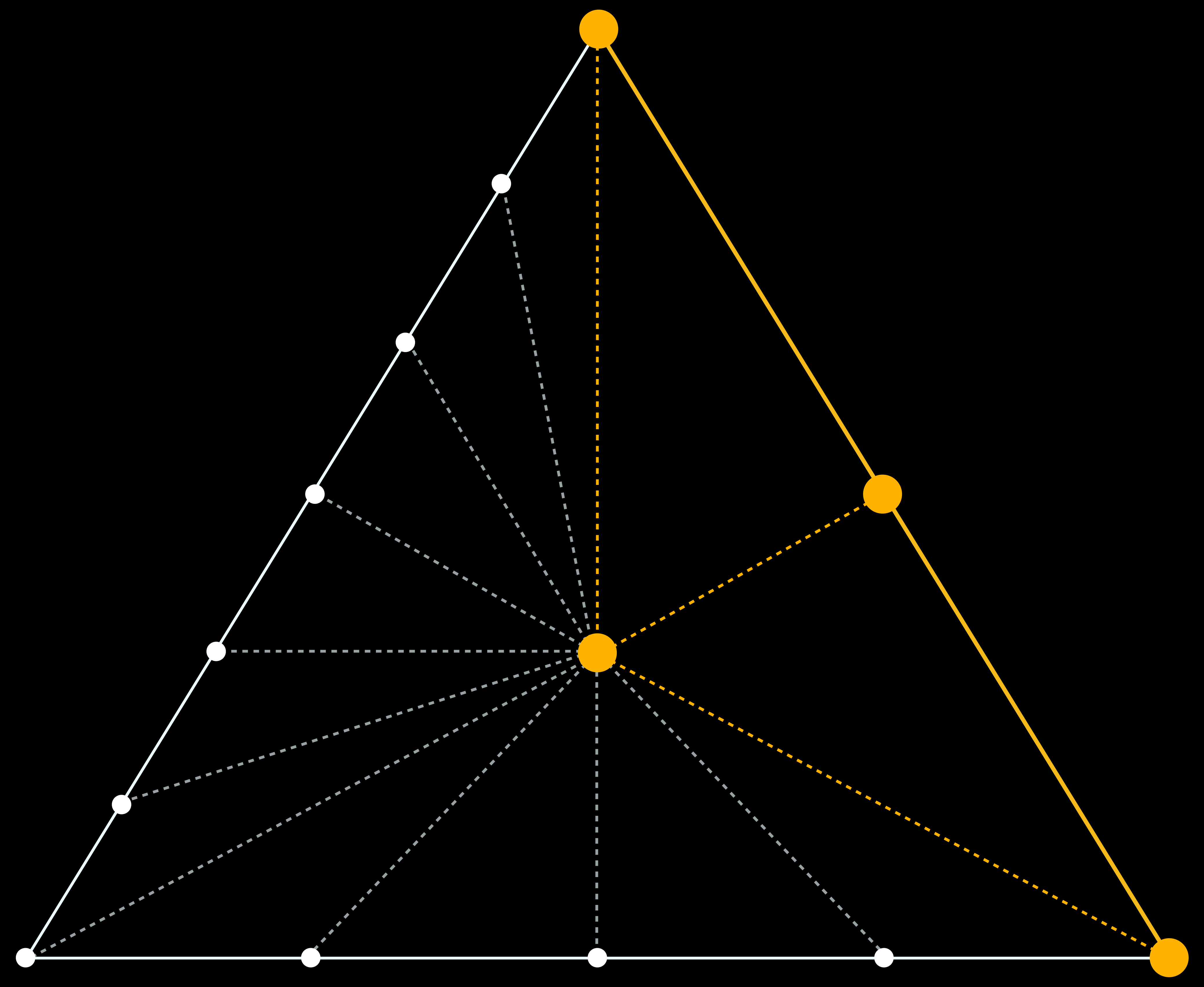
Tessellation

Tessellation factors



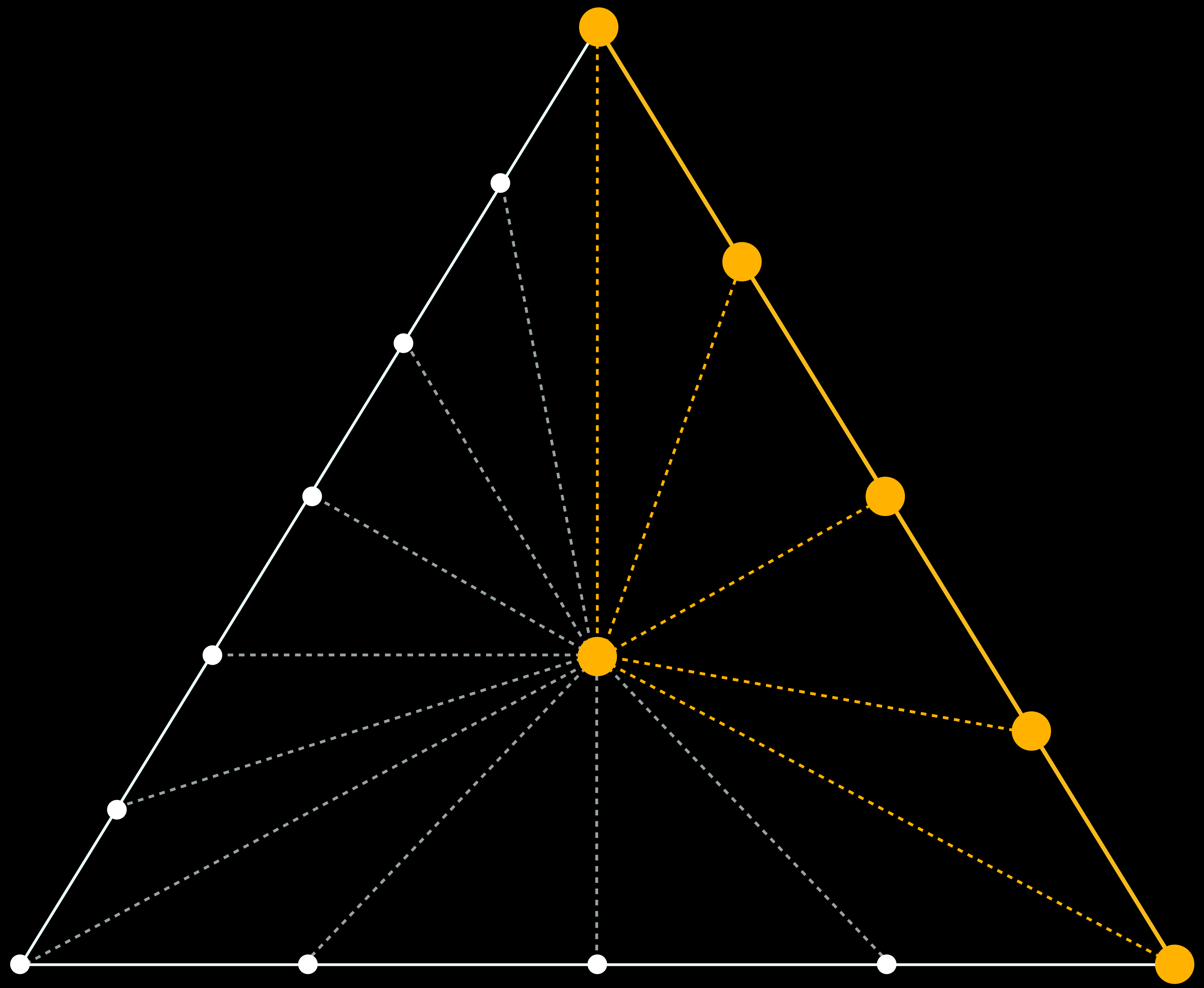
Tessellation

Tessellation factors



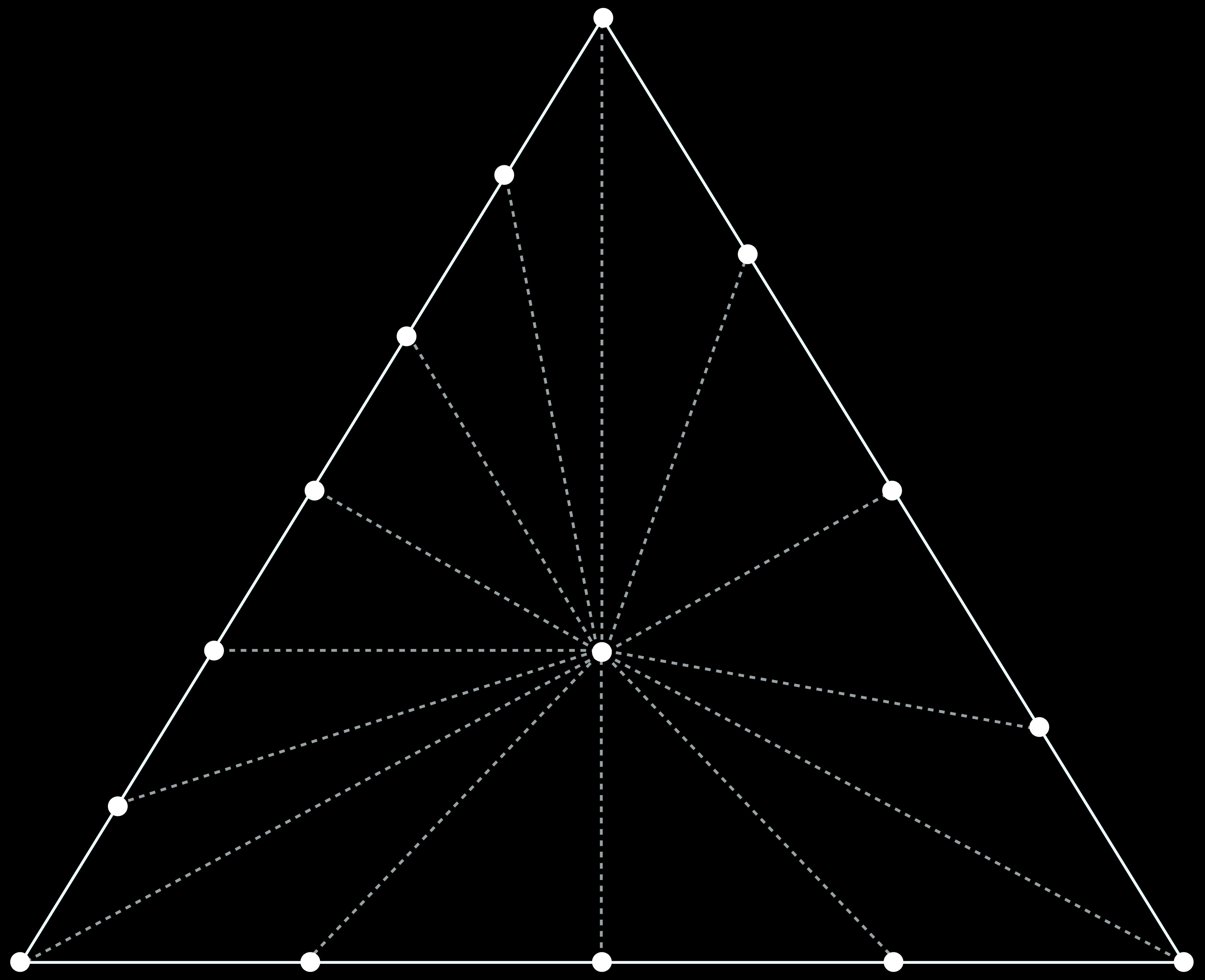
Tessellation

Tessellation factors



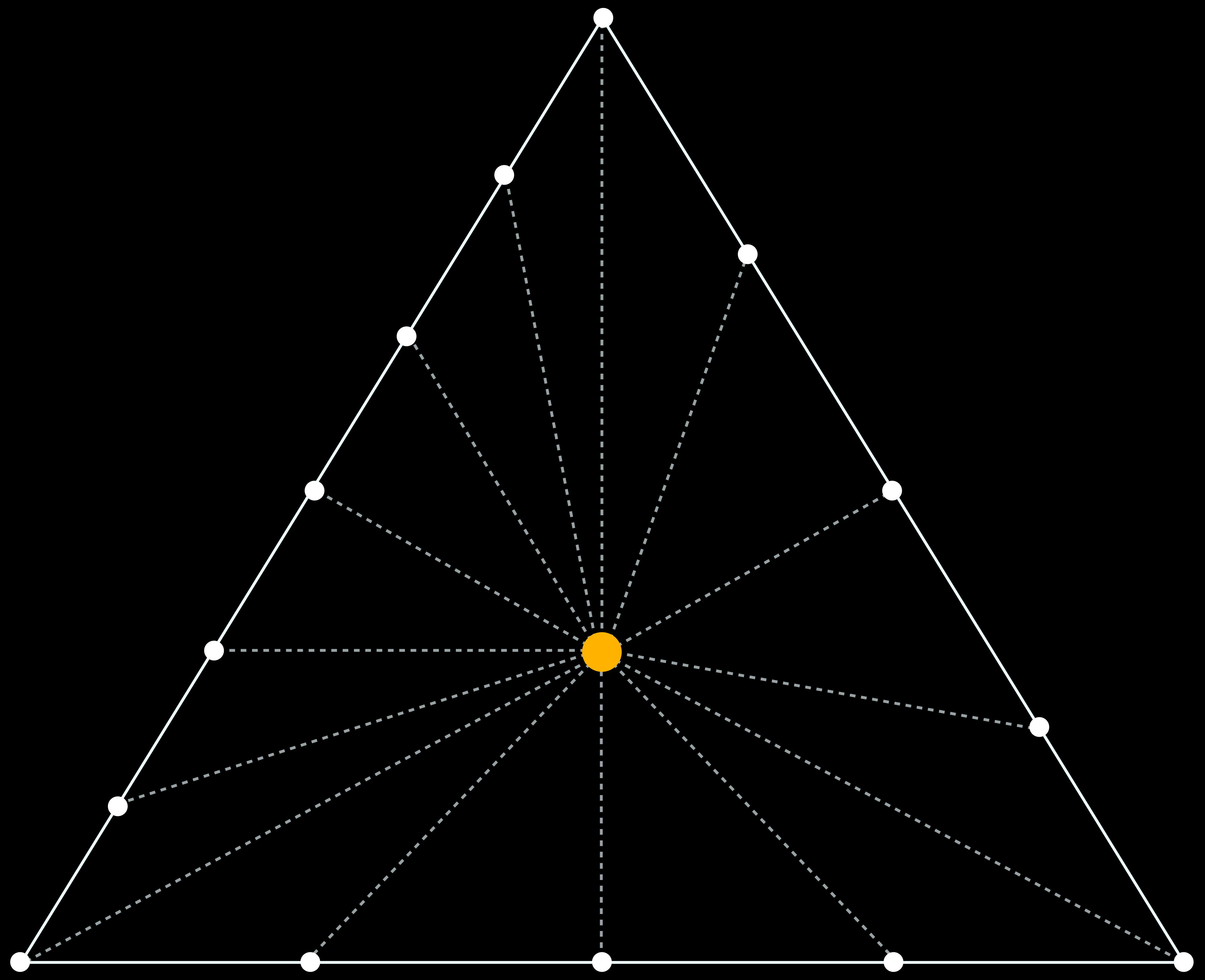
Tessellation

Tessellation factors



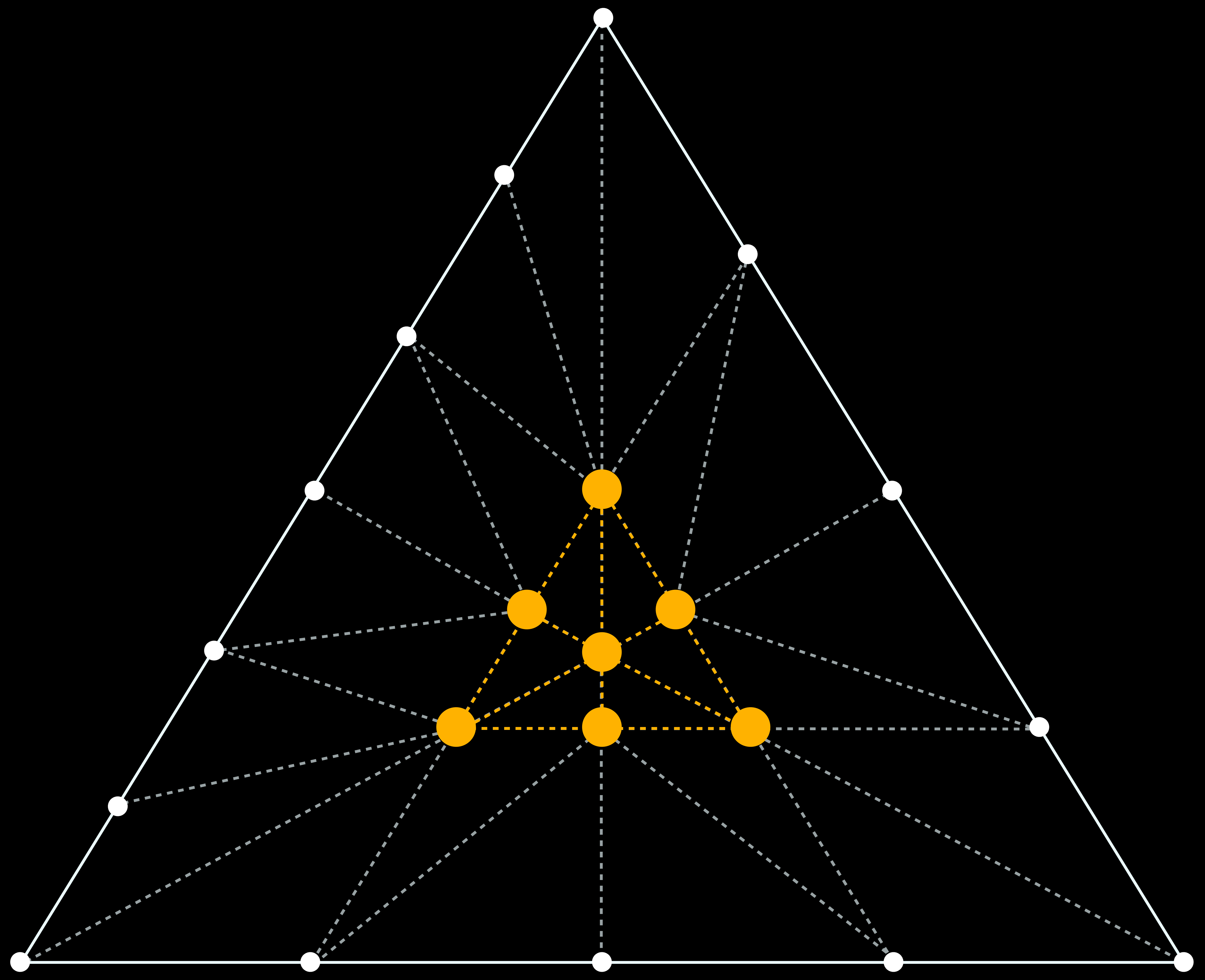
Tessellation

Tessellation factors



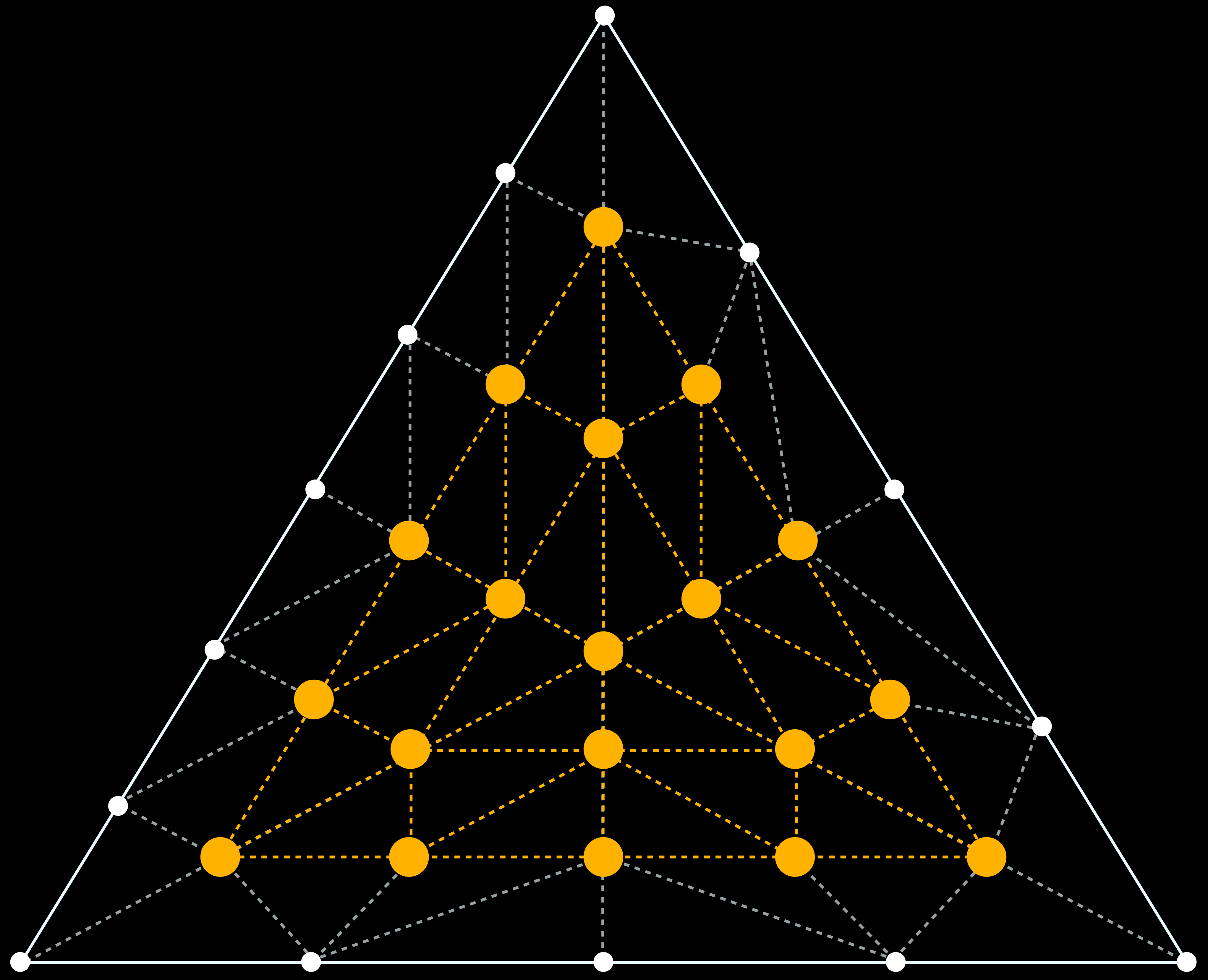
Tessellation

Tessellation factors



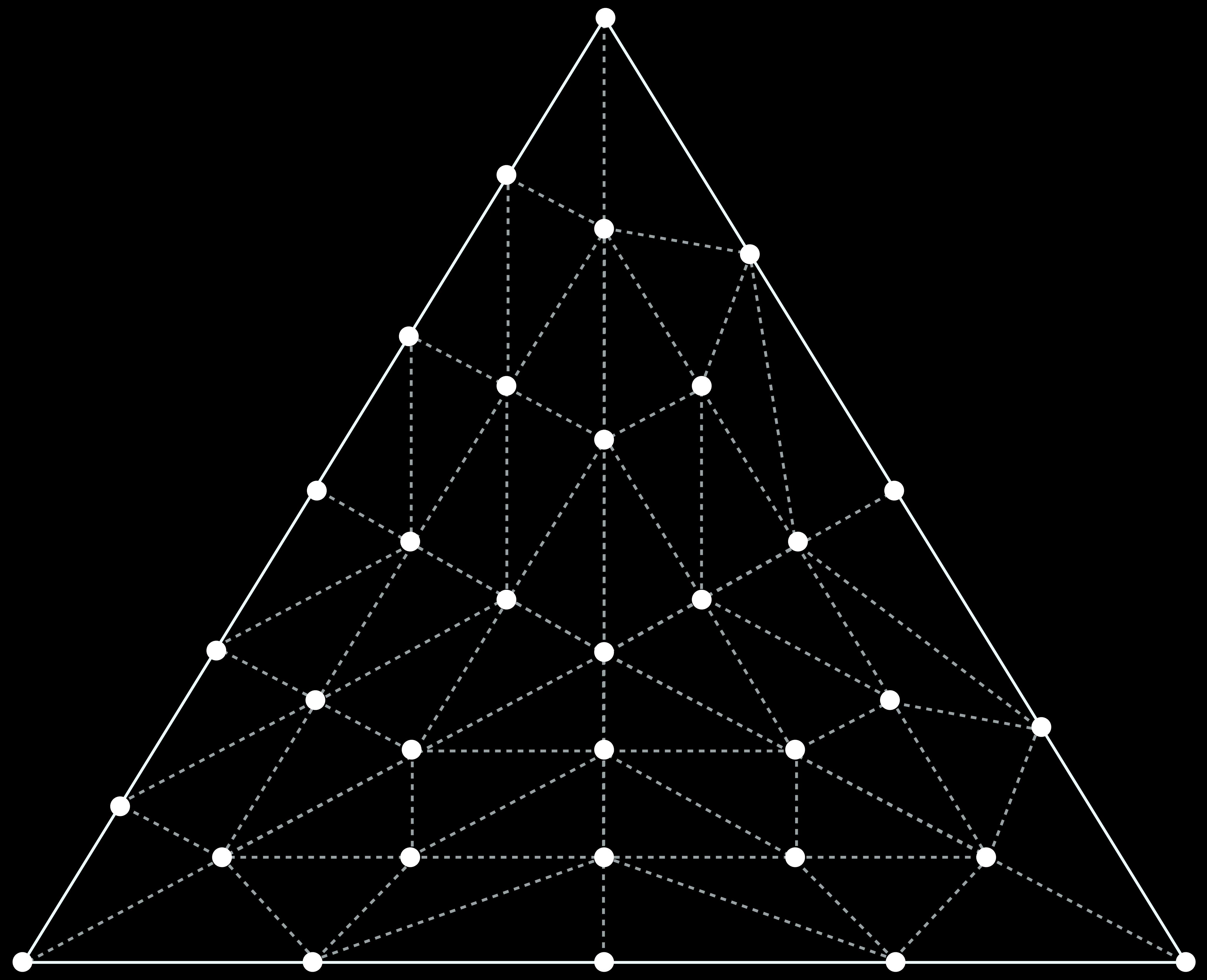
Tessellation

Tessellation factors



Tessellation

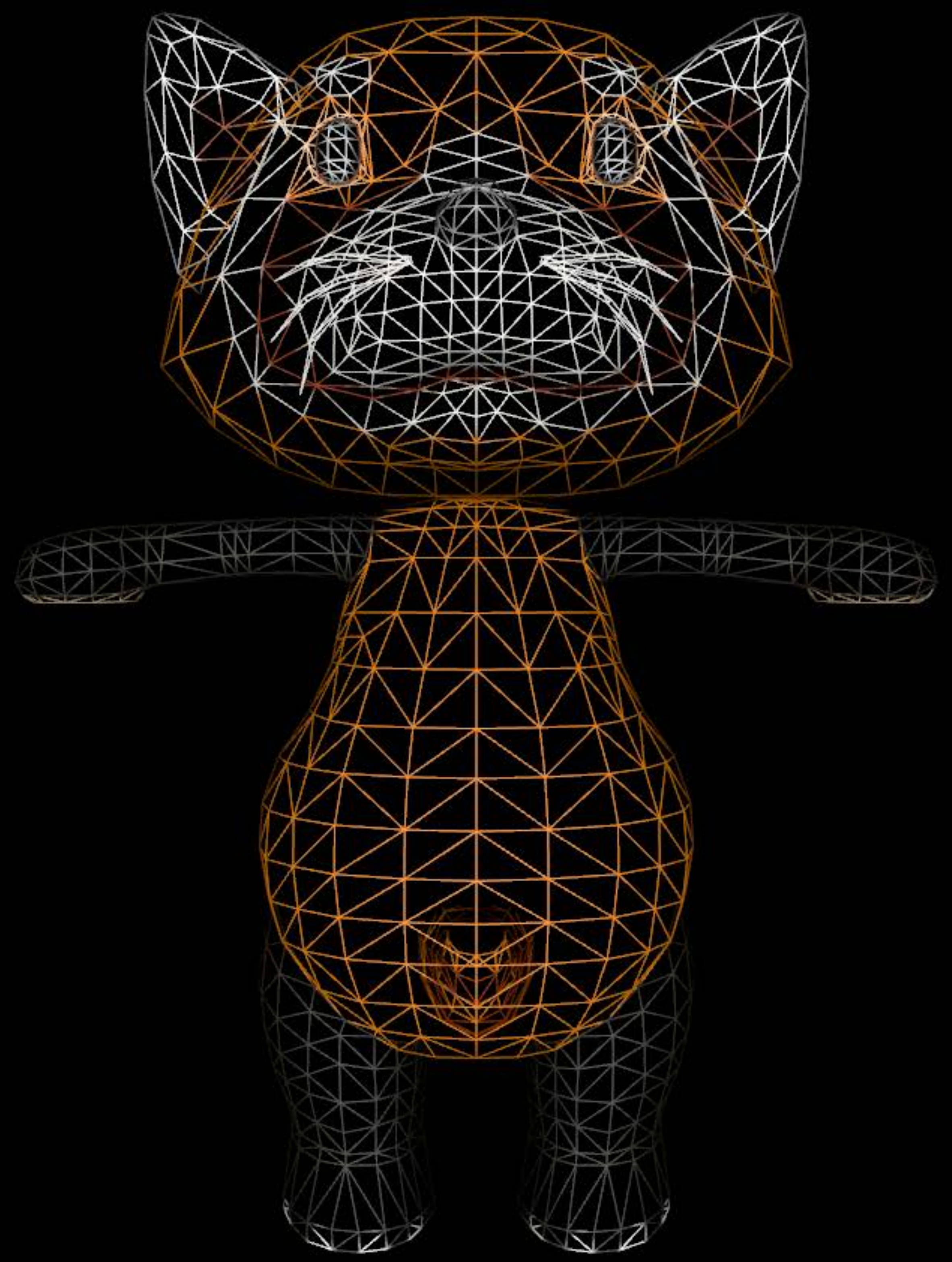
Tessellation factors



Tessellation

SCNGeometryTessellator

NEW



Tessellation

SCNGeometryTessellator

NEW

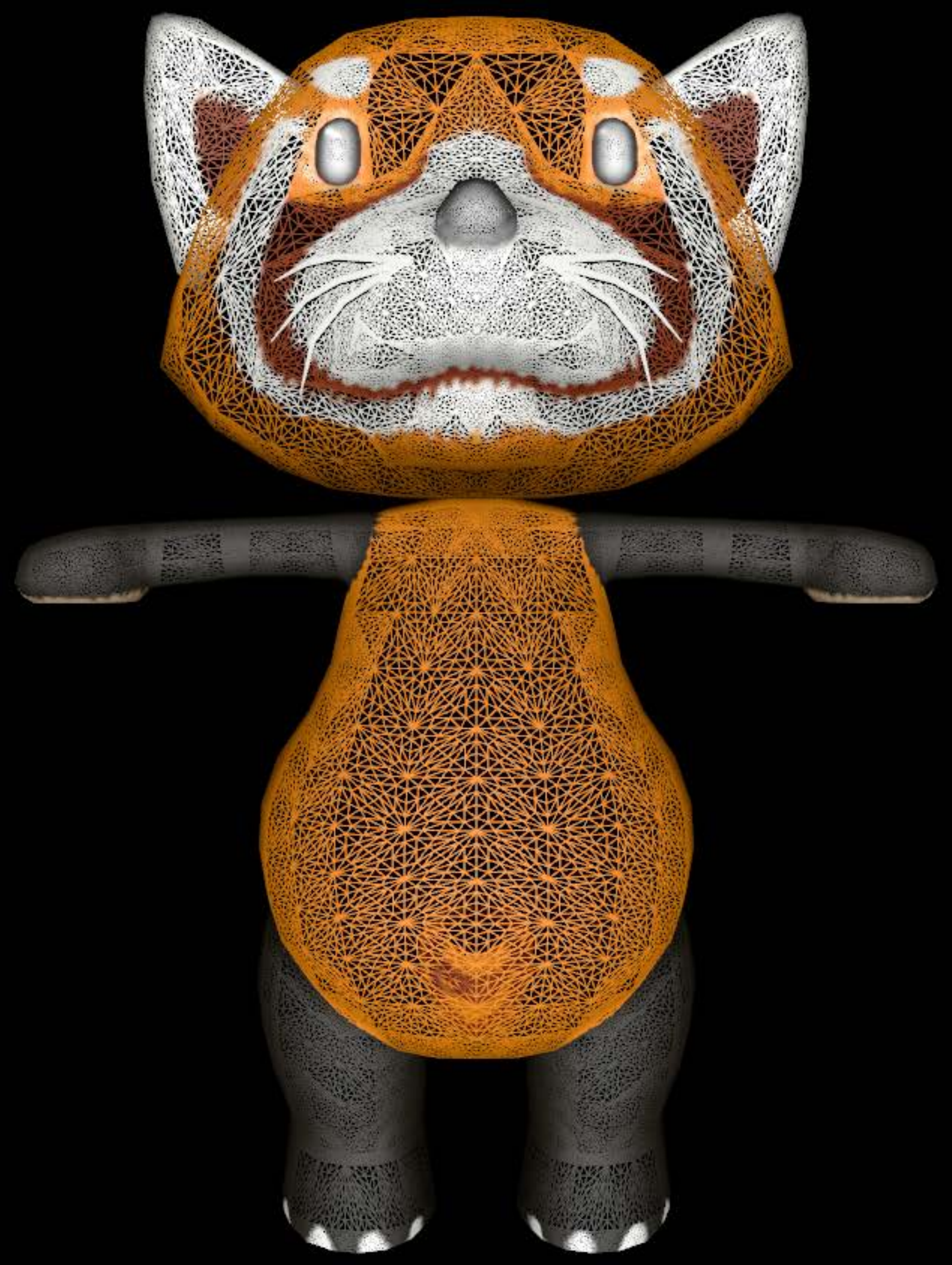
```
let tessellator = SCNGeometryTessellator()
geometry.tessellator = tessellator
```

Tessellation

Uniform tessellation

NEW

```swift
let tessellator = SCNGeometryTessellator()
geometry.tessellator = tessellator

// Uniform tessellation
tessellator.edgeTessellationFactor = 3.0
tessellator.insideTessellationFactor = 3.0
```

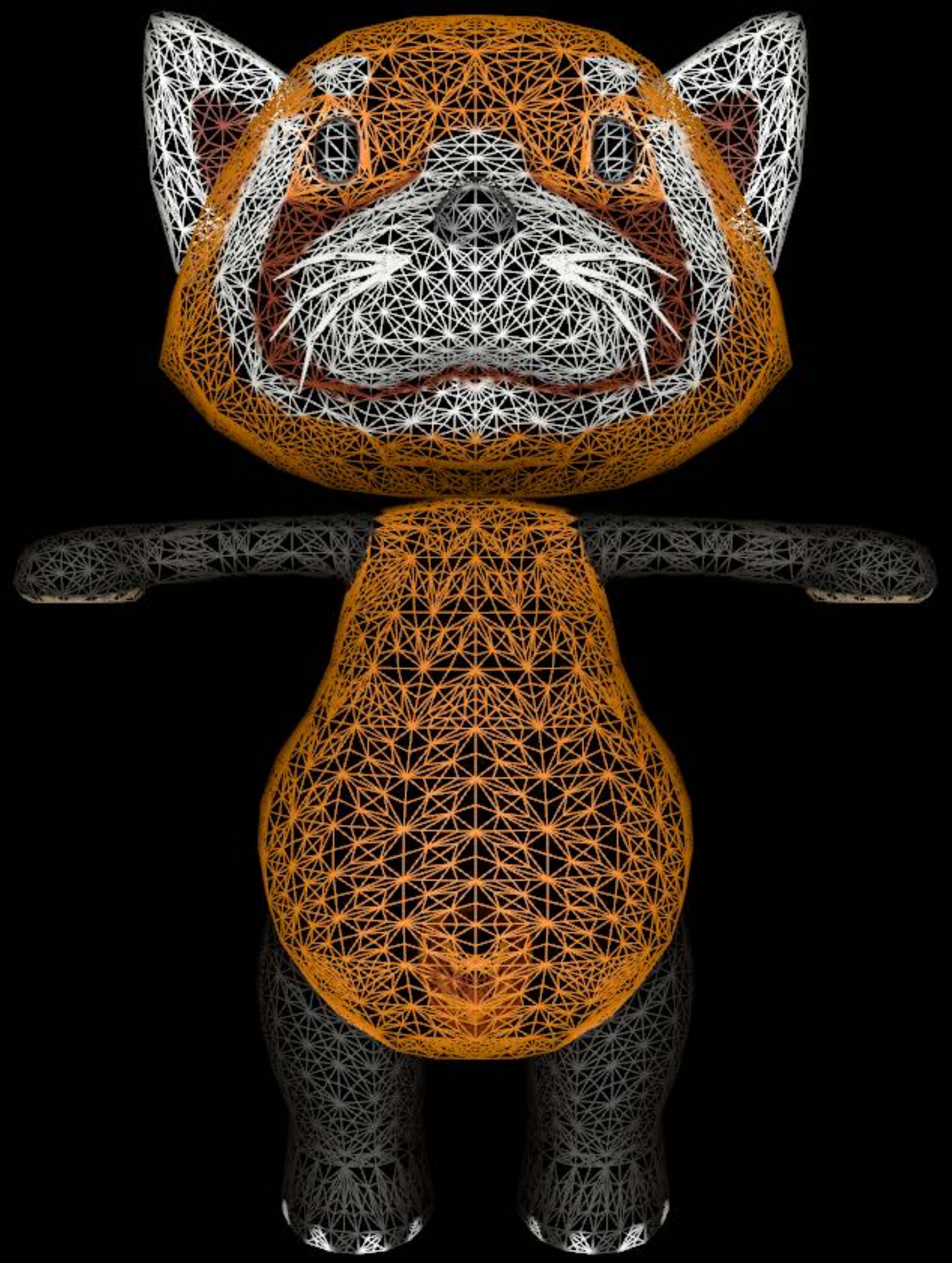


Tessellation

Local space tessellation

NEW

```
let tessellator = SCNGeometryTessellator()
geometry.tessellator = tessellator

// Local space tessellation
tessellator.isAdaptive = true
tessellator.maximumEdgeLength = 0.01 // in local space
```

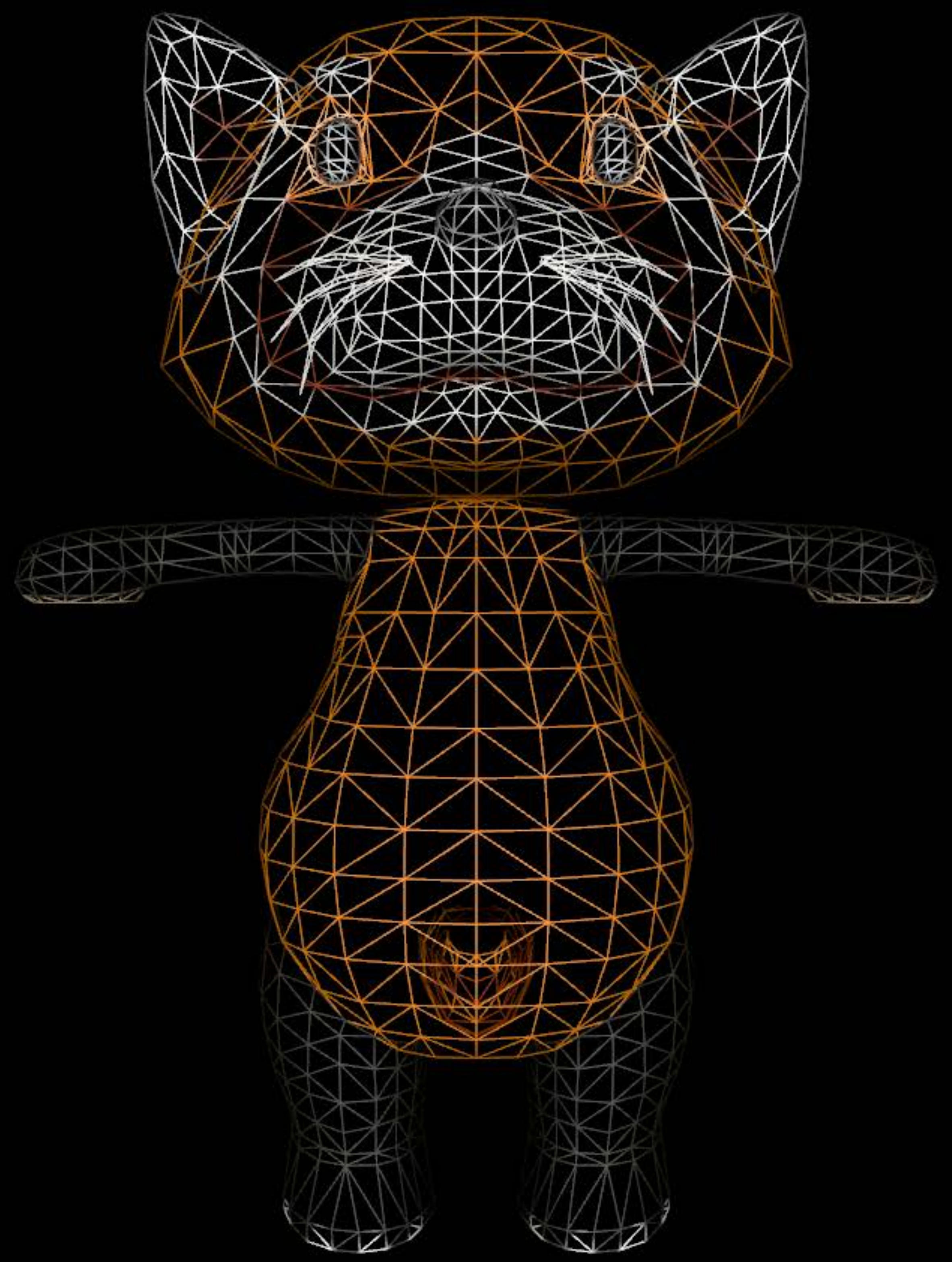


Tessellation

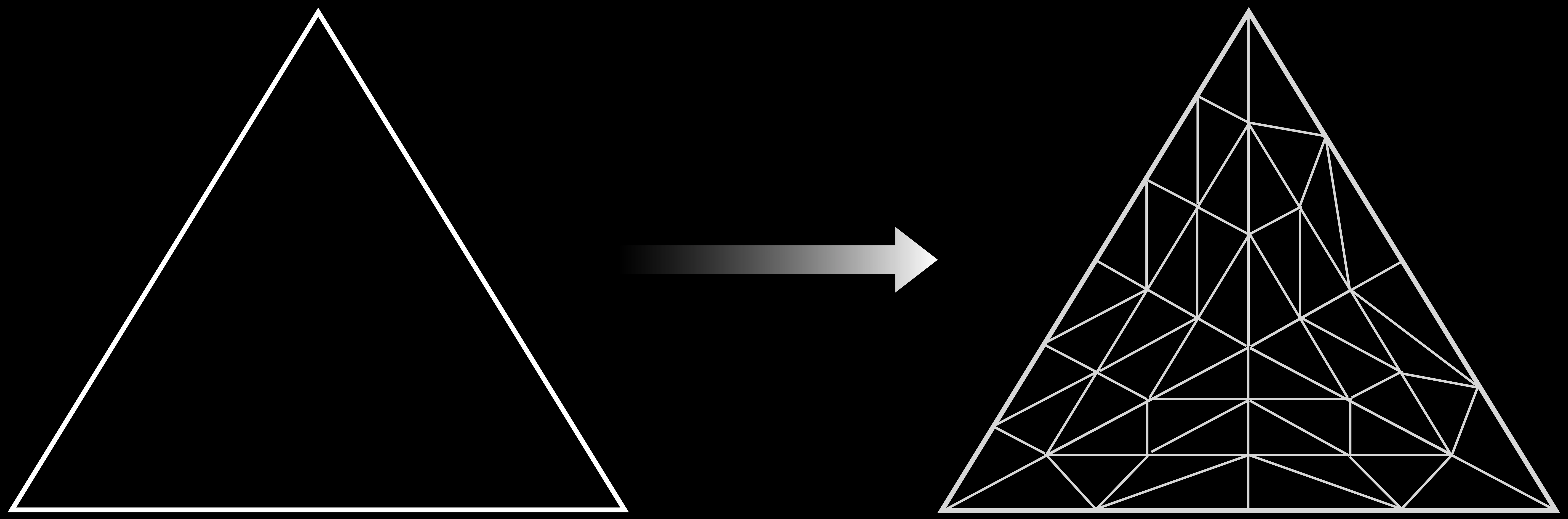
Screen space tessellation

NEW

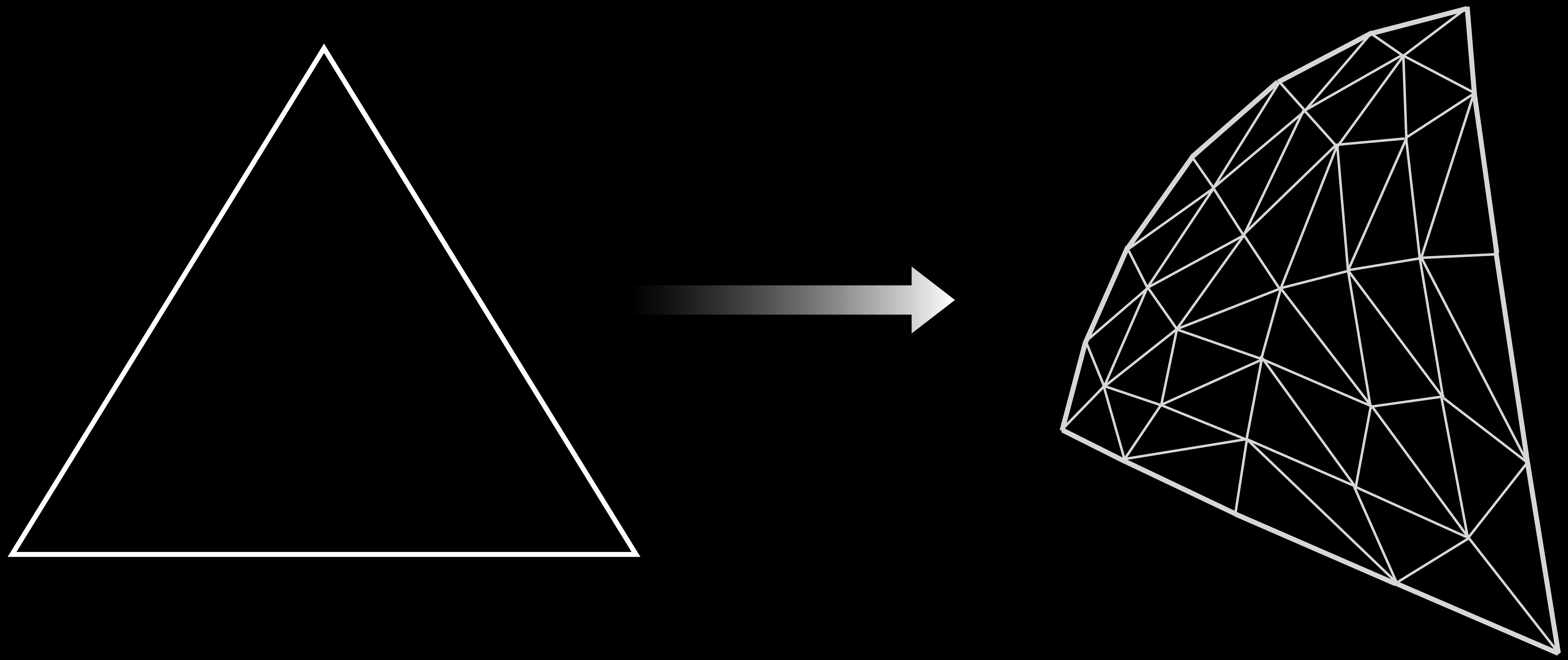
```
let tessellator = SCNGeometryTessellator()
geometry.tessellator = tessellator

// Screen space tessellation
tessellator.isAdaptive = true
tessellator.isScreenSpace = true
tessellator.maximumEdgeLength = 50 // pixels
```



Tessellation



Tessellation



Tessellation and Subdivision Surfaces

Tessellation overview

New tessellation-based geometry APIs

Subdivision surfaces

Shader Modifiers

Fully supported in tessellation pipeline

Allow for completely custom effects

```
// Shader modifier for the "geometry" entry point
float3 p = _geometry.position.xyz;
float disp = sin(p.x + 5.0 * scn_frame.time) * cos(p.y + 2.5 * scn_frame.time);
_geometry.position.xyz += _geometry.normal * disp;
```

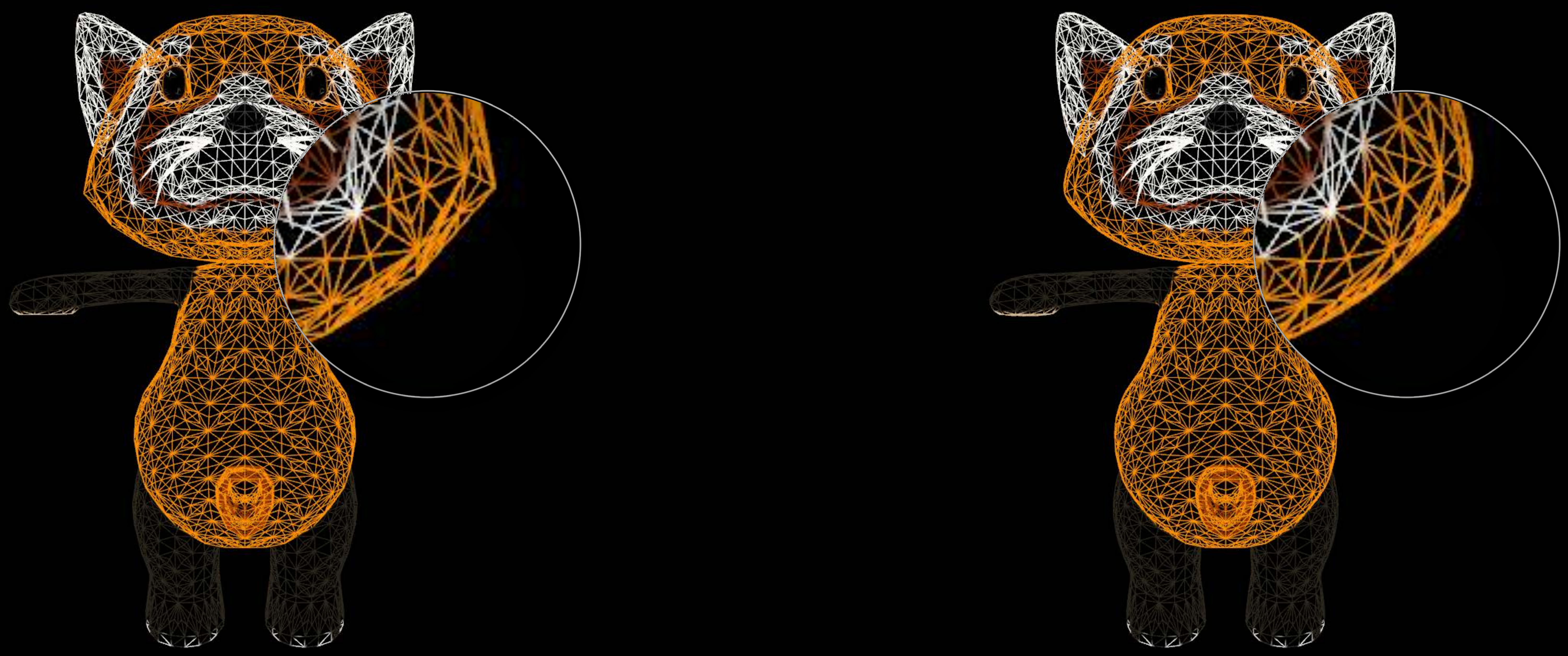
Geometry Smoothing

NEW

```
// Geometry smoothing
tessellator.smoothingMode = .pnTriangles
```

Geometry Smoothing

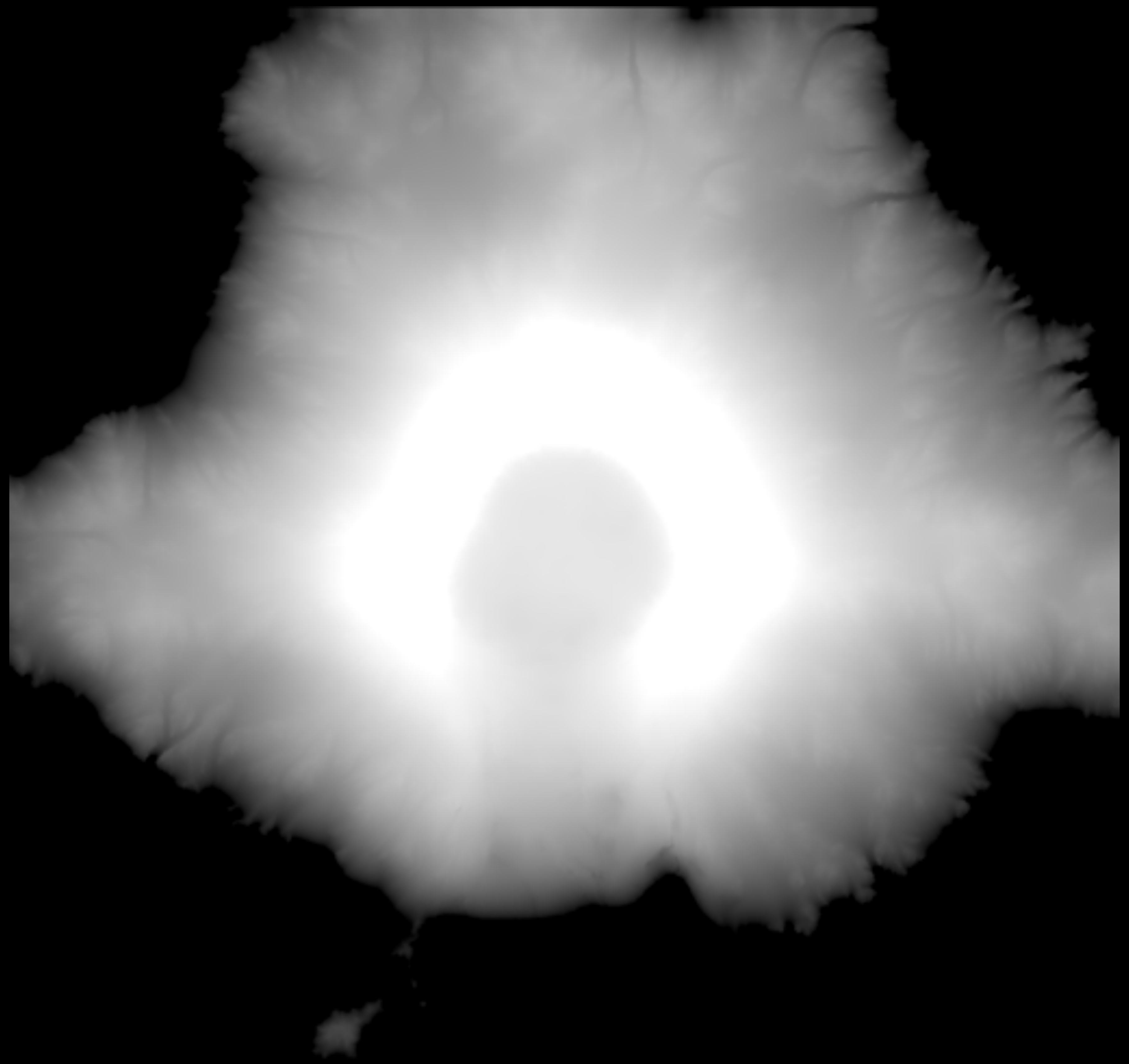
NEW



```
// Geometry smoothing
tessellator.smoothingMode = .pnTriangles
```

Displacement Mapping

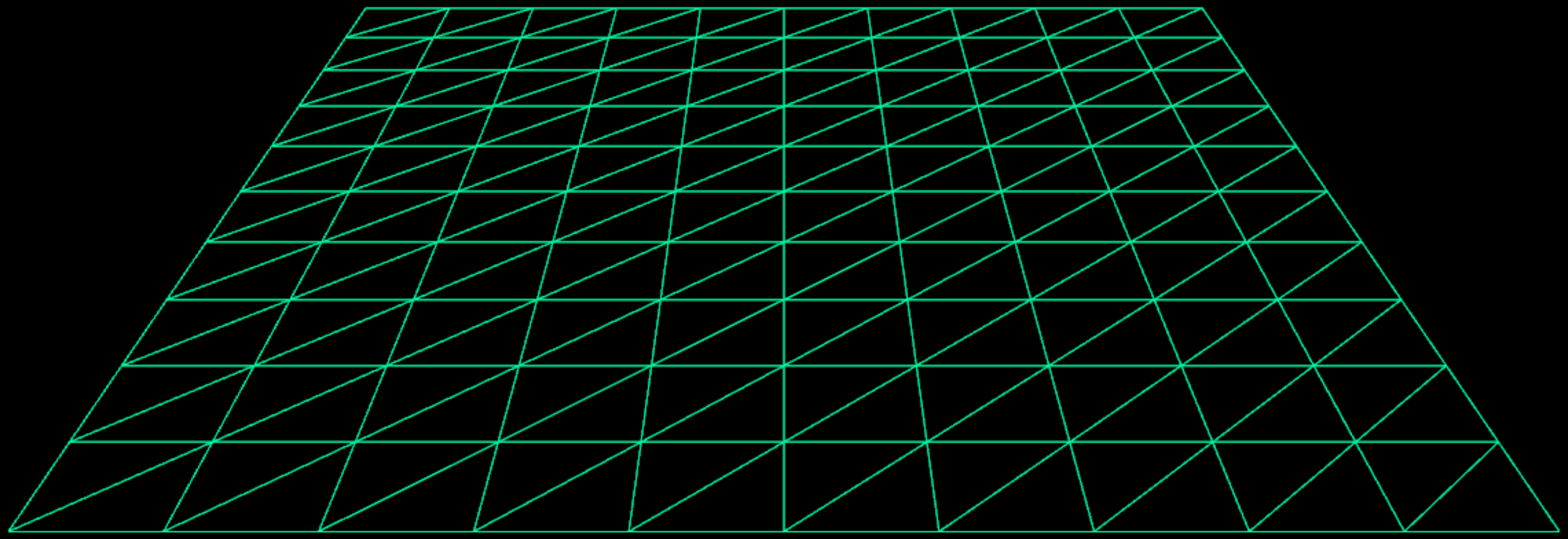
NEW



Displacement Mapping

Height maps

NEW



Displacement Mapping

Height maps

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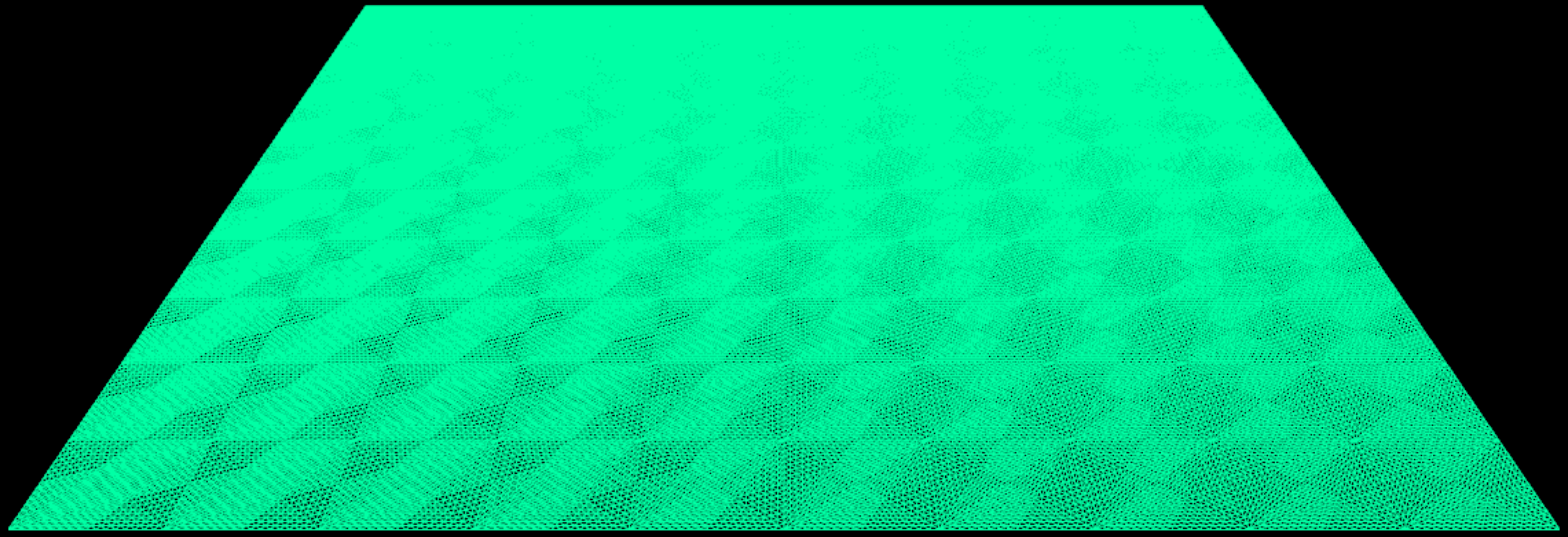
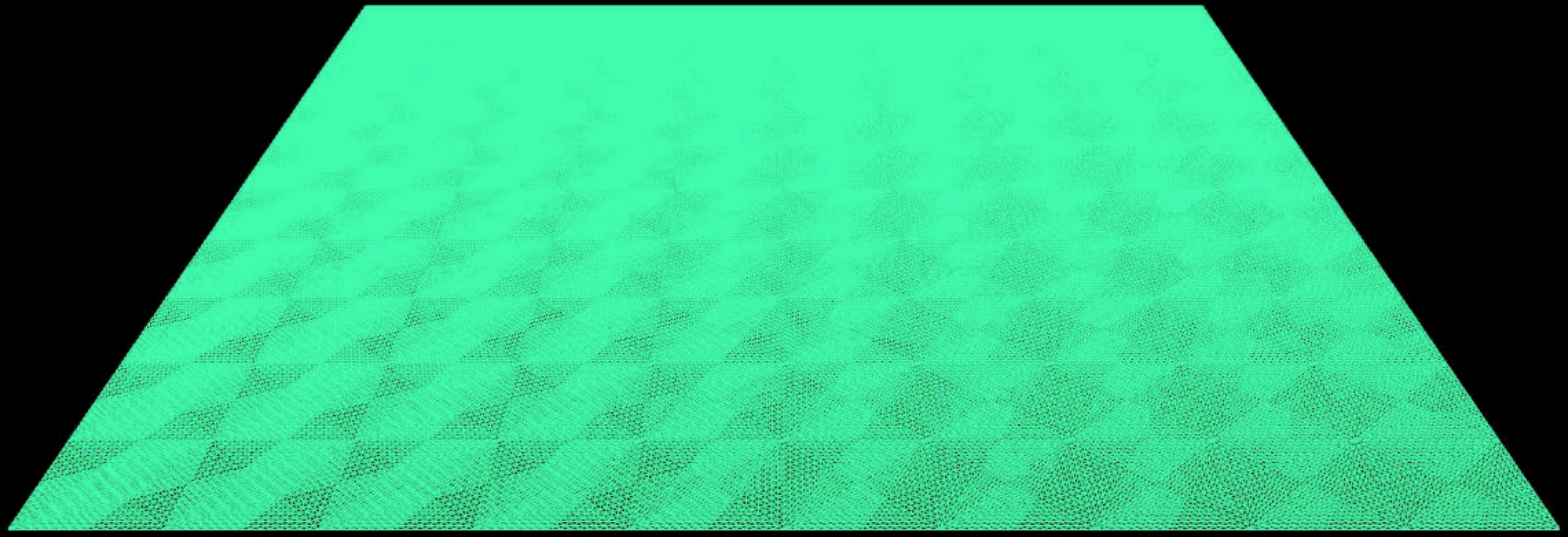


Displacement Mapping

Height maps

NEW



Displacement Mapping

Height maps

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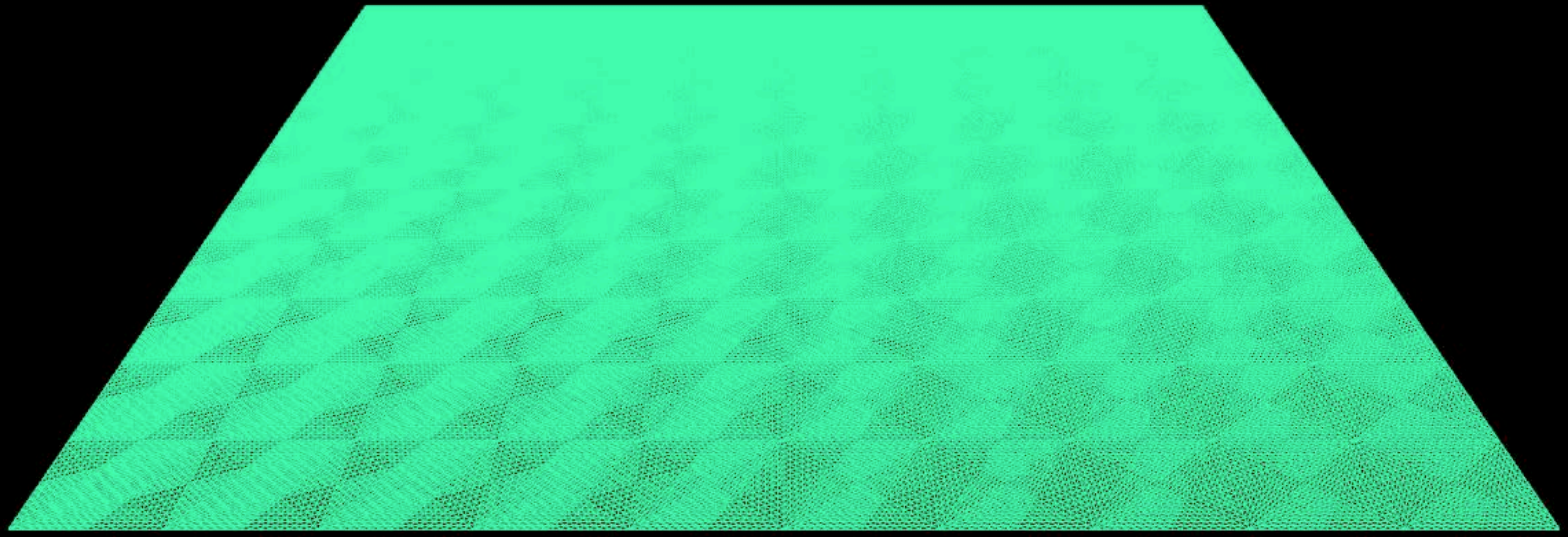

Displacement Mapping

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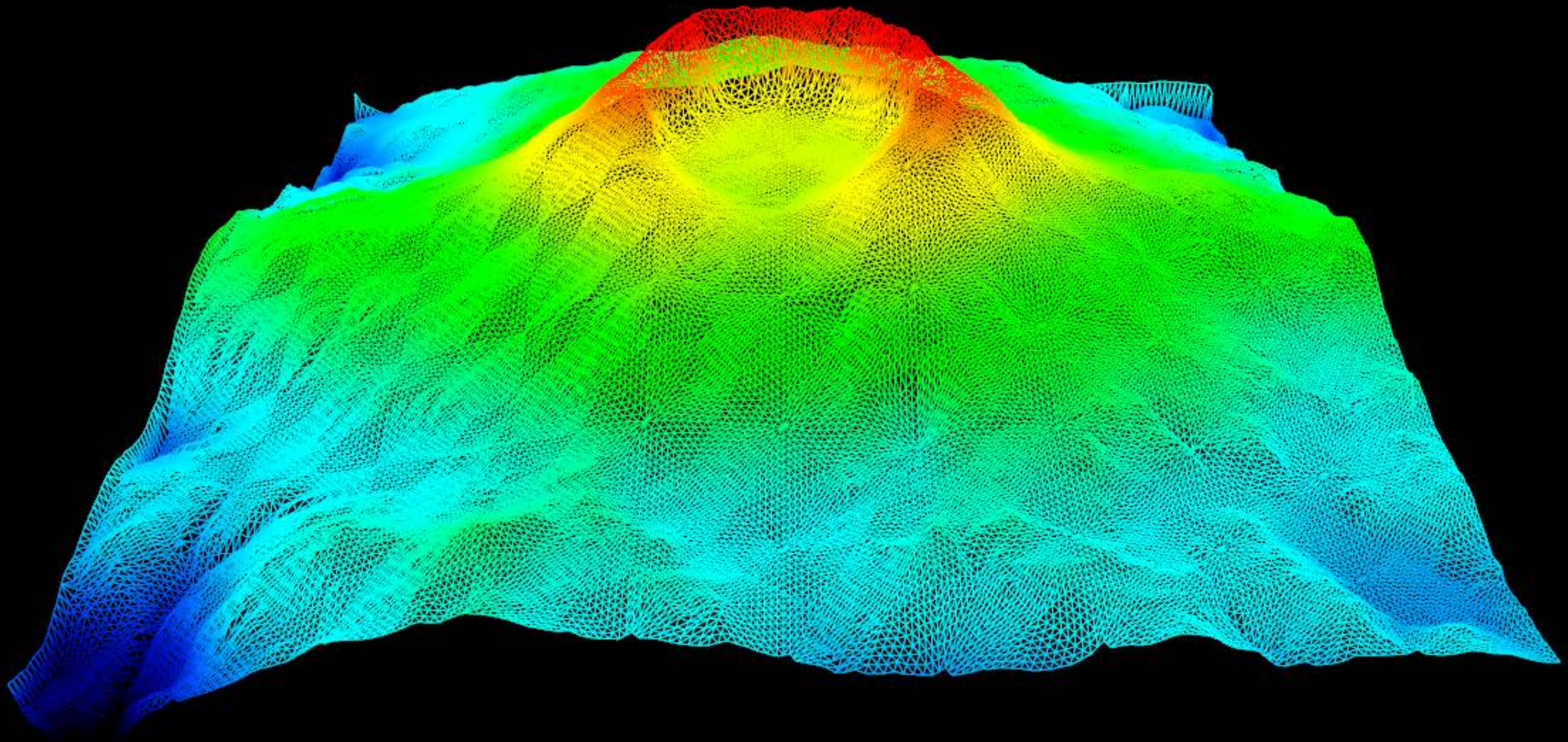


NEW

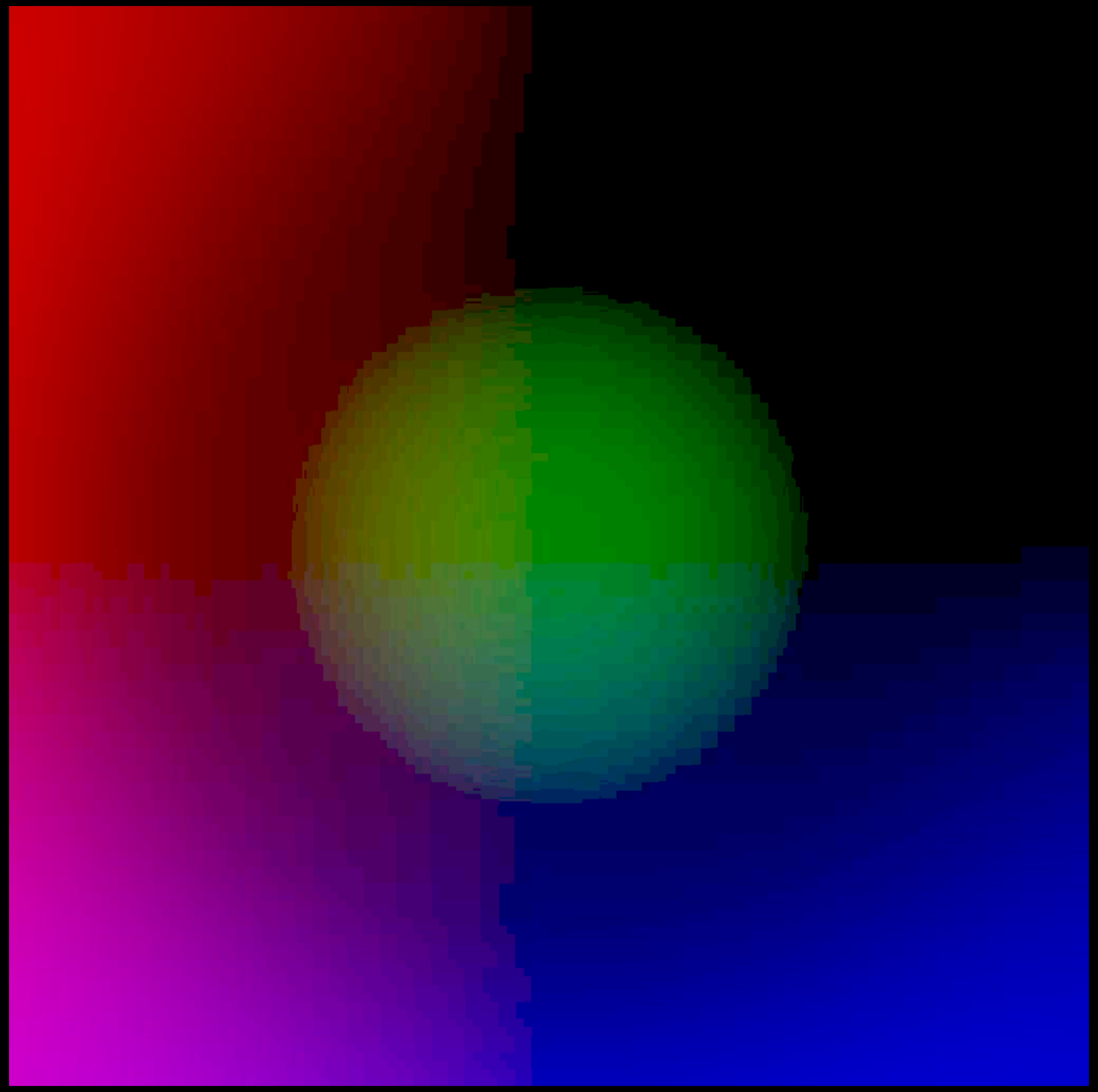
```
//Displacement Mapping

// Height map
material.displacement.contents = "volcano-height-map.png"
material.displacement.textureComponents = .red
```

Displacement Mapping

Vector displacement maps

NEW



Displacement Mapping

Vector displacement maps

NEW

Displacement Mapping

Vector displacement maps

NEW

Displacement Mapping

Vector displacement maps

NEW

NEW

```
//Displacement Mapping

// Vector displacement map
material.displacement.contents = "water-drop-displacement-map.exr"
material.displacement.textureComponents = .all
```

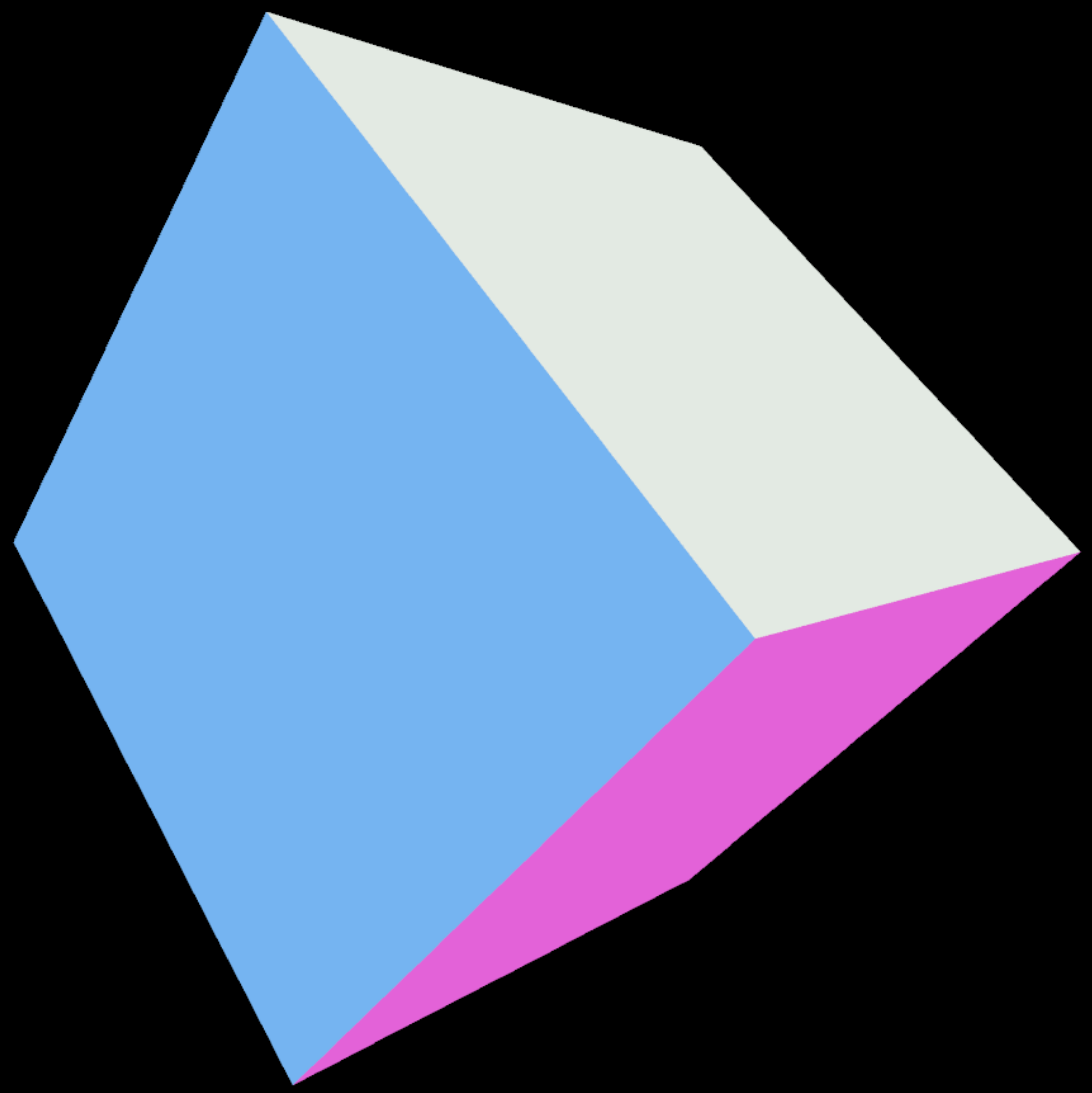
Tessellation and Subdivision Surfaces

Tessellation overview

New tessellation-based geometry APIs

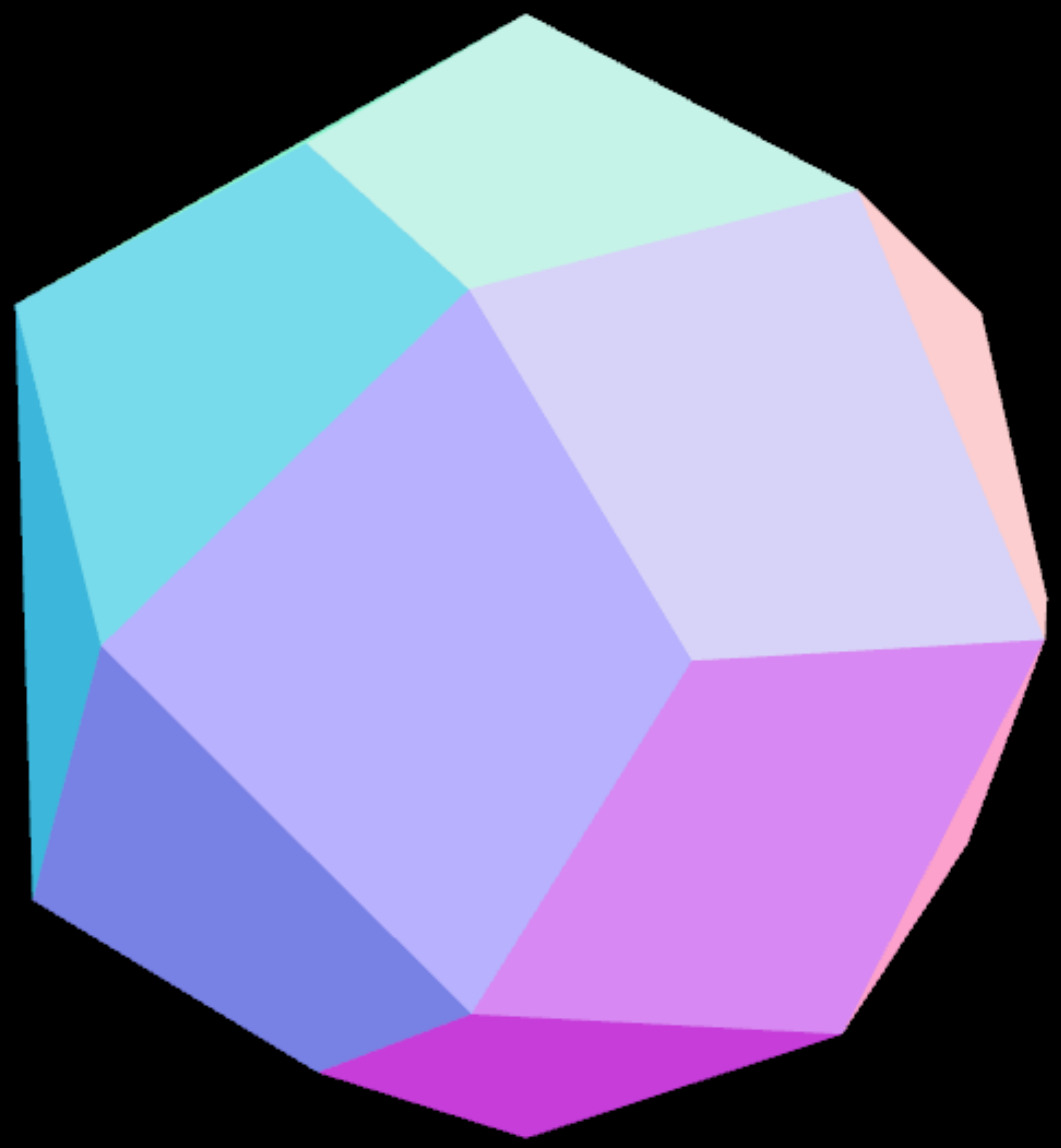
Subdivision surfaces

Subdivision Surfaces



Coarse mesh

Subdivision Surfaces



Subdivision level: 1

Subdivision Surfaces

Subdivision level: 2

Subdivision Surfaces

Subdivision level: 3

Subdivision Surfaces

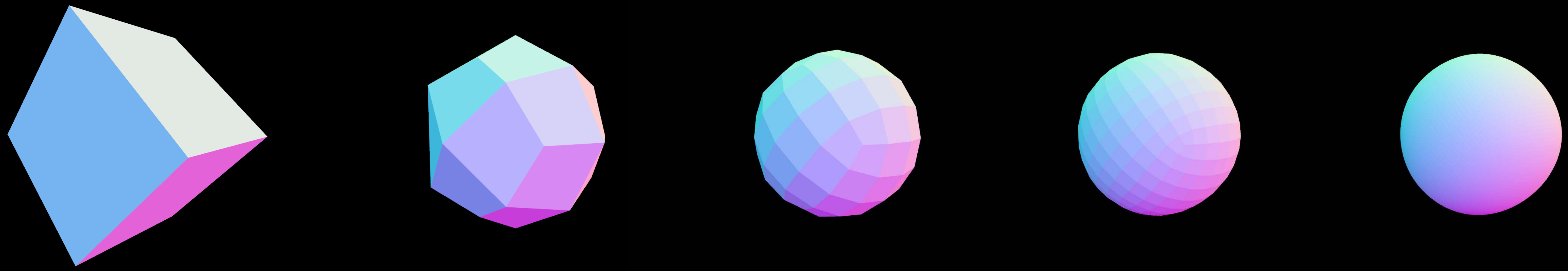
Subdivision level: 4

Subdivision Surfaces

Subdivision level: 5

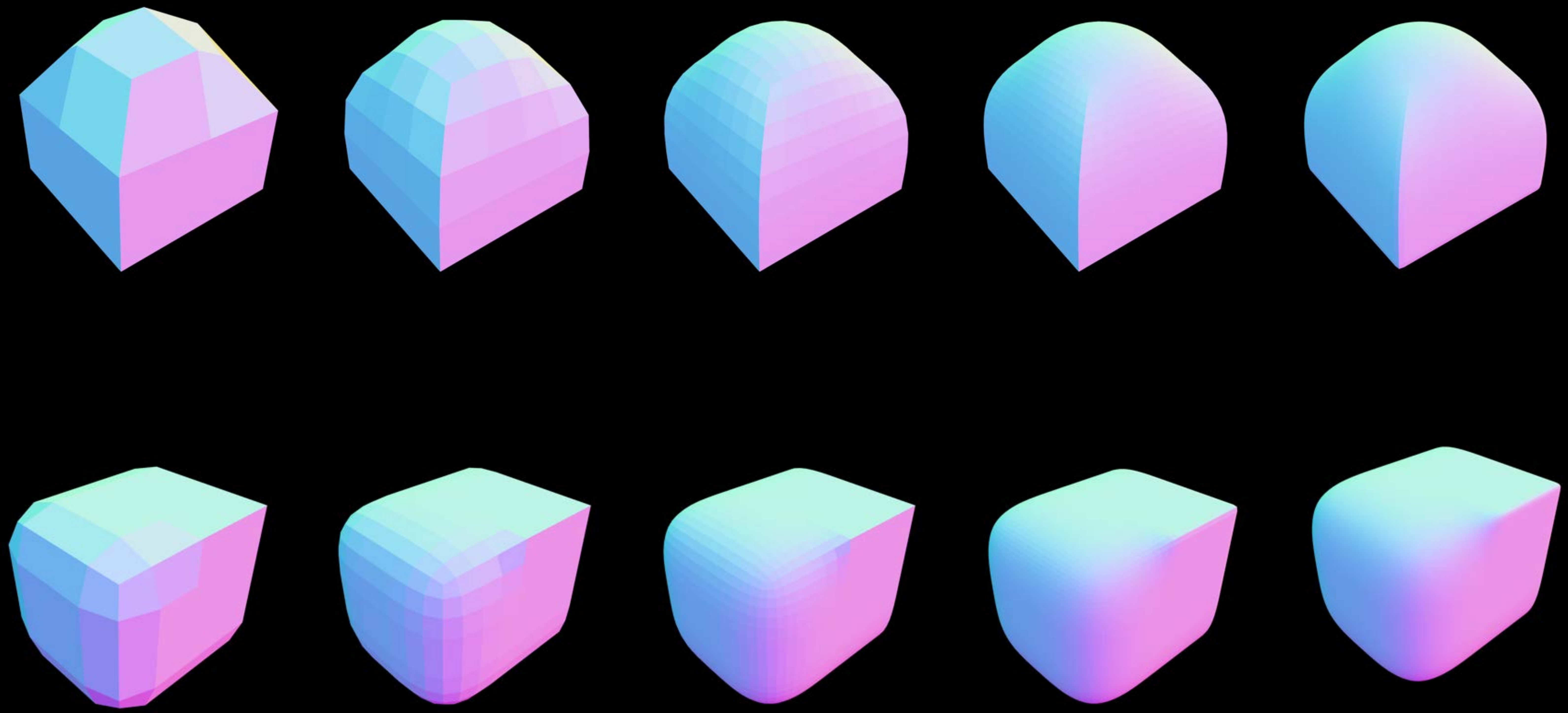
Subdivision Surfaces

Iterative refinement



Subdivision Surfaces

Edge and vertex sharpness



Subdivision Surfaces

Easier and faster to create by artists

Reduced file sizes and faster load times

Dynamic control on quality of rendered geometry

Subdivision Surfaces

Original support for CPU-based subdivision

Better support for per-face data interpolation (e.g. texture coordinates)

```
// Enable subdivision surfaces
geometry.subdivisionLevel = 1
```

OpenSubdiv on Metal

Subdivision Surfaces

NEW

Leverages tessellation with Metal-based GPU backend

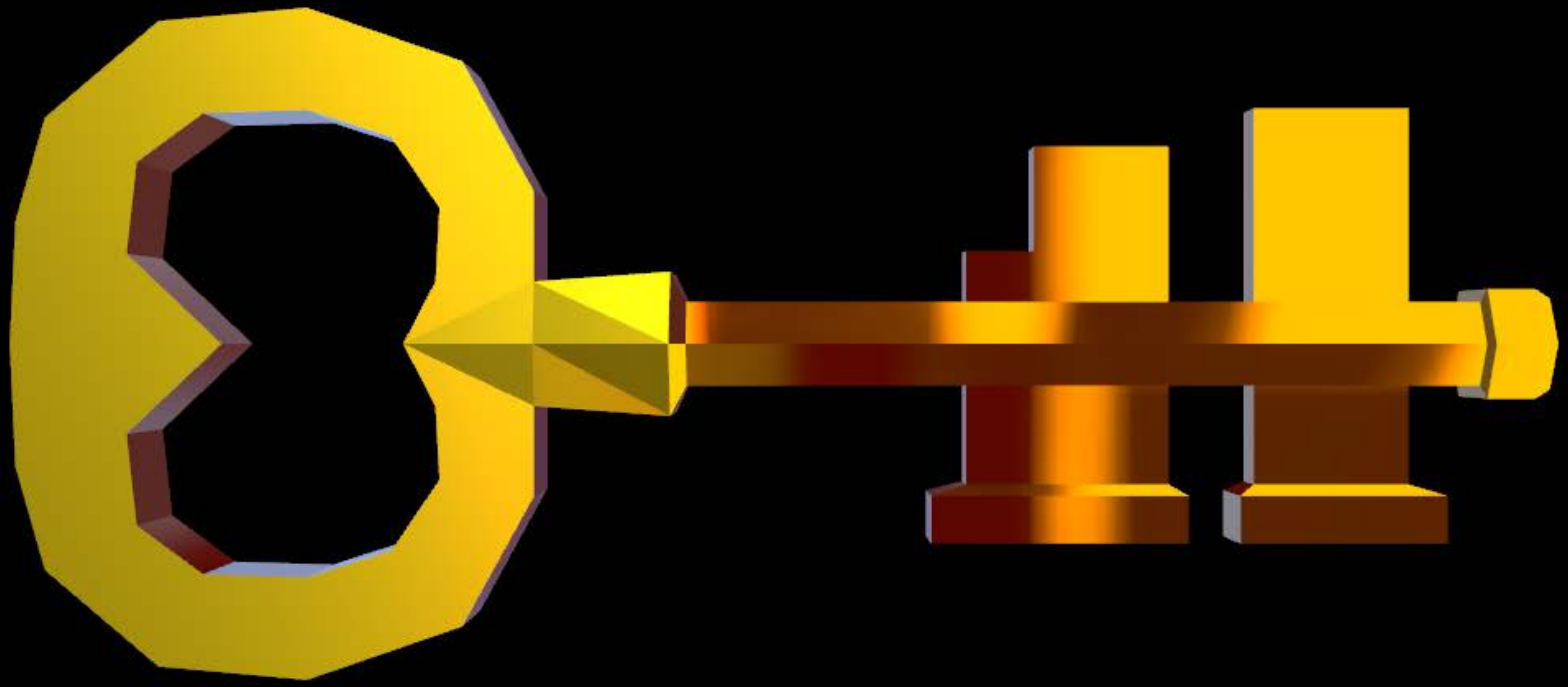
Both uniform and feature-adaptive subdivision are now supported

Efficient implementation for animated models with skinning and morphing

Subdivision Surfaces

Coarse mesh

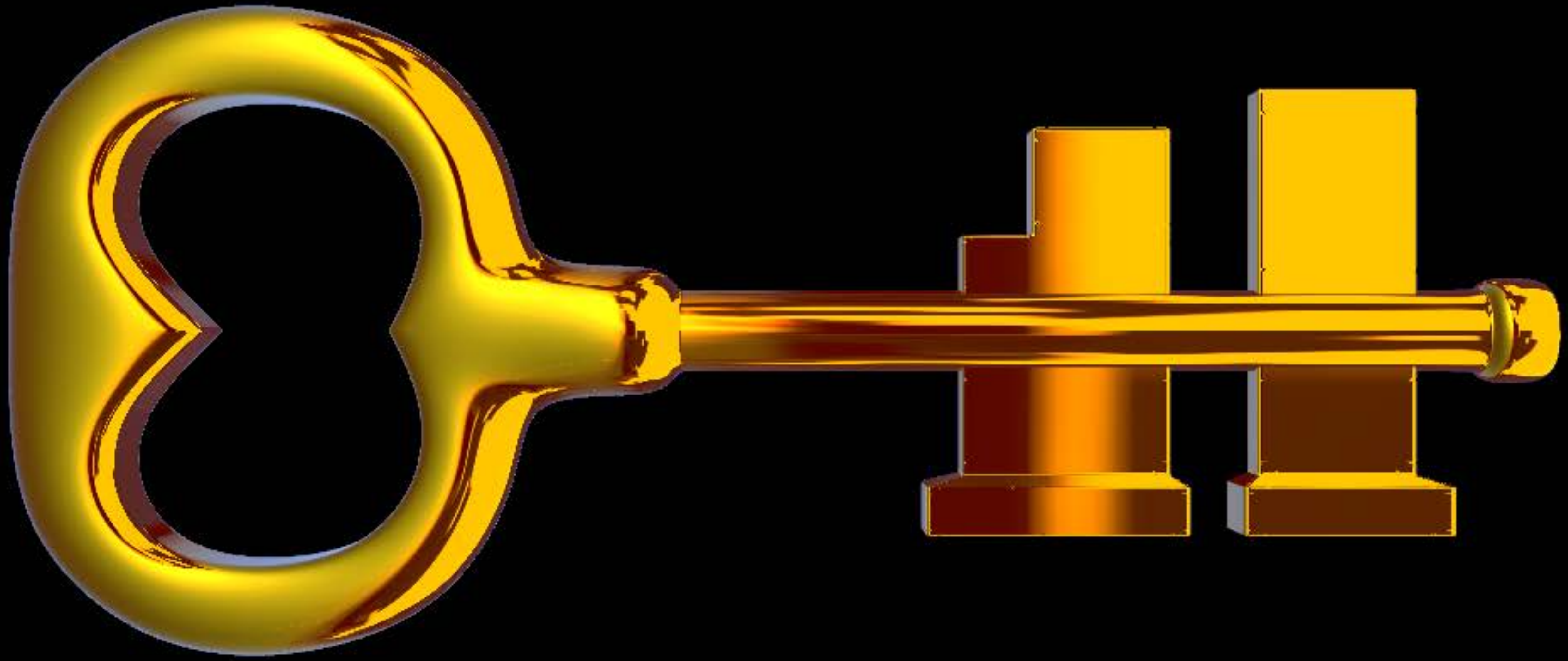
NEW



Subdivision Surfaces

Refined mesh

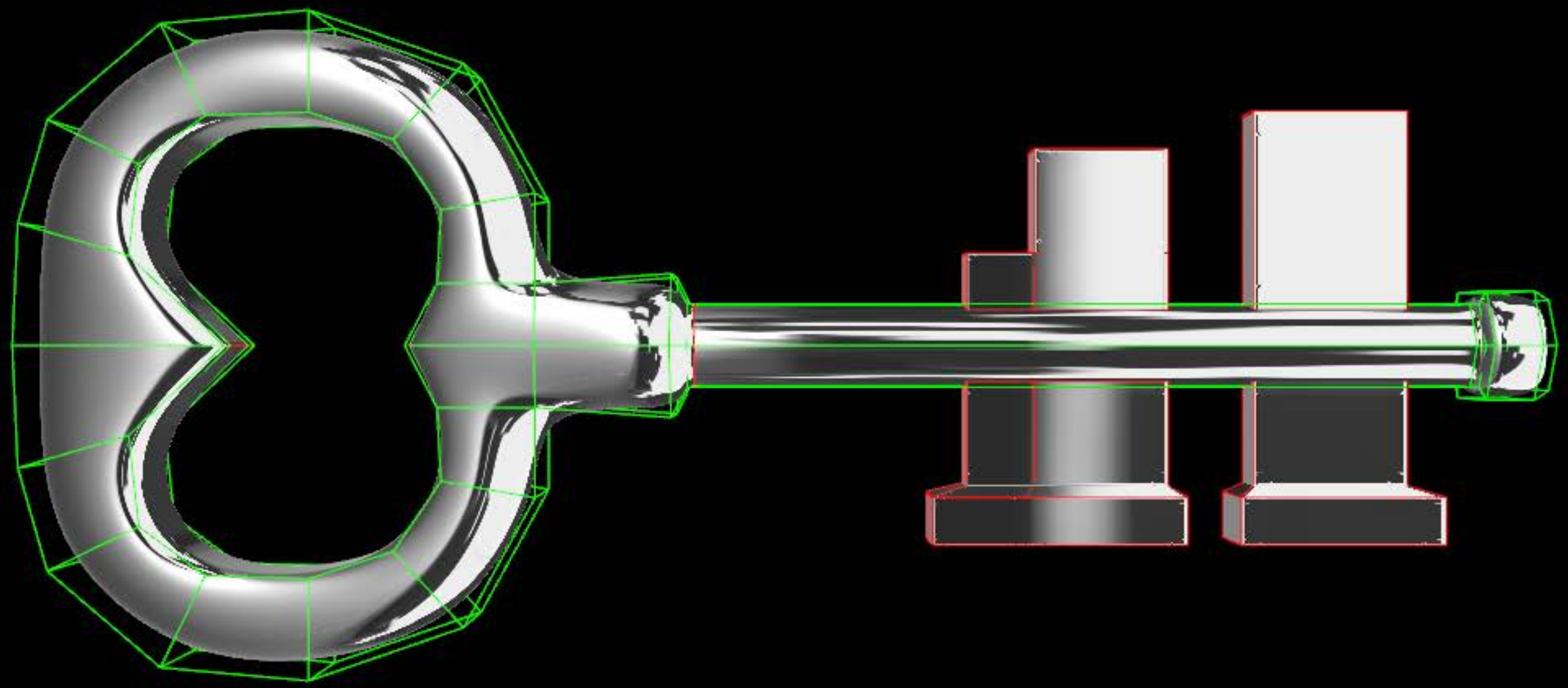
NEW



Subdivision Surfaces

Creases

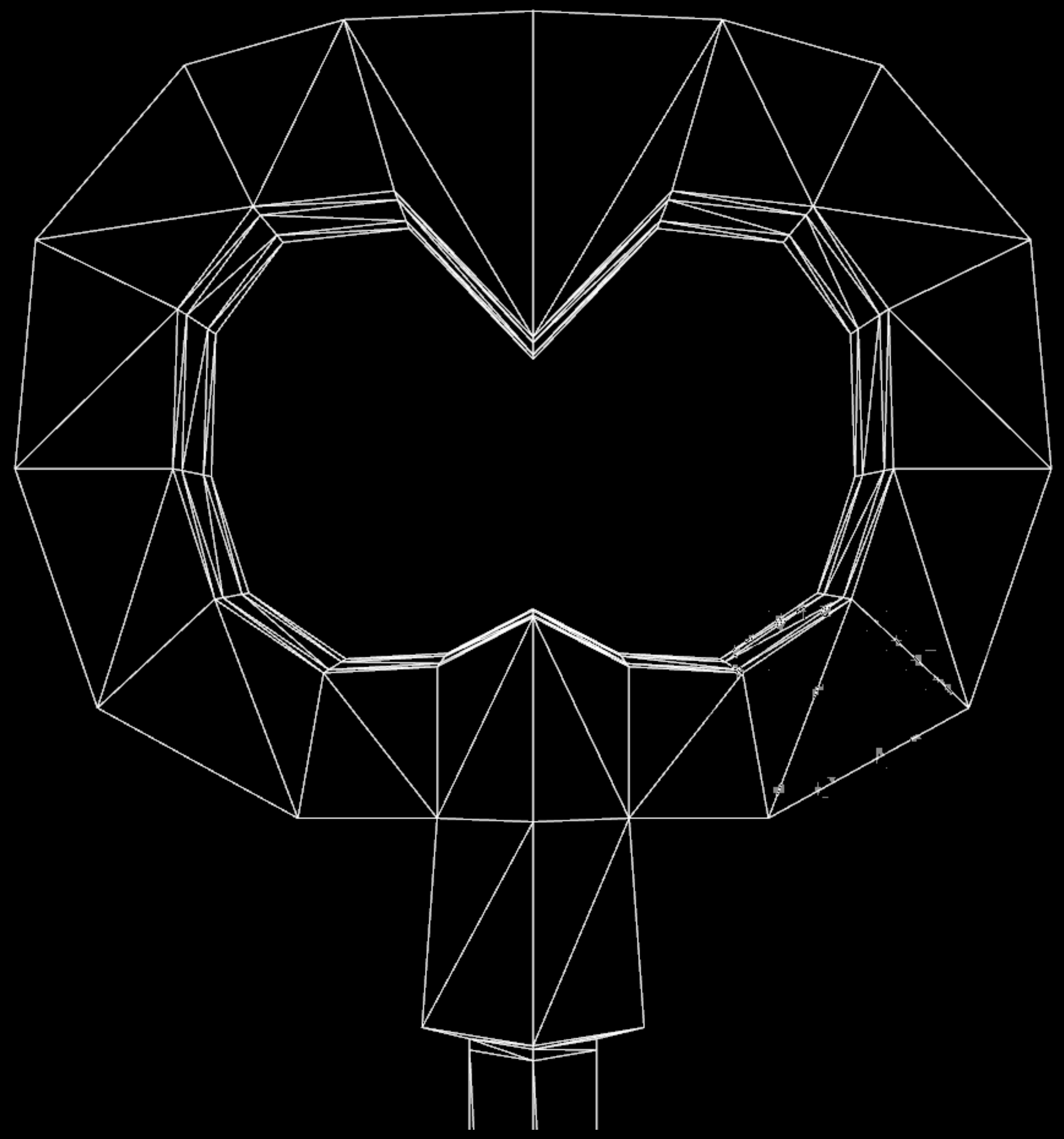
NEW

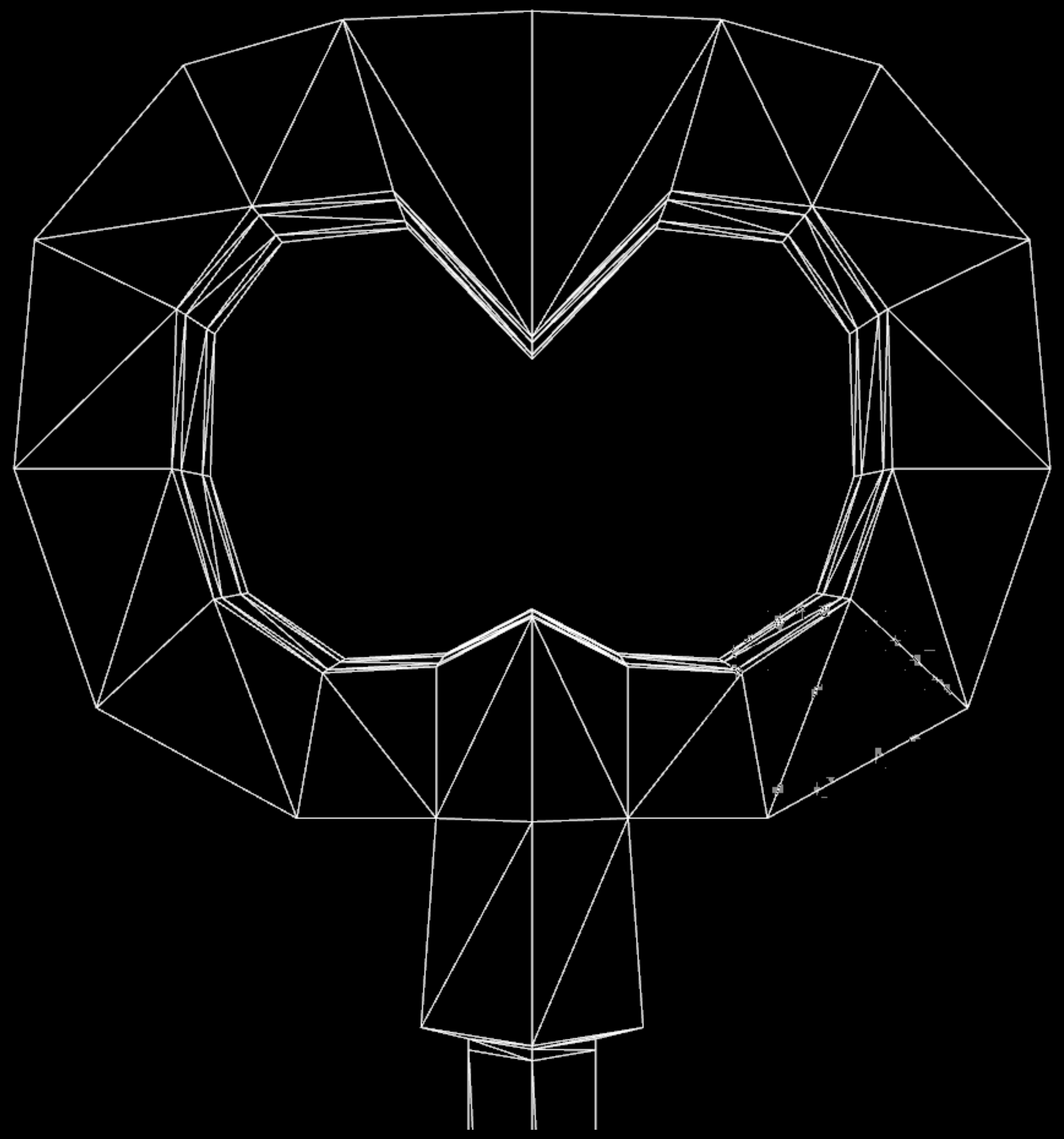


Subdivision Surfaces

Feature-adaptive and uniform subdivision

NEW

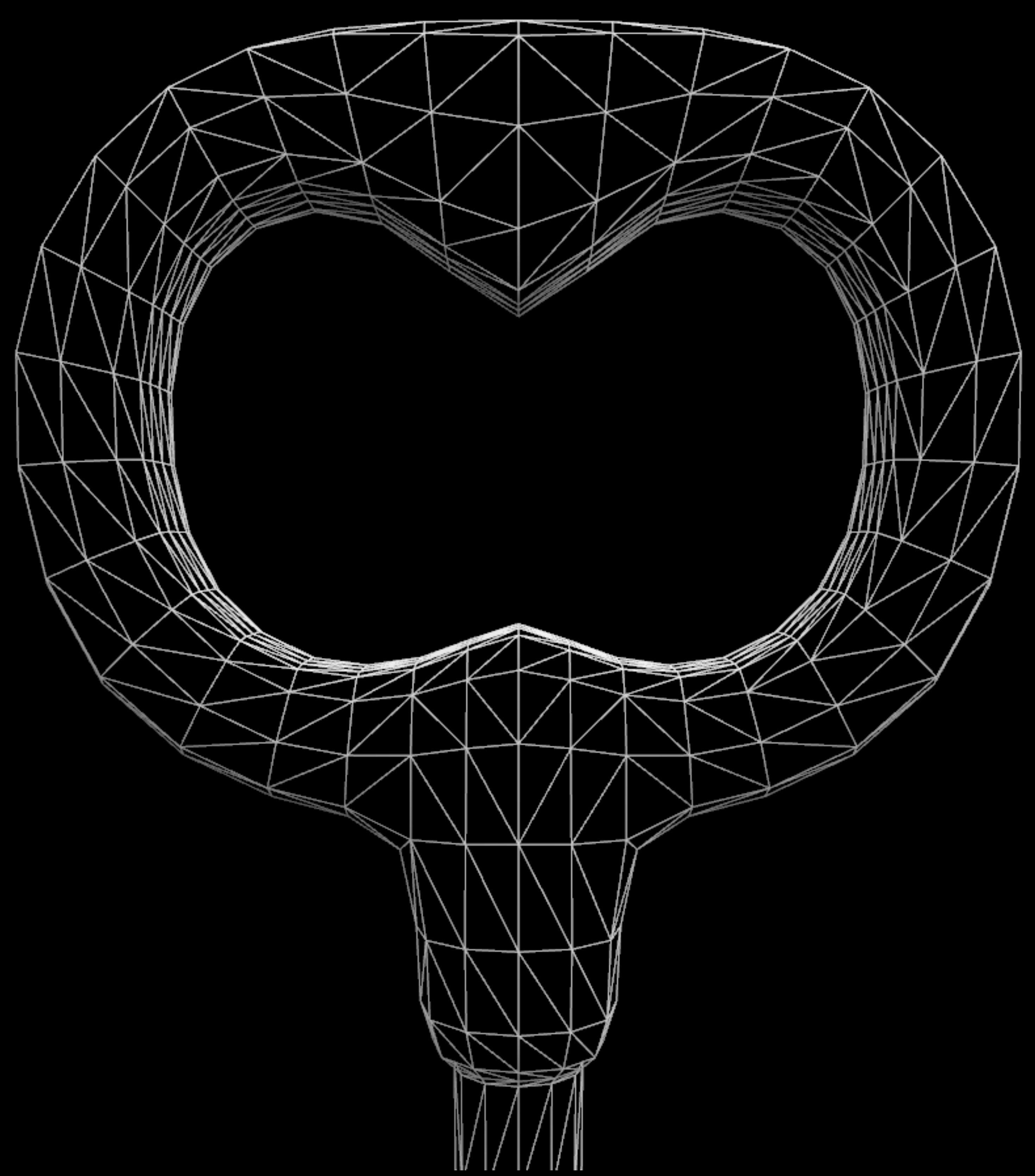


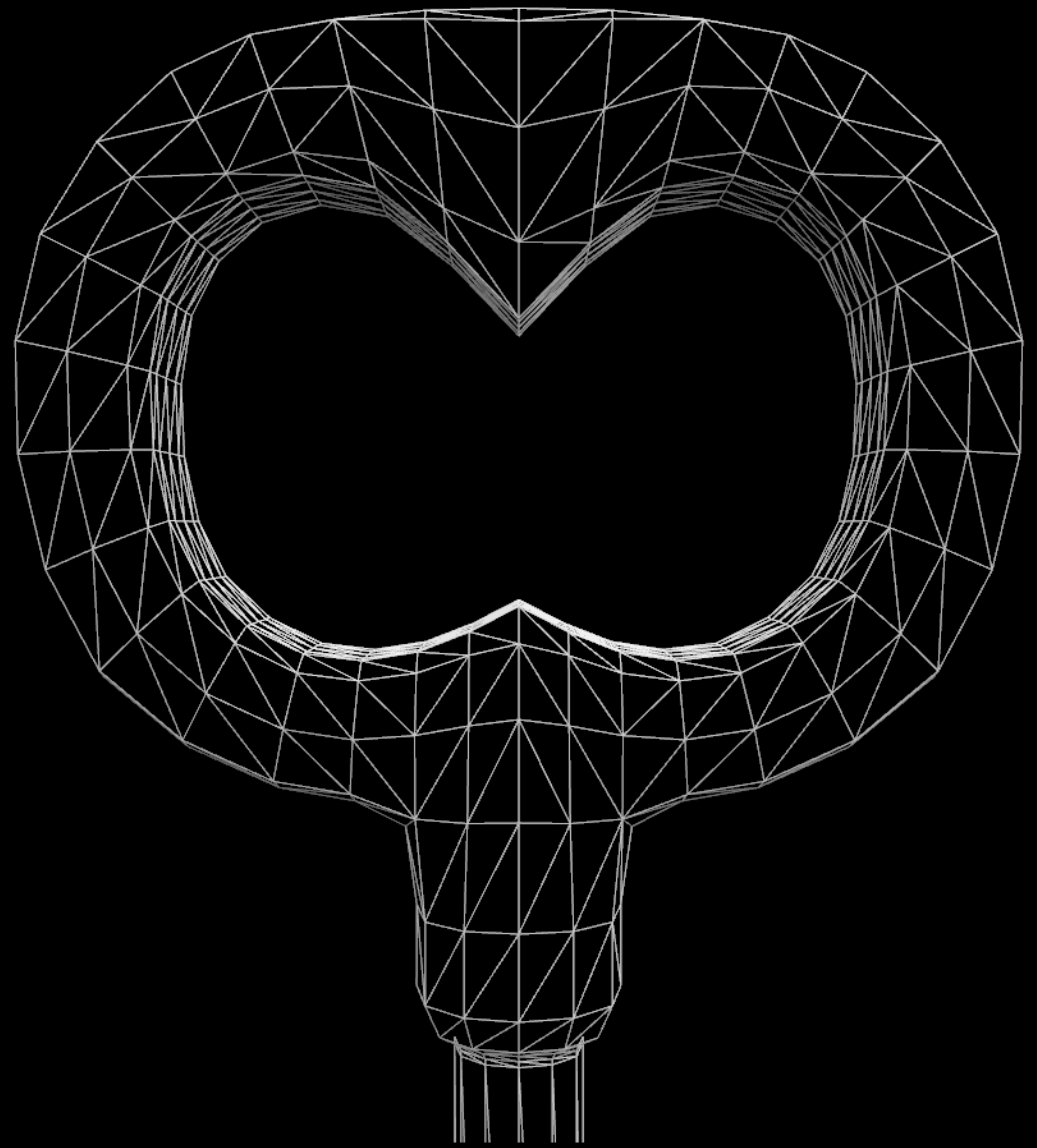


Subdivision Surfaces

Feature-adaptive and uniform subdivision

NEW

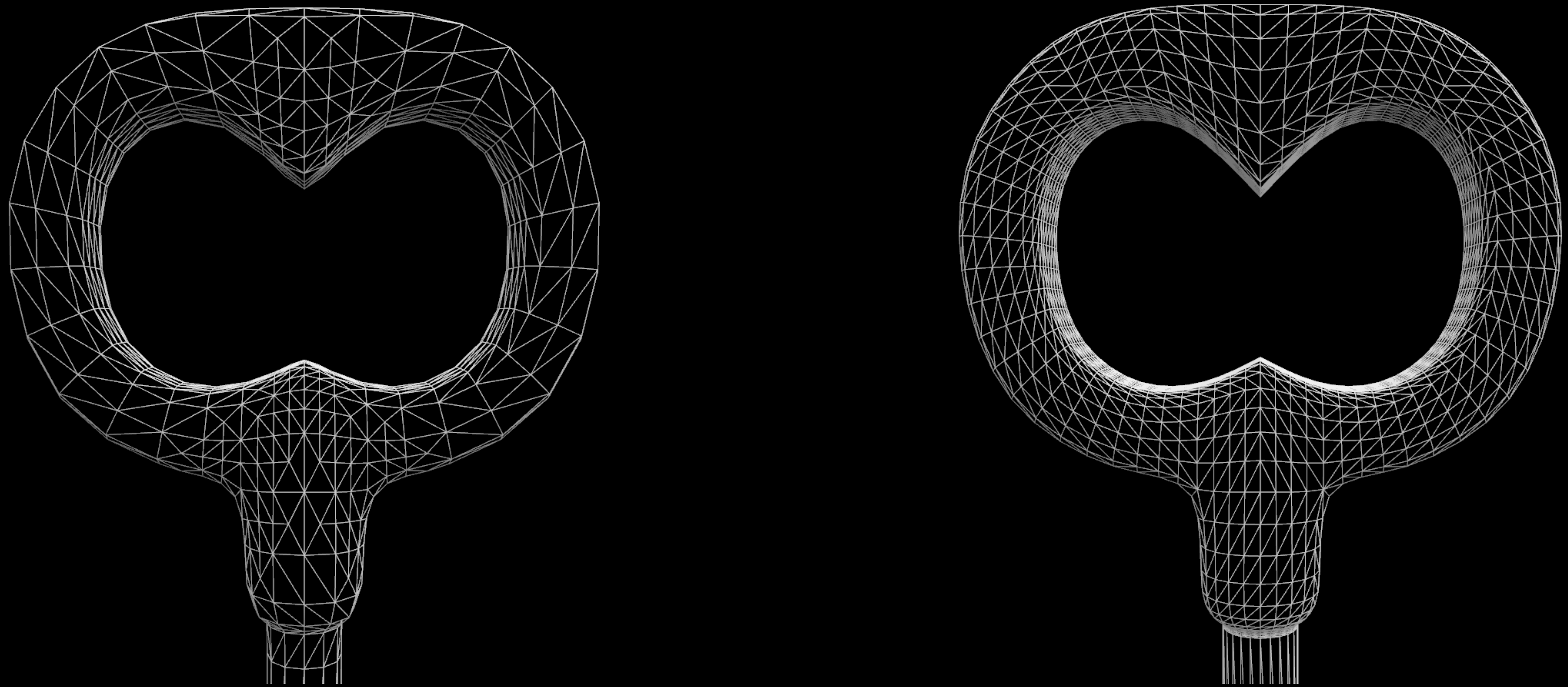




Subdivision Surfaces

Feature-adaptive and uniform subdivision

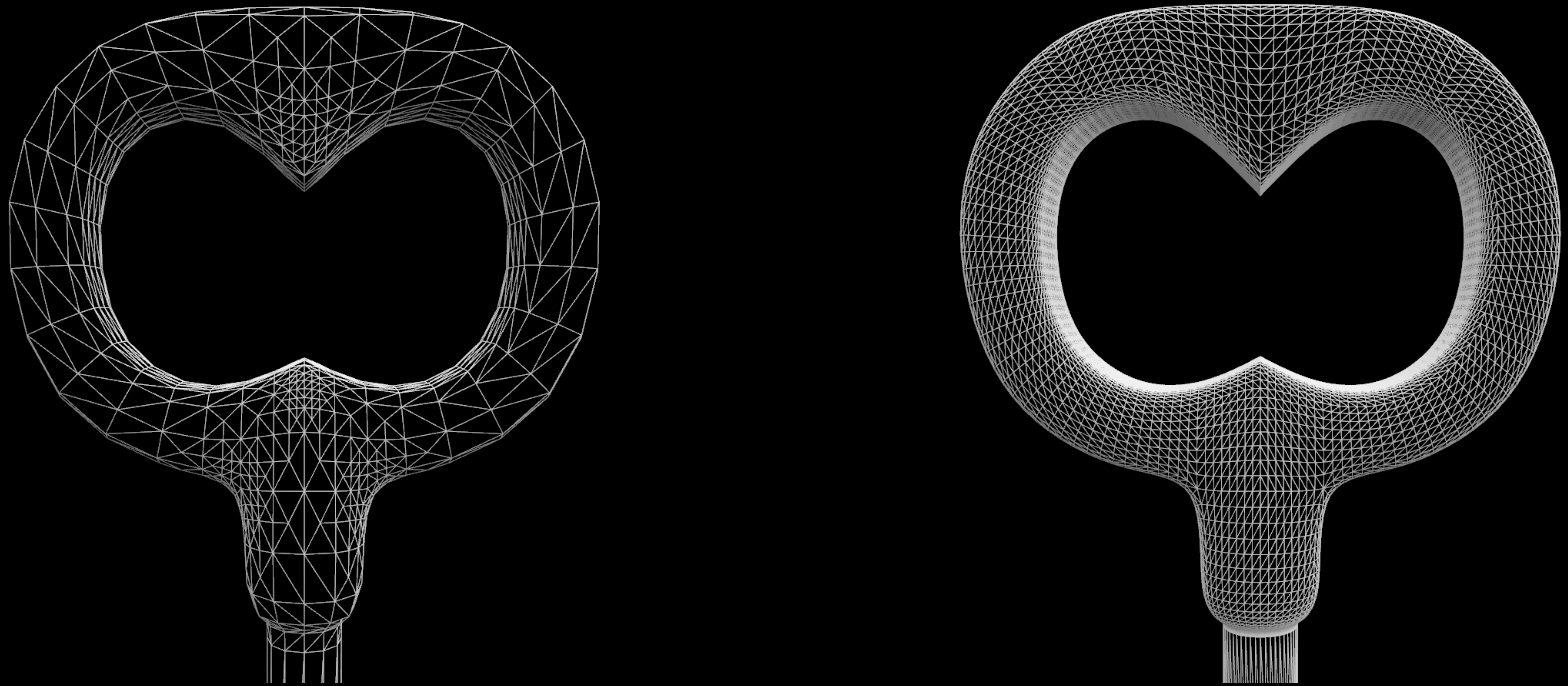
NEW



Subdivision Surfaces

Feature-adaptive and uniform subdivision

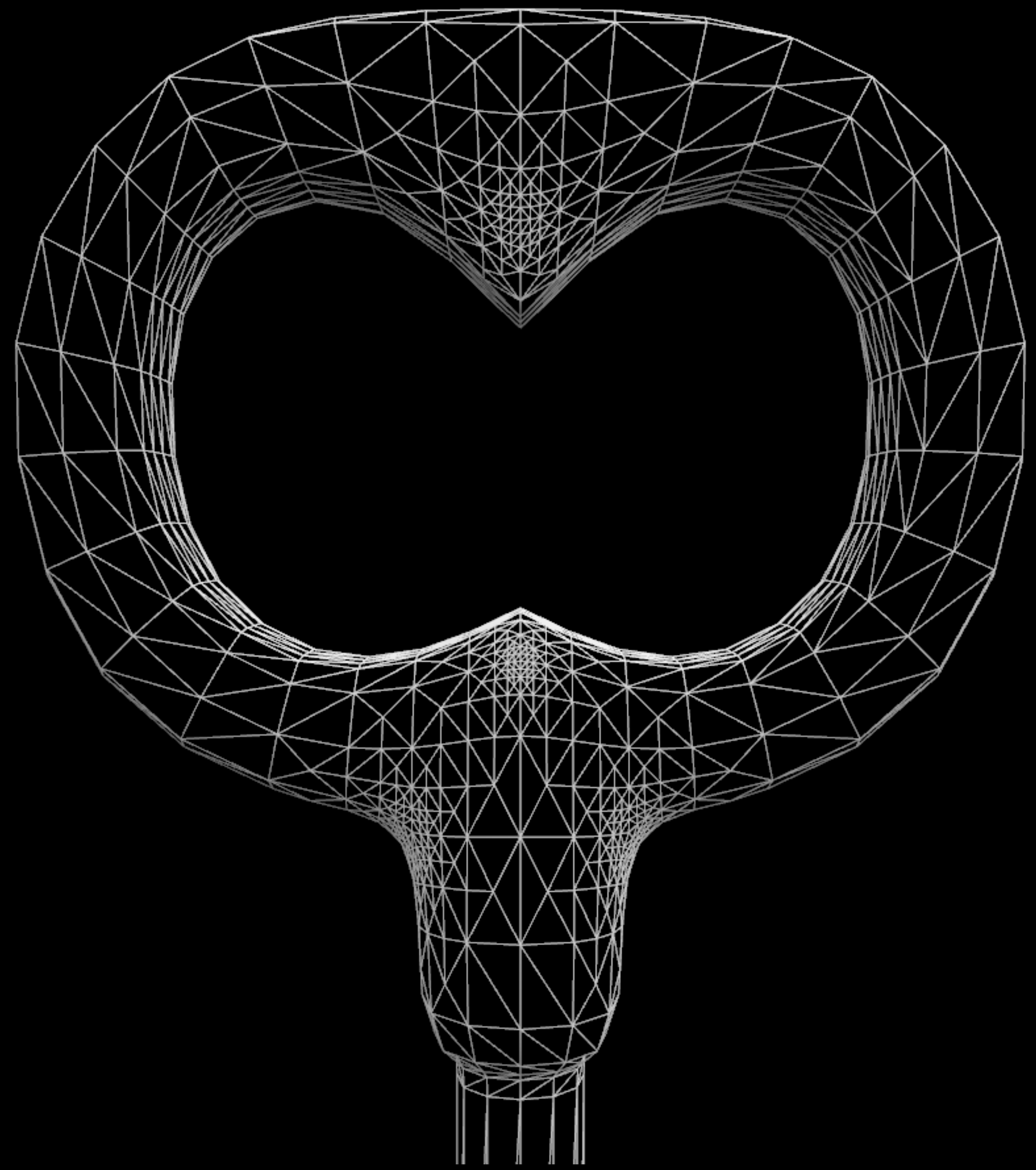
NEW

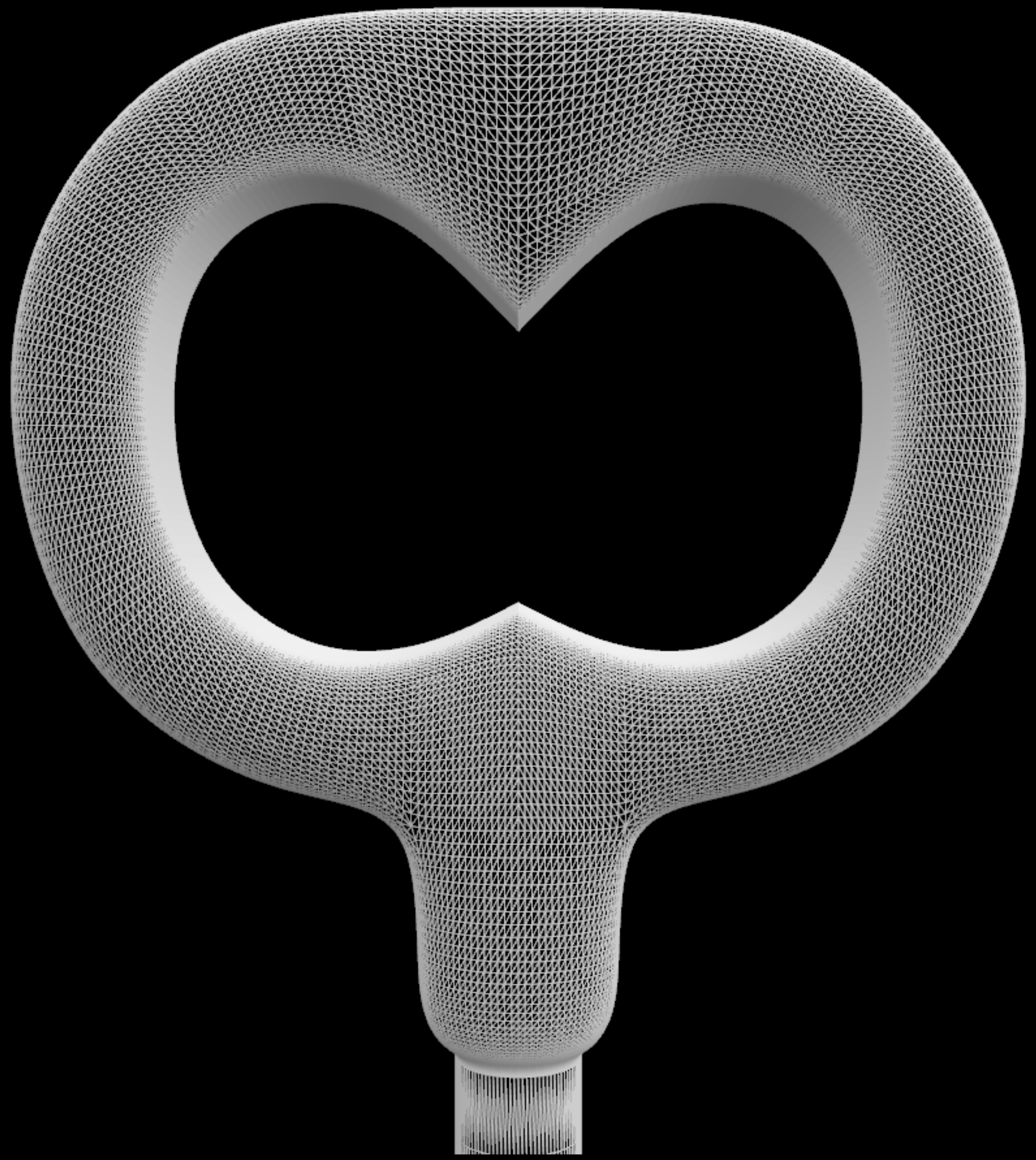


Subdivision Surfaces

Feature-adaptive and uniform subdivision

NEW

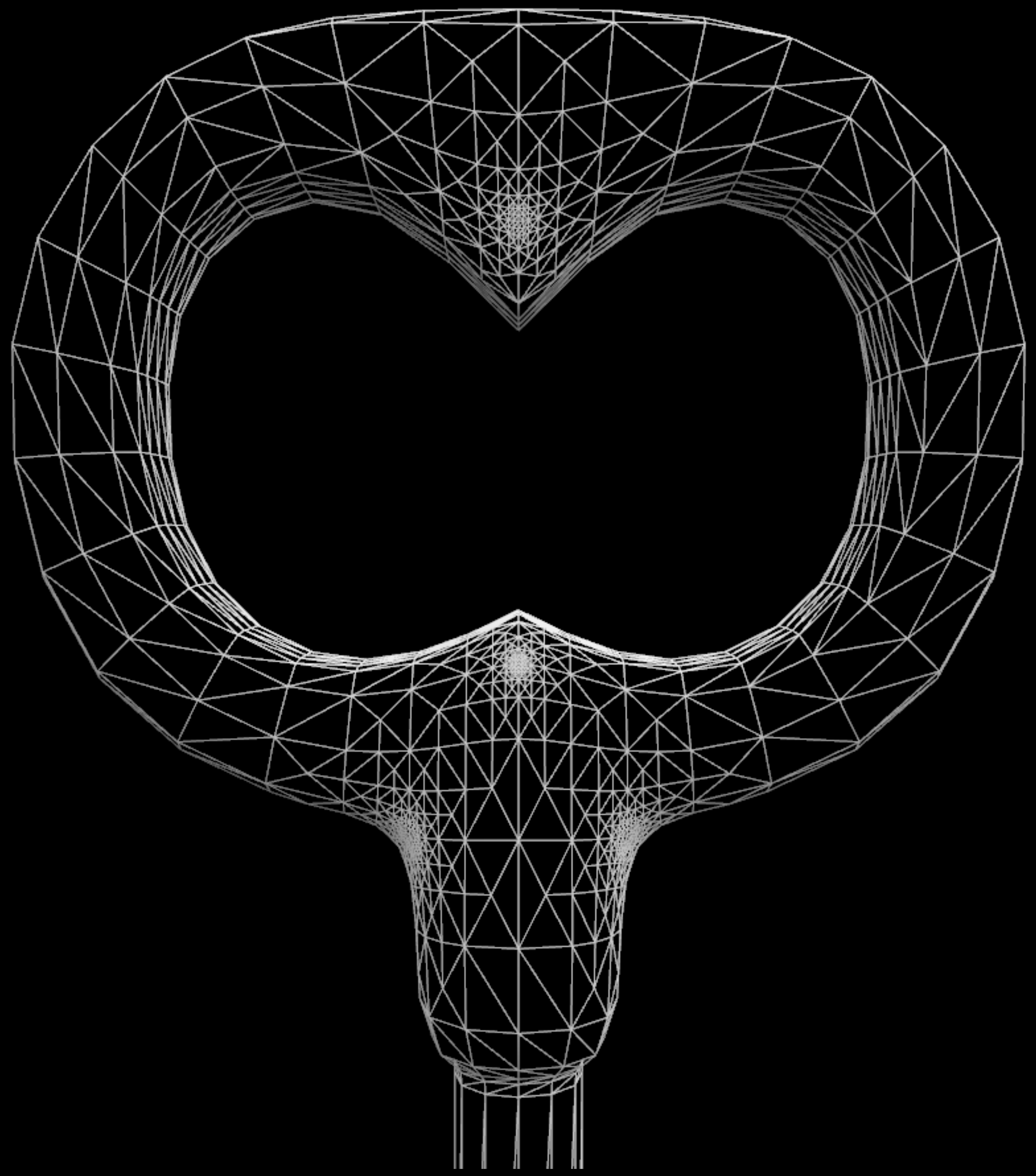


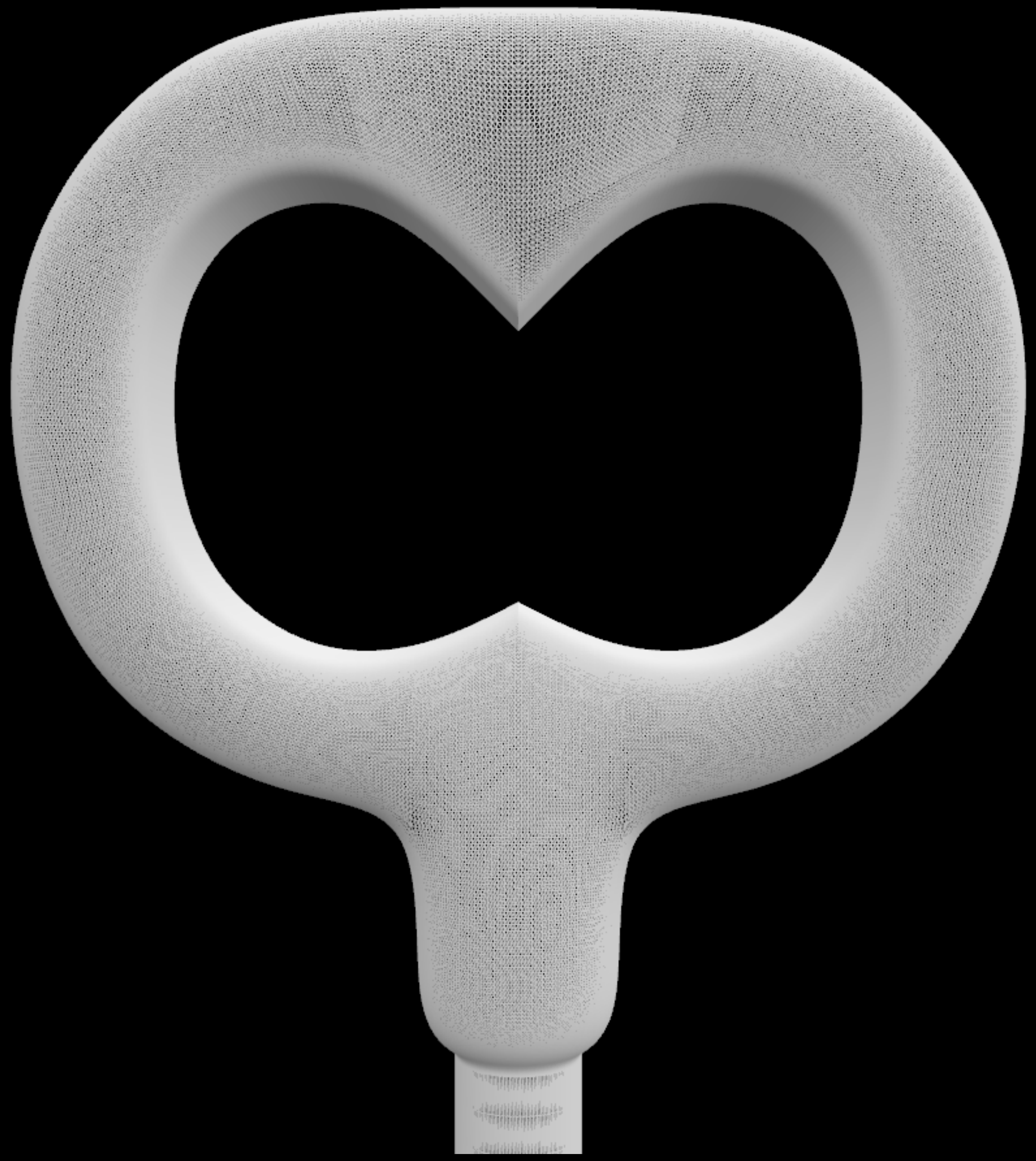


Subdivision Surfaces

Feature-adaptive and uniform subdivision

NEW





NEW

```swift
//Subdivision Surfaces
//Adaptive subdivision on the GPU

// Enable subdivision surfaces
geometry.subdivisionLevel = 1
geometry.wantsAdaptiveSubdivision = true

// Enable tessellation
let tessellator = SCNGeometryTessellator()
geometry.tessellator = tessellator
```

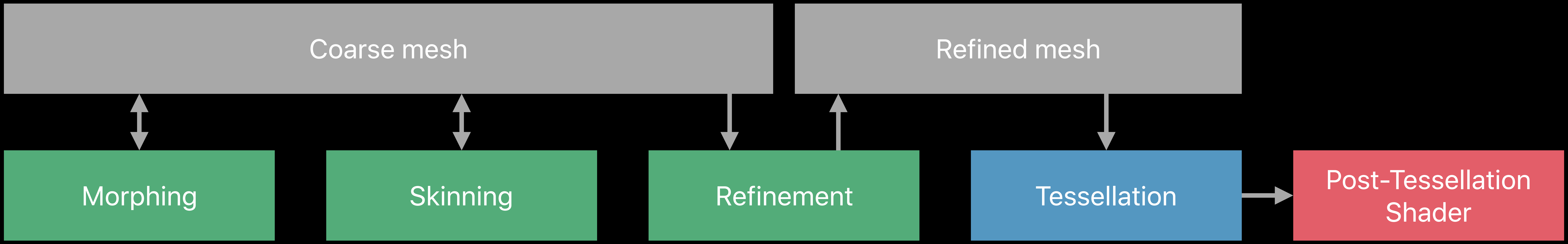
Subdivision Surfaces

Faster skinning and morphing

NEW

Only the coarse mesh is animated

Leverages the GPU for morphing, skinning and refinement



```swift
//Subdivision Surfaces
//Asset authoring

// Preserve topology when importing from files
let scene = try! SCNScene(url: url, options: [.preserveOriginalTopology: true])

// Use quads when creating geometries programmatically
let element = SCNGeometryElement(data: elementData,
                                 primitiveType: .polygon,
                                 primitiveCount: 1,
                                 bytesPerIndex: MemoryLayout<UInt8>.size)
```

Demo

Tessellation and Subdivision Surfaces

macOS

All configurations

iOS

A9 chip

Animation Enhancements

Animations

NEW

Introducing `SCNAnimation` and `SCNAnimationPlayer`

Mutability while playing

- Speed
- Pausing
- Blending

Bridged with Core Animation

Available on all platforms

```
//Animations
//Old approach

// start walking
character.addAnimation(animation, forKey: "walk")

// later: stop walking, start jumping
character.removeAnimation(forKey: "walk")
character.addAnimation(jumpAnimation, forKey: "jump")
```

NEW

```
//Animations
//New approach

// configure the players
character.addAnimationPlayer(walkAnimationPlayer, forKey: "walk")
character.addAnimationPlayer(jumpAnimationPlayer, forKey: "jump")

// start walking
walkAnimationPlayer.play()

// later: stop walking, start jumping
walkAnimationPlayer.stop()
jumpAnimationPlayer.play()
```

NEW

```
//Animations
//New approach

// at any time: mutate the players
walkAnimationPlayer.speed = characterSpeed // walk slower or faster
runAnimationPlayer.blendFactor = walkRunFactor // `walkRunFactor` of walk
                                               // `1.0 – walkRunFactor` of run
```

Animations

Animation blending

NEW

Step

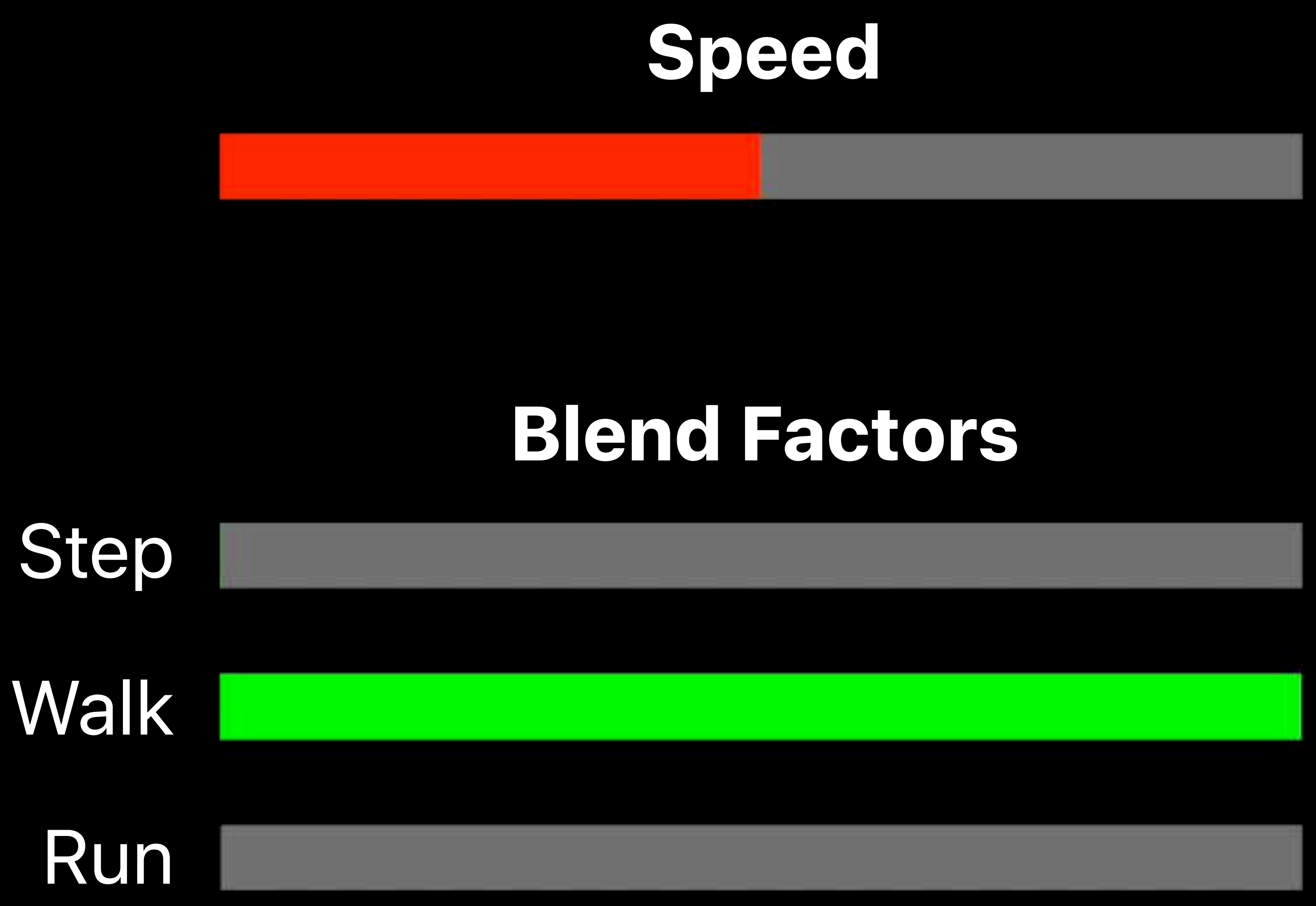
Walk

Run

Animations

Animation blending

NEW



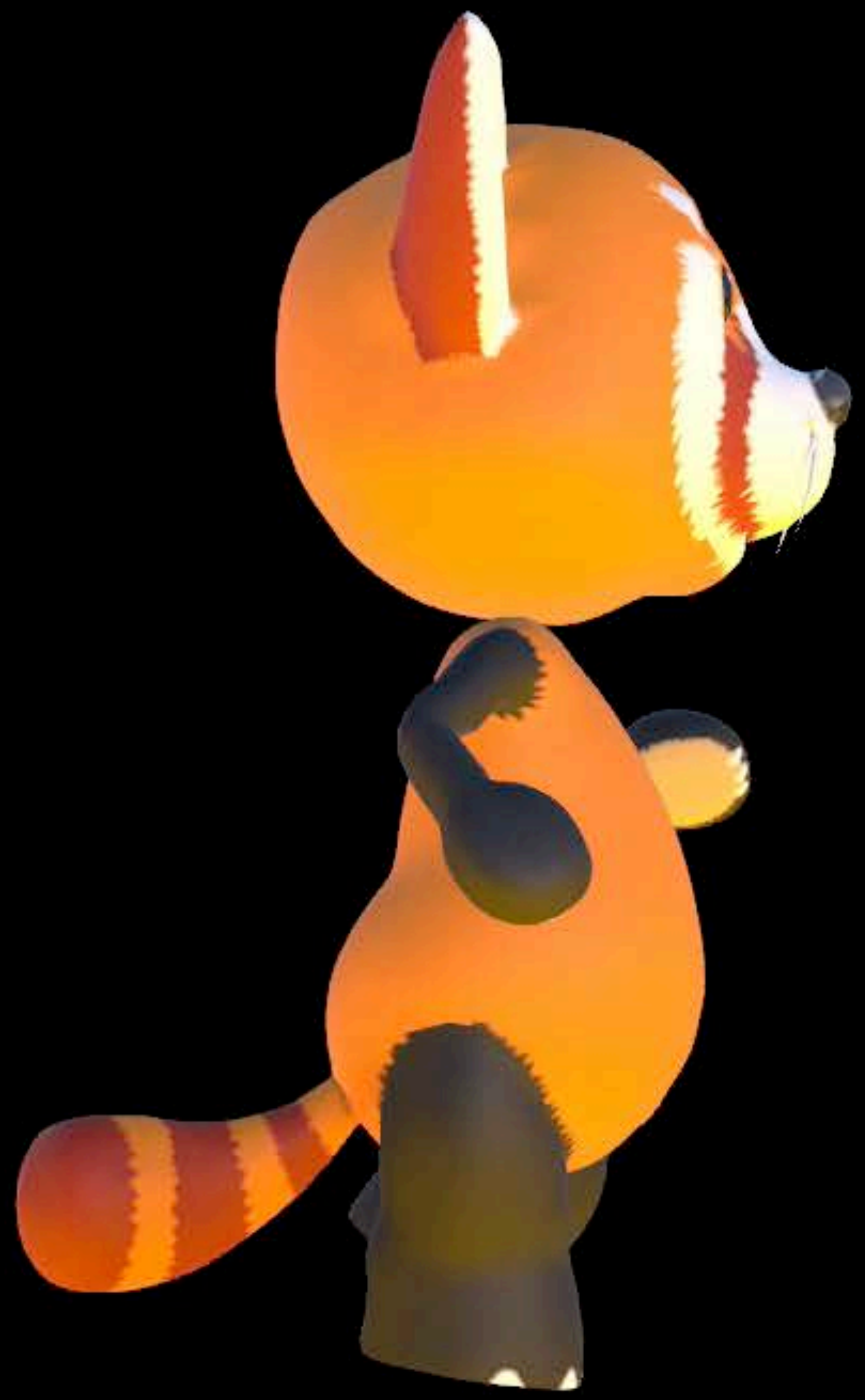
Speed

Blend Factors

Step

Walk

Run



Animations

Performance

Starting, pausing and stopping animations is much faster

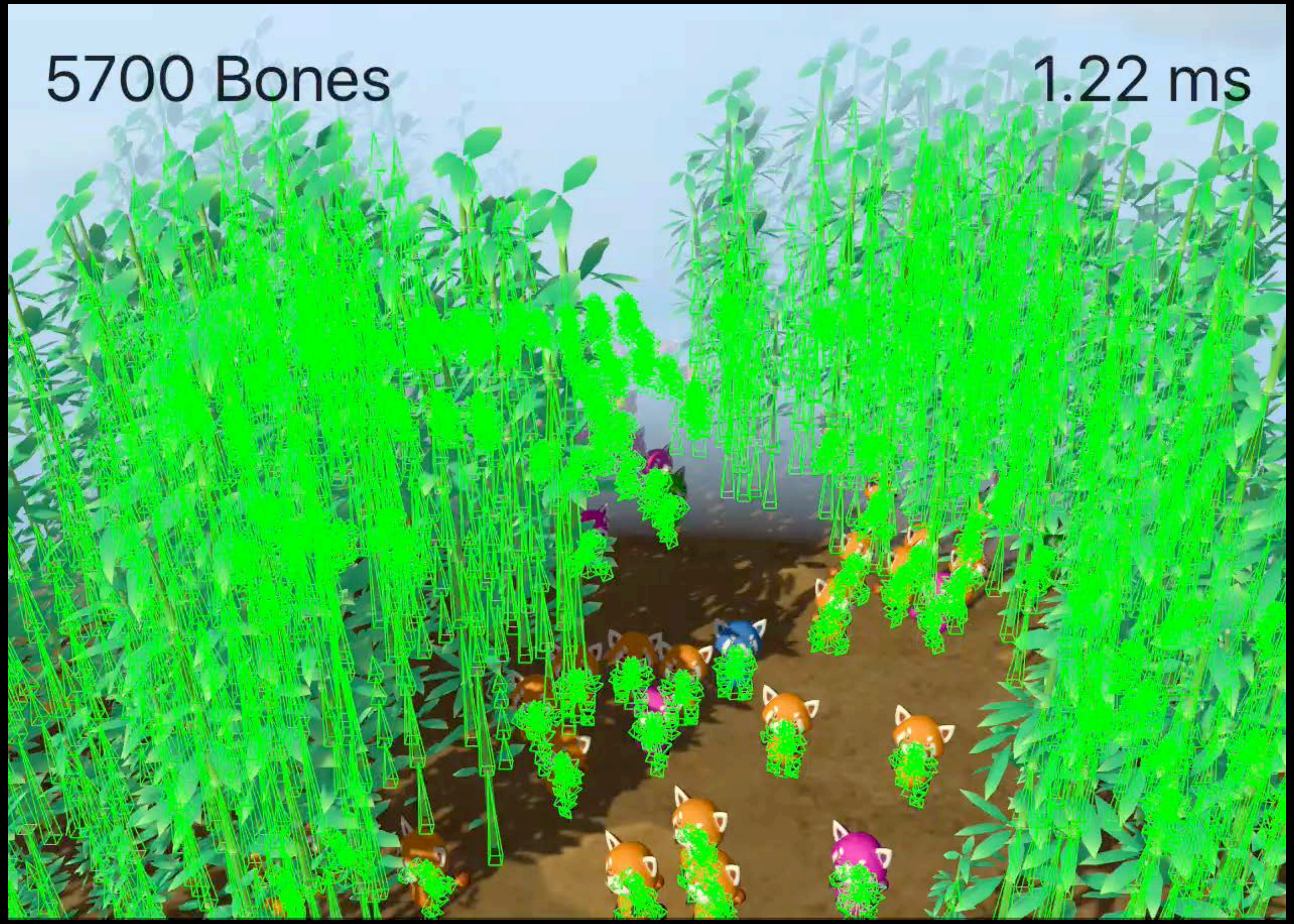
Efficient evaluation of skeletal animation

Animations

Performance

Starting, pausing and stopping animations is much faster

Efficient evaluation of skeletal animation

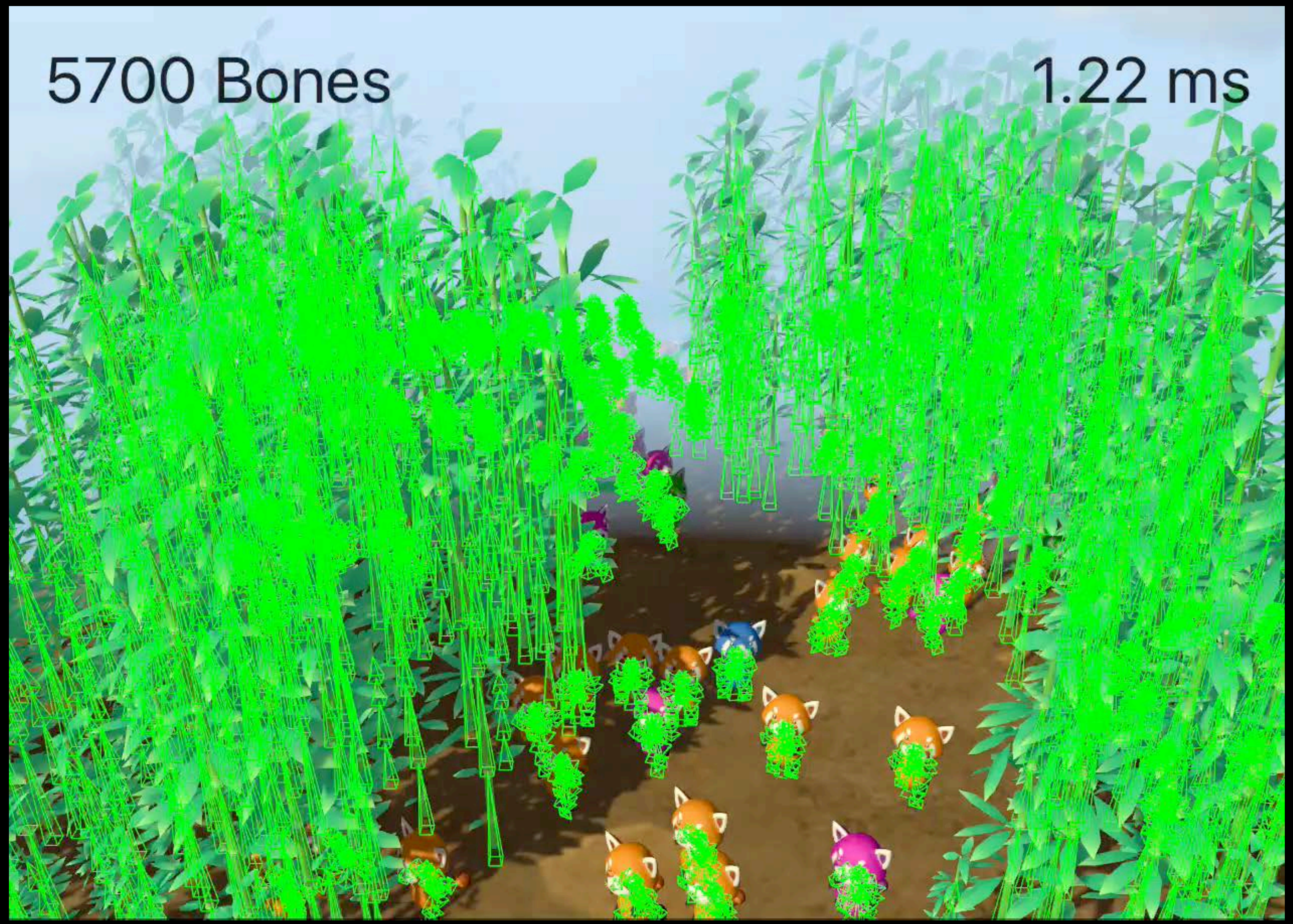


Animations

Performance

Starting, pausing and stopping animations is much faster

Efficient evaluation of skeletal animation



Developer Tools

Sébastien Métrot, SceneKit engineer

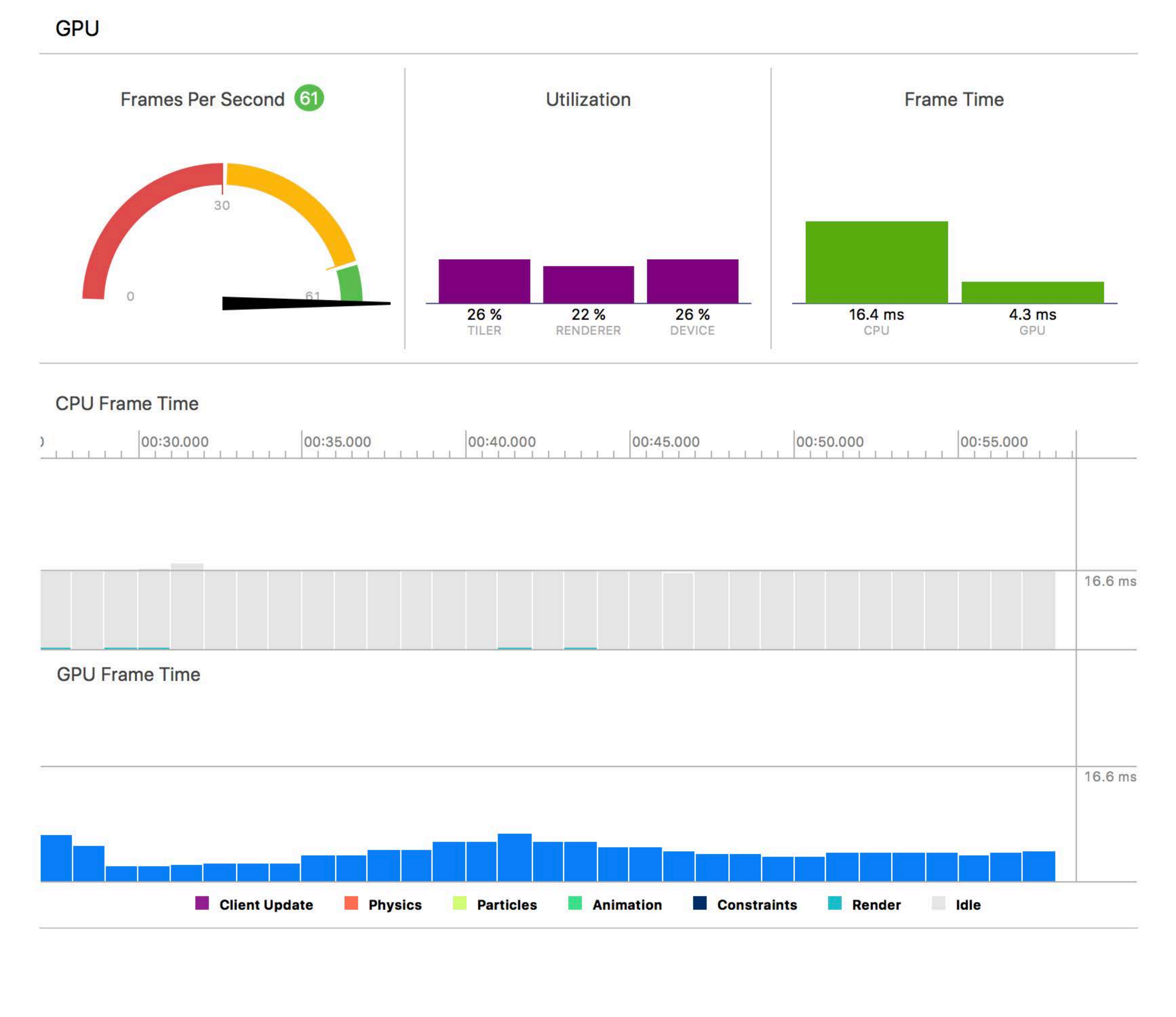
FPS Gauge

Split per categories

Real-time

Integrated in Xcode

Great for performance overview



SceneKit Instrument

NEW

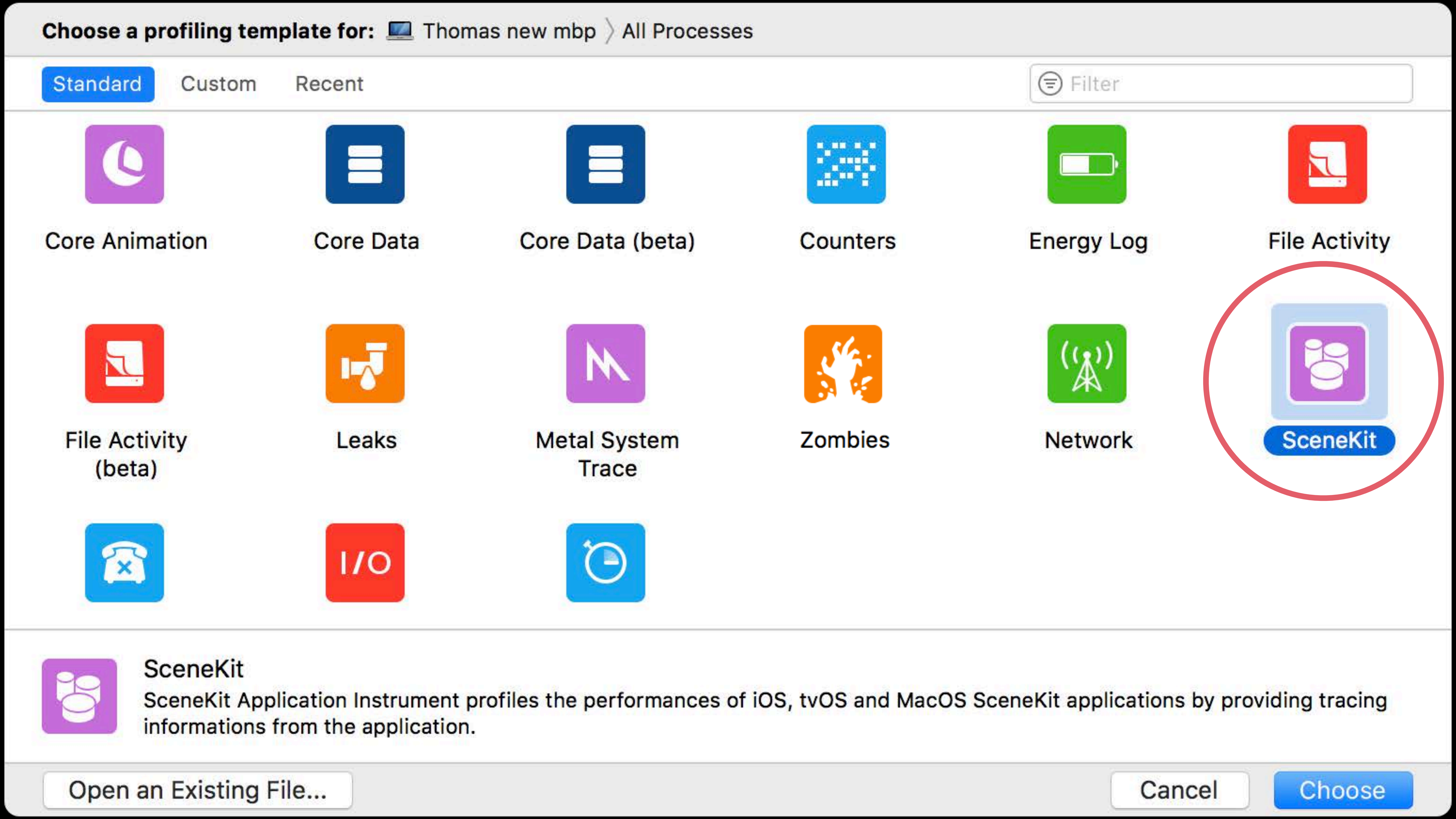
Understand performance issues

Record a trace of SceneKit's behavior

Accurate per-frame performance analysis

SceneKit Instrument

NEW



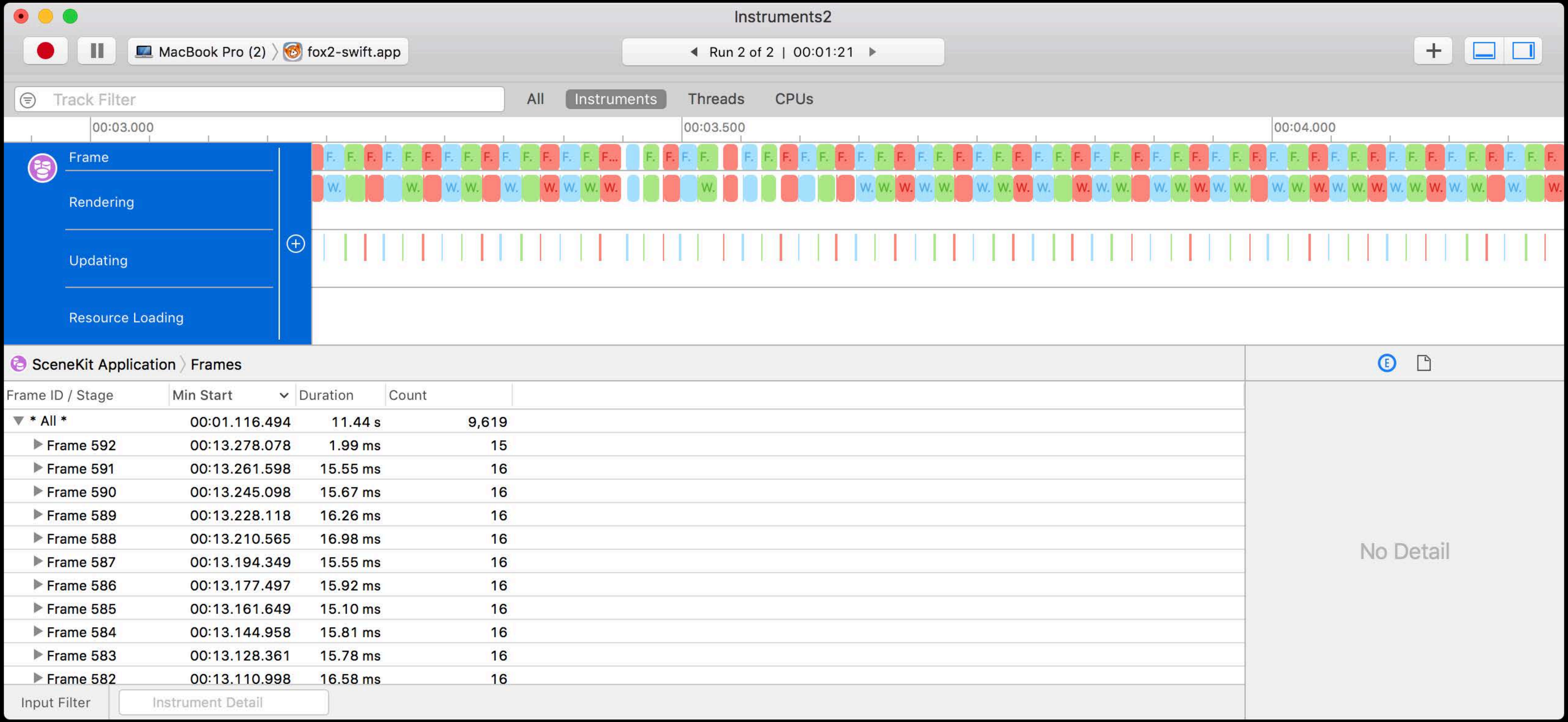
Choose a profiling template for: Thomas new mbp 〉 All Processes

SceneKit

SceneKit Application Instrument profiles the performances of iOS, tvOS and MacOS SceneKit applications by providing tracing informations from the application.

SceneKit Instrument

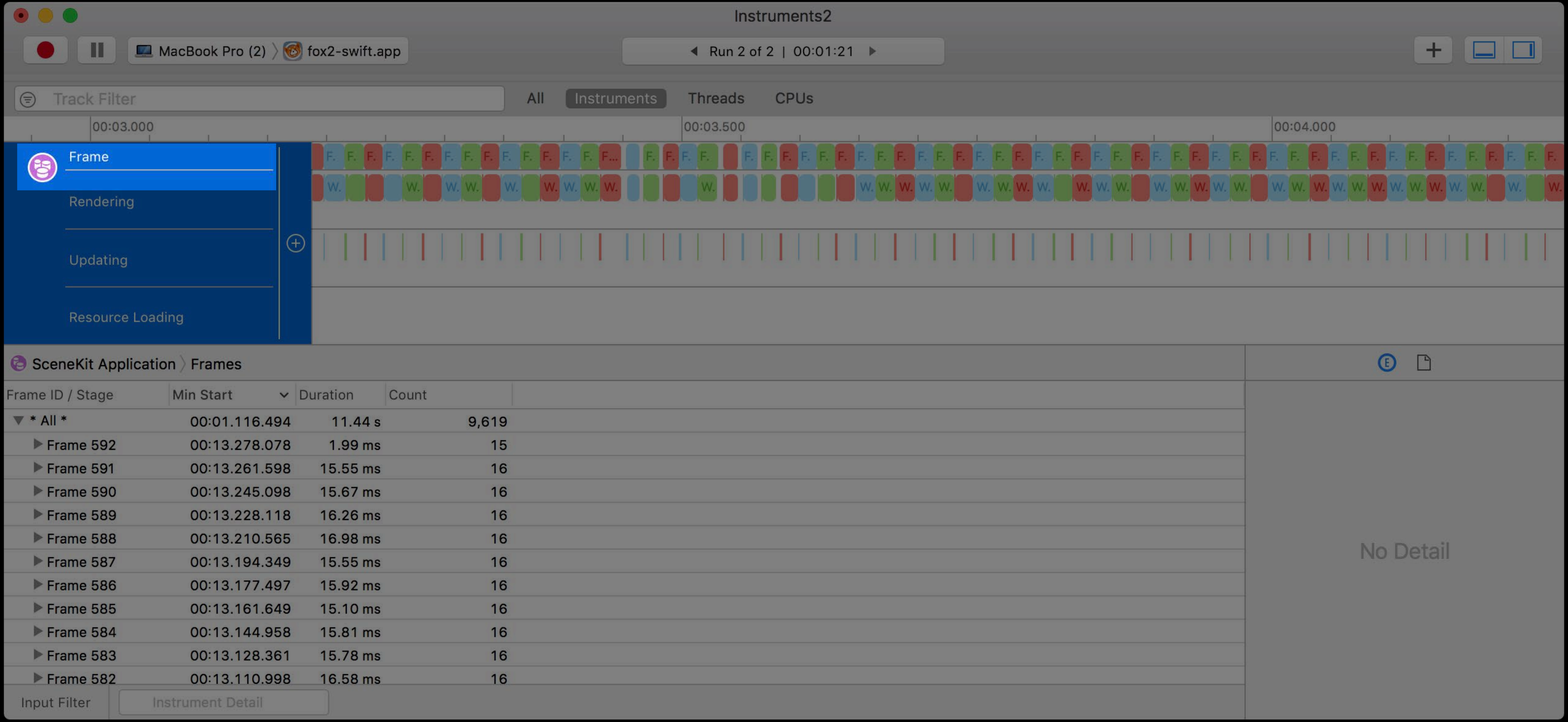
NEW



Frame ID / Stage	Min Start	Duration	Count
* All *	00:01.116.494	11.44 s	9,619
Frame 592	00:13.278.078	1.99 ms	15
Frame 591	00:13.261.598	15.55 ms	16
Frame 590	00:13.245.098	15.67 ms	16
Frame 589	00:13.228.118	16.26 ms	16
Frame 588	00:13.210.565	16.98 ms	16
Frame 587	00:13.194.349	15.55 ms	16
Frame 586	00:13.177.497	15.92 ms	16
Frame 585	00:13.161.649	15.10 ms	16
Frame 584	00:13.144.958	15.81 ms	16
Frame 583	00:13.128.361	15.78 ms	16
Frame 582	00:13.110.998	16.58 ms	16

SceneKit Instrument

NEW



SceneKit Application 〉 Frames

Frame ID / Stage	Min Start	Duration	Count
▼ * All *	00:01.116.494	11.44 s	9,619
▶ Frame 592	00:13.278.078	1.99 ms	15
▶ Frame 591	00:13.261.598	15.55 ms	16
▶ Frame 590	00:13.245.098	15.67 ms	16
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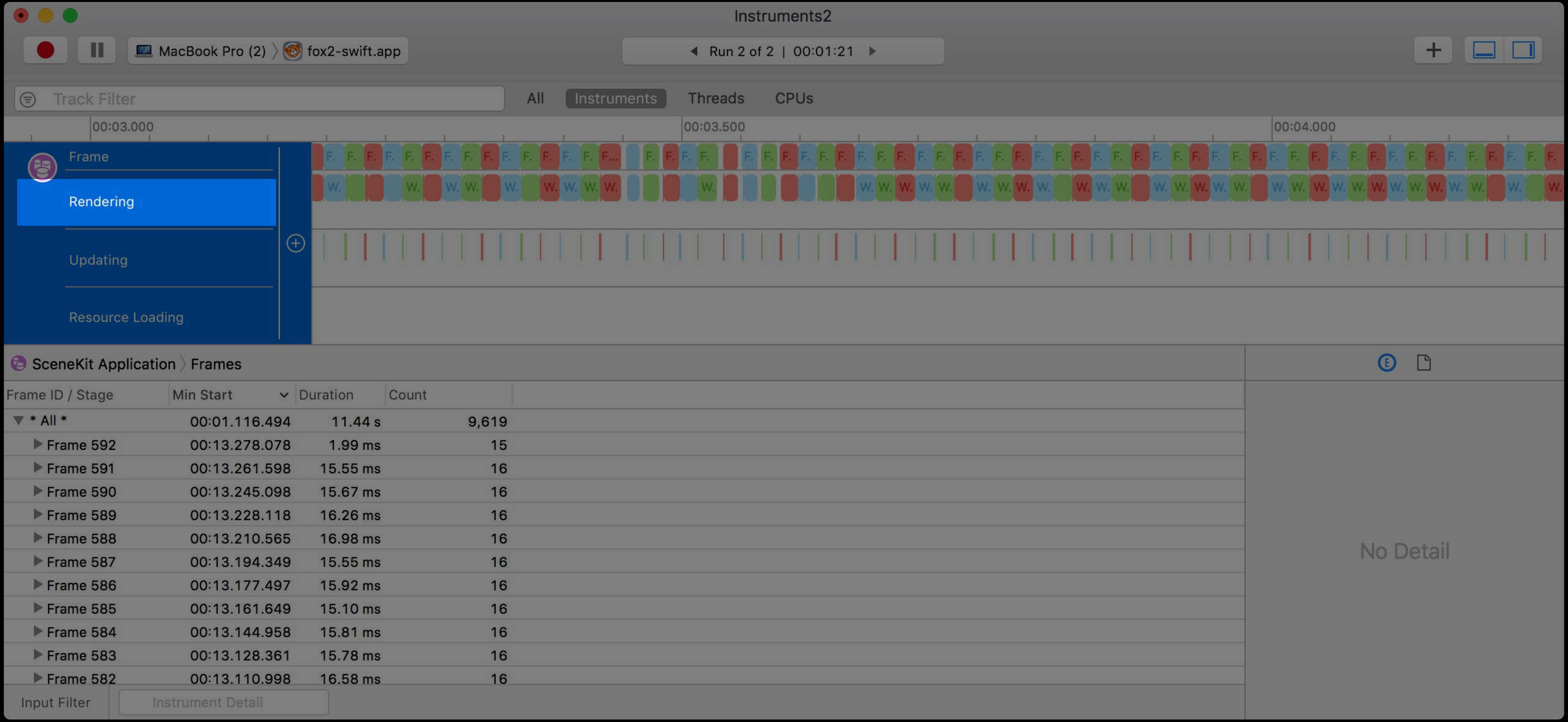
▶ Frame 583	00:13.128.361	15.78 ms	16
▶ Frame 582	00:13.110.998	16.58 ms	16

No Detail

SceneKit Instrument

NEW



Frame ID / Stage	Min Start	Duration	Count
* All *	00:01.116.494	11.44 s	9,619
Frame 592	00:13.278.078	1.99 ms	15
Frame 591	00:13.261.598	15.55 ms	16
Frame 590	00:13.245.098	15.67 ms	16
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Frame 586	00:13.177.497	15.92 ms	16
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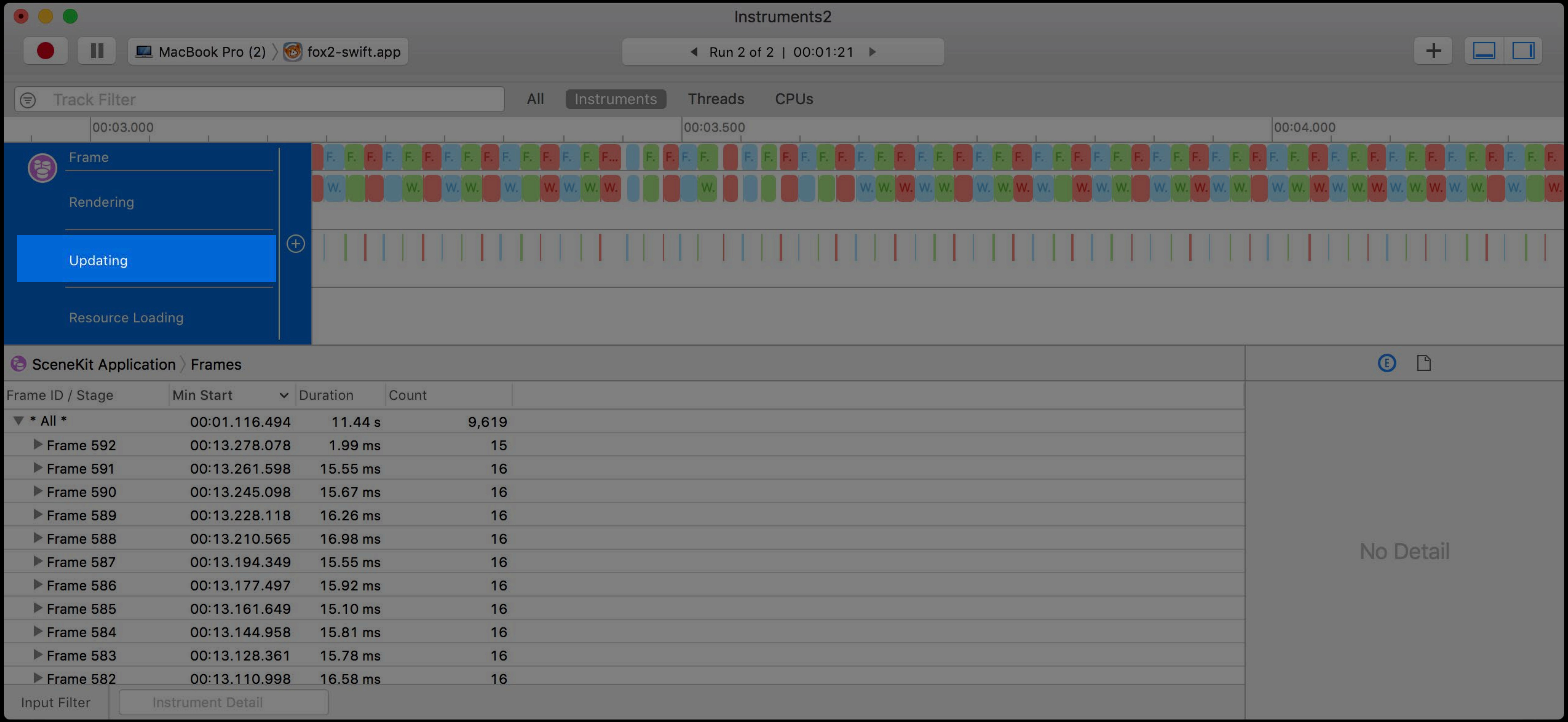
SceneKit Instrument

NEW



Frame ID / Stage	Min Start	Duration	Count
* All *	00:01.116.494	11.44 s	9,619
Frame 592	00:13.278.078	1.99 ms	15
Frame 591	00:13.261.598	15.55 ms	16
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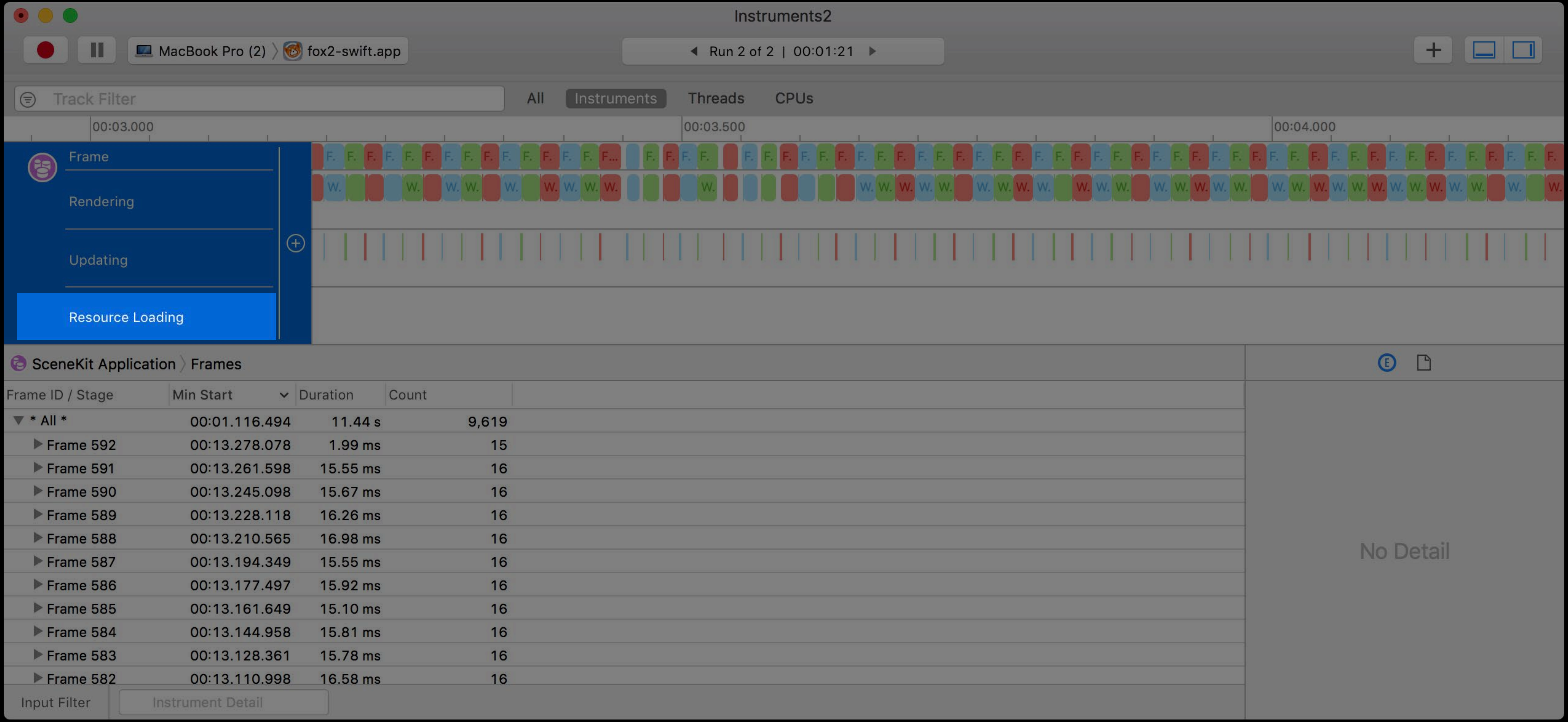
Frame 584	00:13.144.958	15.81 ms	16
Frame 583	00:13.128.361	15.78 ms	16
Frame 582	00:13.110.998	16.58 ms	16

SceneKit Instrument

NEW



Frame ID / Stage	Min Start	Duration	Count
* All *	00:01.116.494	11.44 s	9,619
Frame 592	00:13.278.078	1.99 ms	15
Frame 591	00:13.261.598	15.55 ms	16
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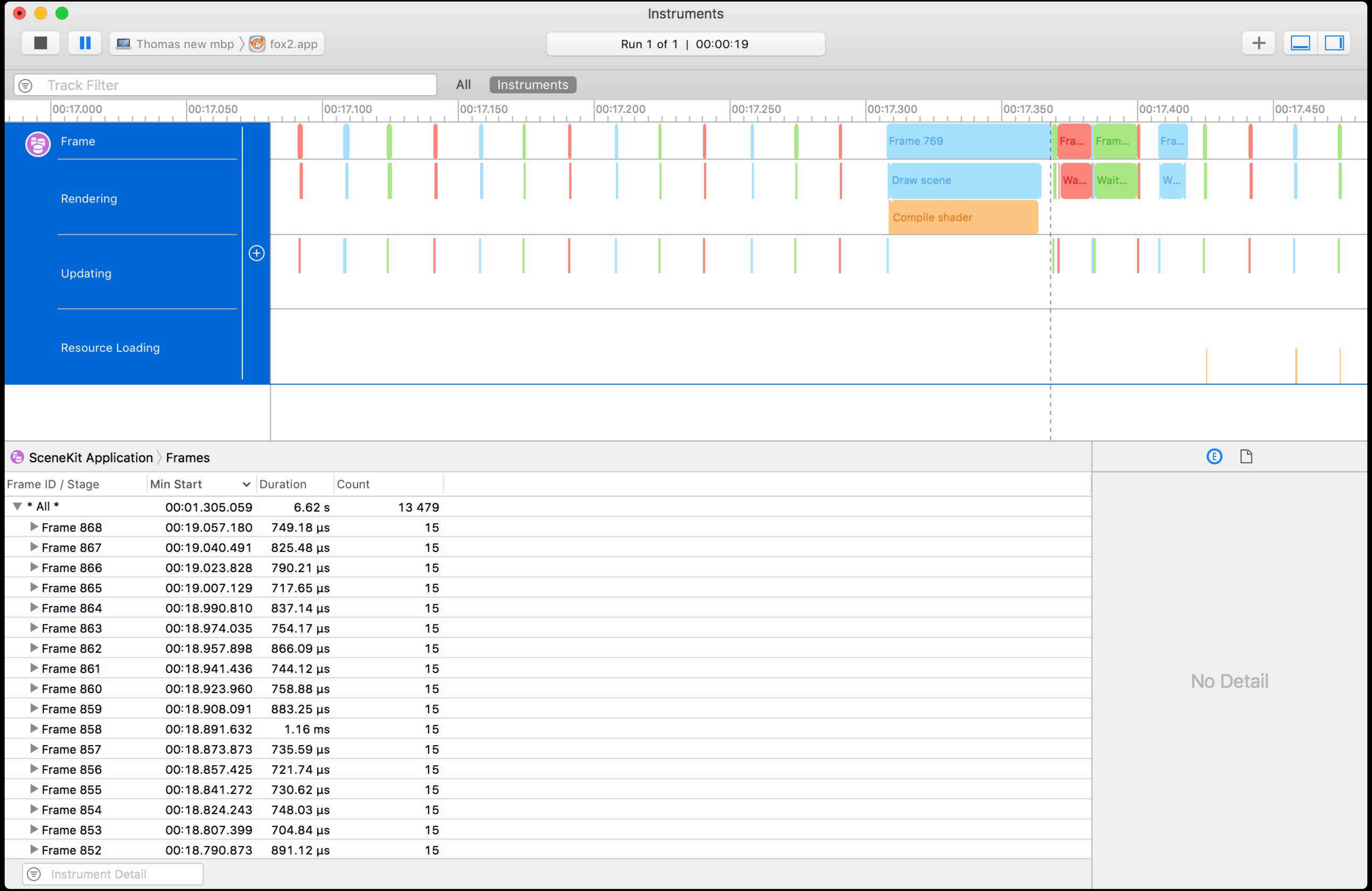
Frame 584	00:13.144.958	15.81 ms	16
Frame 583	00:13.128.361	15.78 ms	16
Frame 582	00:13.110.998	16.58 ms	16

SceneKit Instrument

Example: Slow shader compilation

NEW



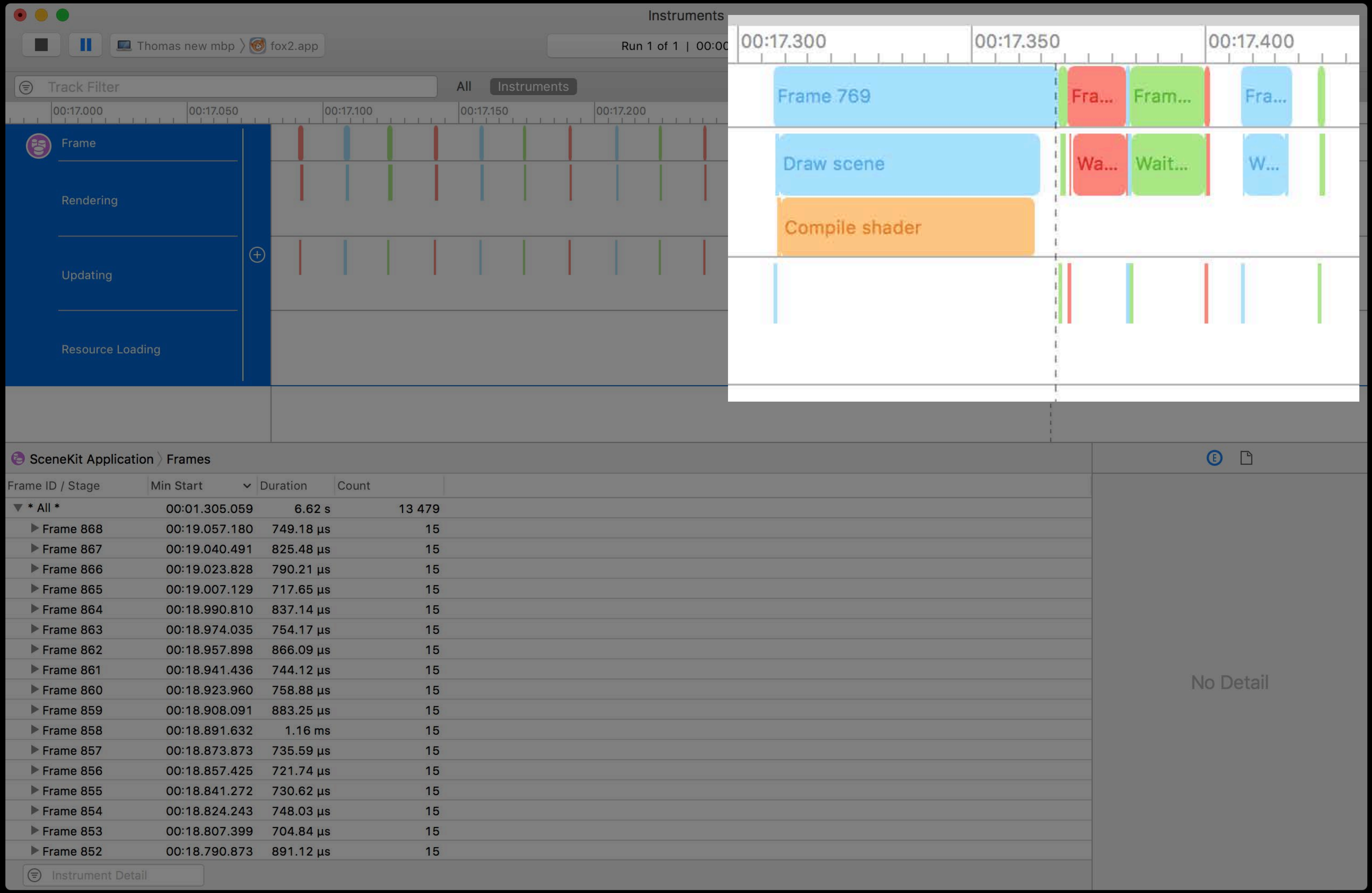
SceneKit Application 〉 Frames

Frame ID / Stage	Min Start	Duration	Count
▼ * All *	00:01.305.059	6.62 s	13 479
▶ Frame 868	00:19.057.180	749.18 µs	15
▶ Frame 867	00:19.040.491	825.48 µs	15
▶ Frame 866	00:19.023.828	790.21 µs	15
▶ Frame 865	00:19.007.129	717.65 µs	15
▶ Frame 864	00:18.990.810	837.14 µs	15
▶ Frame 863	00:18.974.035	754.17 µs	15
▶ Frame 862	00:18.957.898	866.09 µs	15
▶ Frame 861	00:18.941.436	744.12 µs	15
▶ Frame 860	00:18.923.960	758.88 µs	15
▶ Frame 859	00:18.908.091	883.25 µs	15
▶ Frame 858	00:18.891.632	1.16 ms	15
▶ Frame 857	00:18.873.873	735.59 µs	15
▶ Frame 856	00:18.857.425	721.74 µs	15
▶ Frame 855	00:18.841.272	730.62 µs	15
▶ Frame 854	00:18.824.243	748.03 µs	15
▶ Frame 853	00:18.807.399	704.84 µs	15
▶ Frame 852	00:18.790.873	891.12 µs	15

SceneKit Instrument

Example: Slow shader compilation

NEW



Frame ID / Stage	Min Start	Duration	Count
* All *	00:01.305.059	6.62 s	13 479
Frame 868	00:19.057.180	749.18 µs	15
Frame 867	00:19.040.491	825.48 µs	15
Frame 866	00:19.023.828	790.21 µs	15
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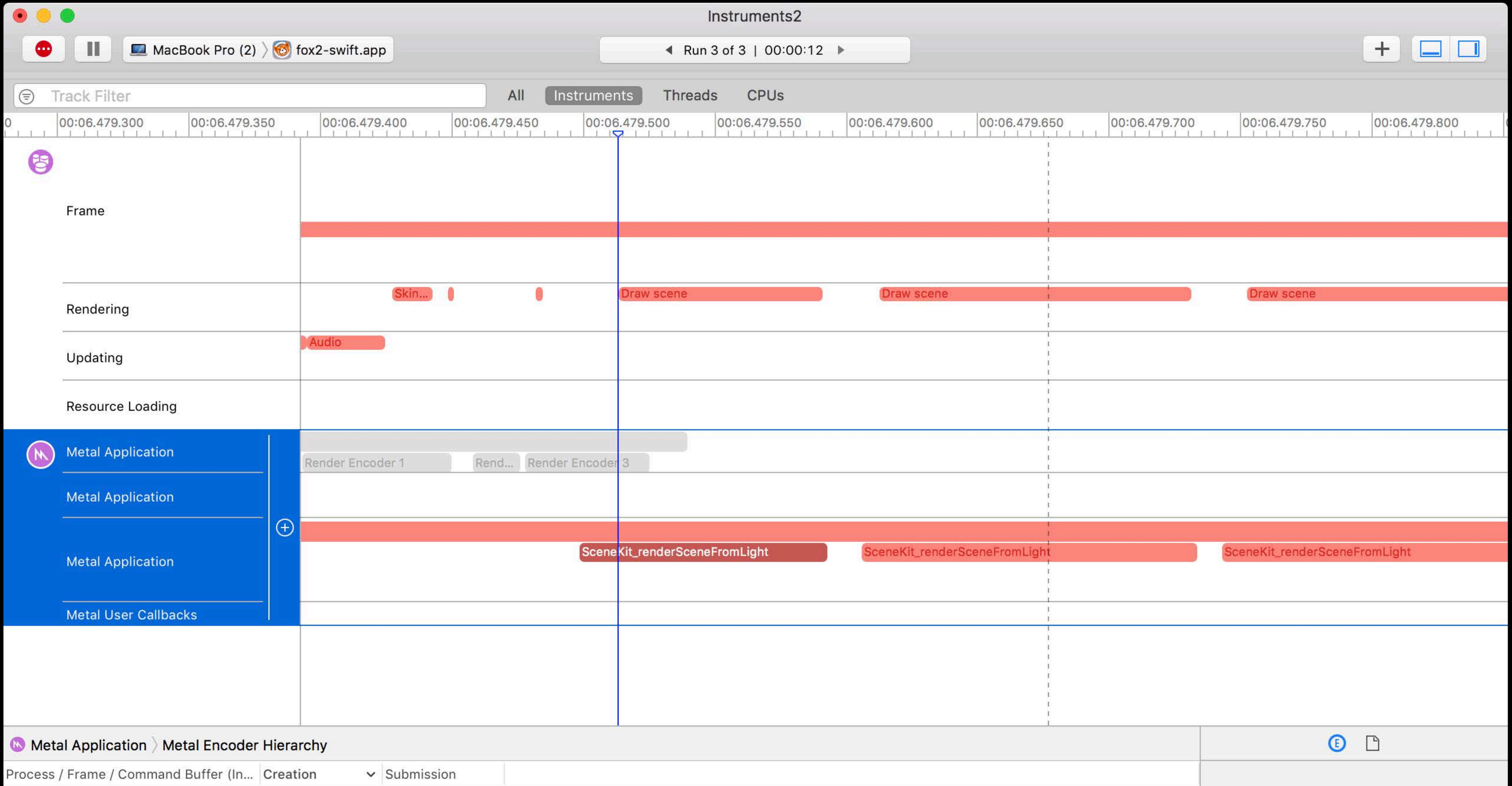
Frame 855	00:18.841.272	730.62 µs	15
Frame 854	00:18.824.243	748.03 µs	15
Frame 853	00:18.807.399	704.84 µs	15
Frame 852	00:18.790.873	891.12 µs	15

SceneKit Instrument

In combination with the Metal Instrument trace

NEW



SceneKit Capture

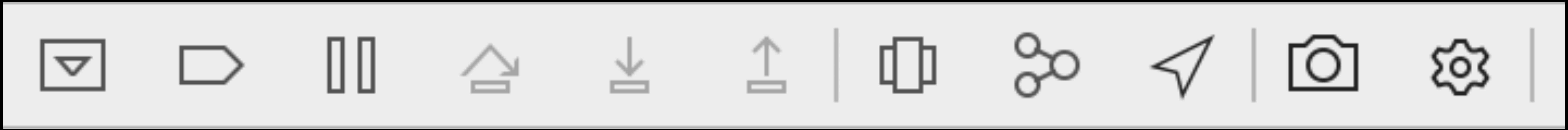
Debugging with SceneKit

SceneKit Capture

Debugging with SceneKit

View debugger enhancements

Captures the current state of your scene

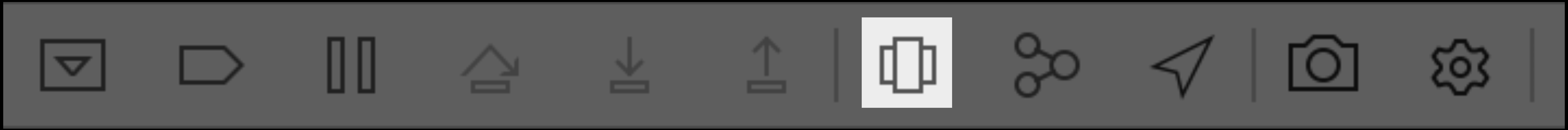


SceneKit Capture

Debugging with SceneKit

View debugger enhancements

Captures the current state of your scene

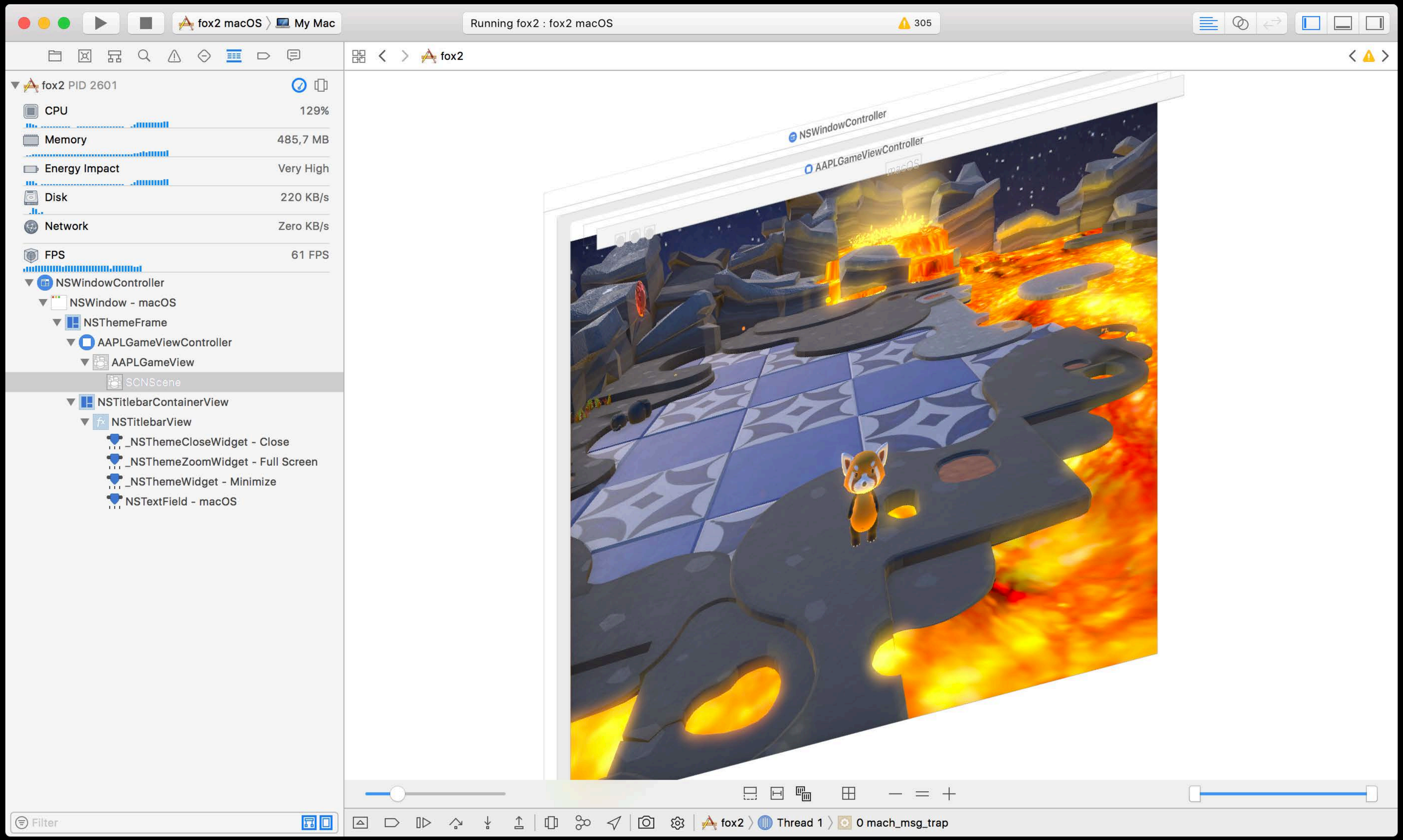


SceneKit Capture

View debugger enhancements

NEW

Captures the current state of your scene



fox2 PID 2601

CPU	129%
Memory	485,7 MB
Energy Impact	Very High
Disk	220 KB/s
Network	Zero KB/s
FPS	61 FPS

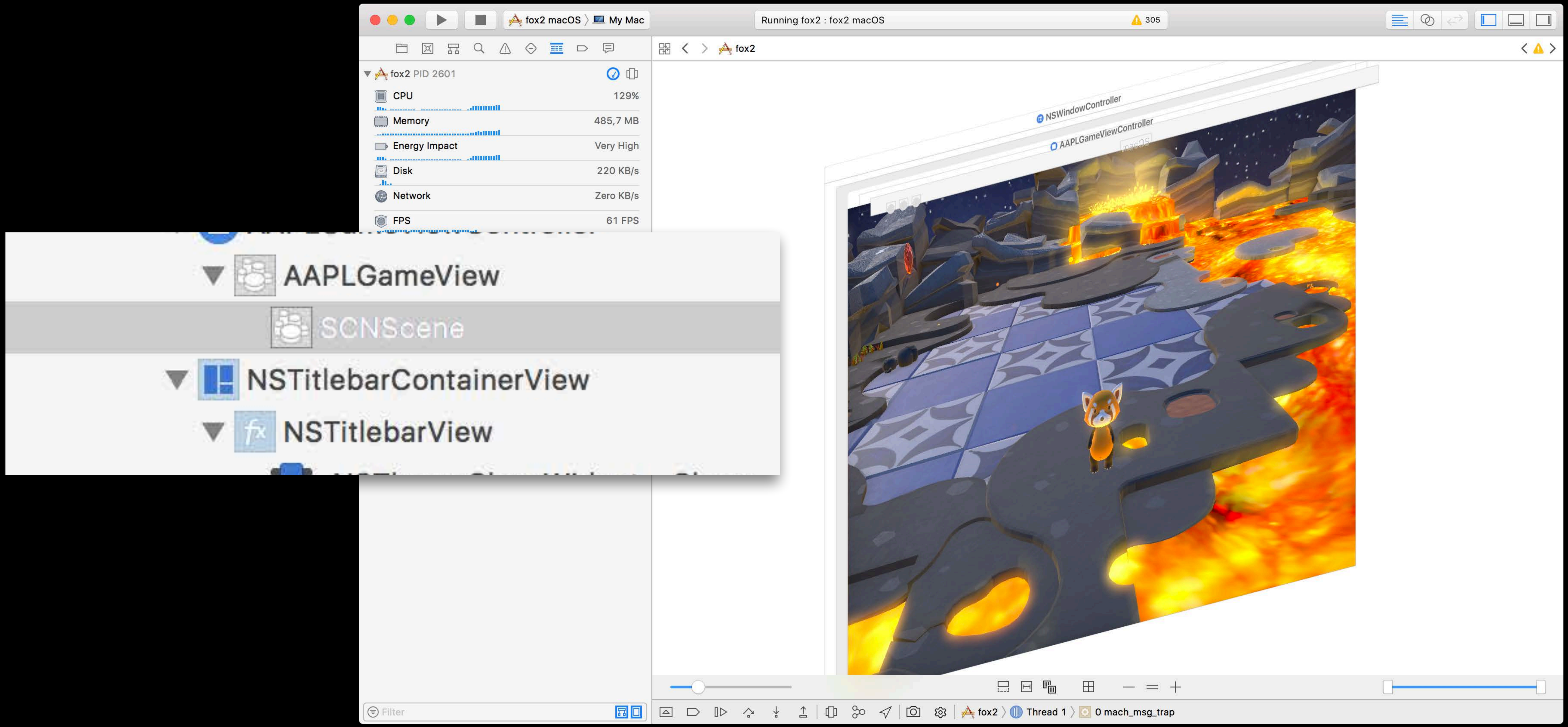
- NSWindowController
  - NSWindow - macOS
    - NSThemeFrame
      - AAPLGameViewController
        - AAPLGameView
          - SCNScene
      - NSTitlebarContainerView
        - NSTitlebarView
          - _NSThemeCloseWidget - Close
          - _NSThemeZoomWidget - Full Screen
          - _NSThemeWidget - Minimize
          - NSTextField - macOS

SceneKit Capture

View debugger enhancements

NEW

Captures the current state of your scene

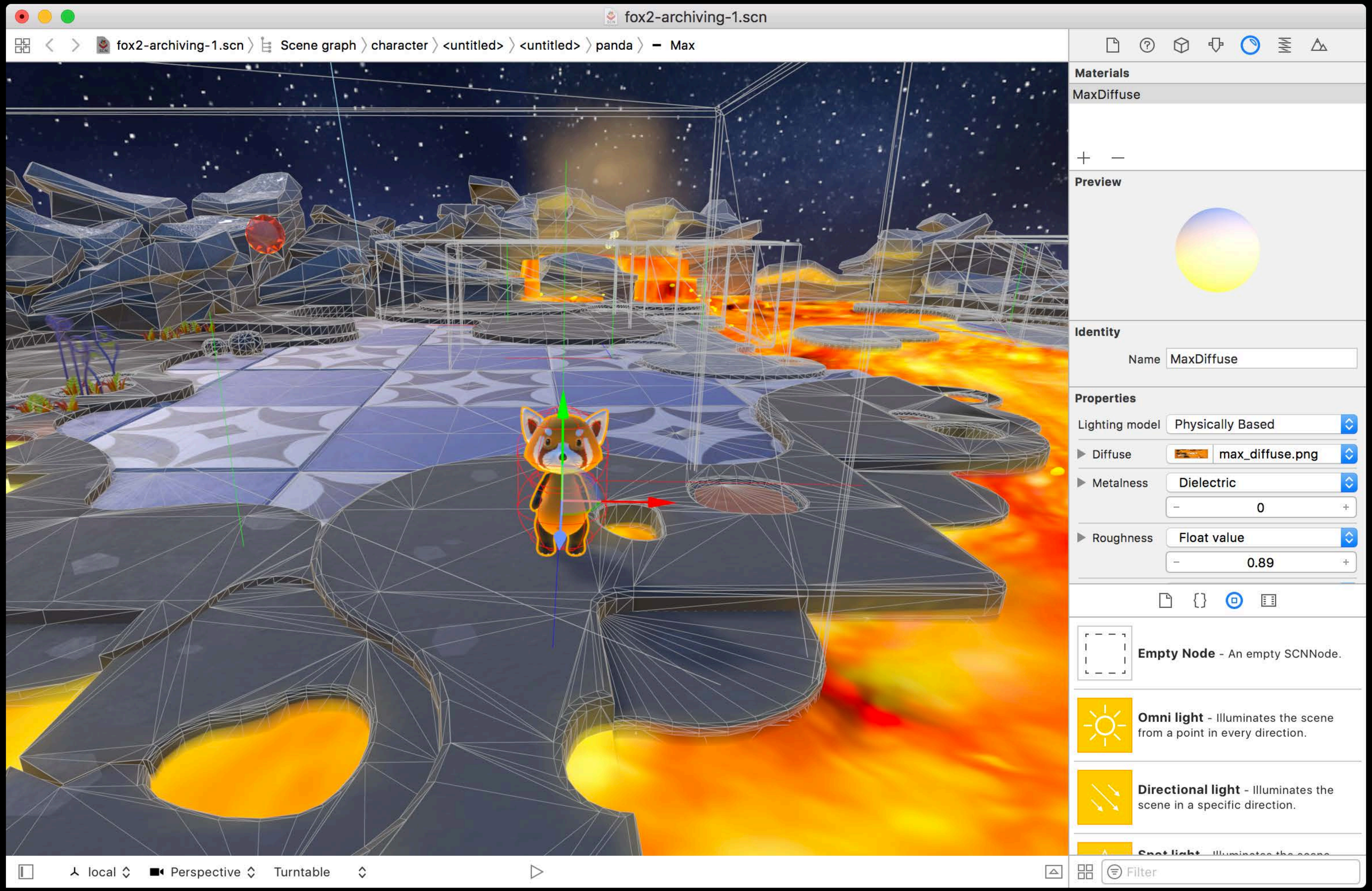


SceneKit Capture

View debugger enhancements

NEW

Captures the current state of your scene



fox2-archiving-1.scn

fox2-archiving-1.scn 〉 Scene graph 〉 character 〉 <untitled> 〉 <untitled> 〉 panda 〉 Max

Materials

MaxDiffuse

Preview

Identity

Name: MaxDiffuse

Properties

Lighting model: Physically Based

Diffuse: max_diffuse.png

Metalness: Dielectric

0

Roughness: Float value

0.89

Empty Node - An empty SCNNode.

Omni light - Illuminates the scene from a point in every direction.

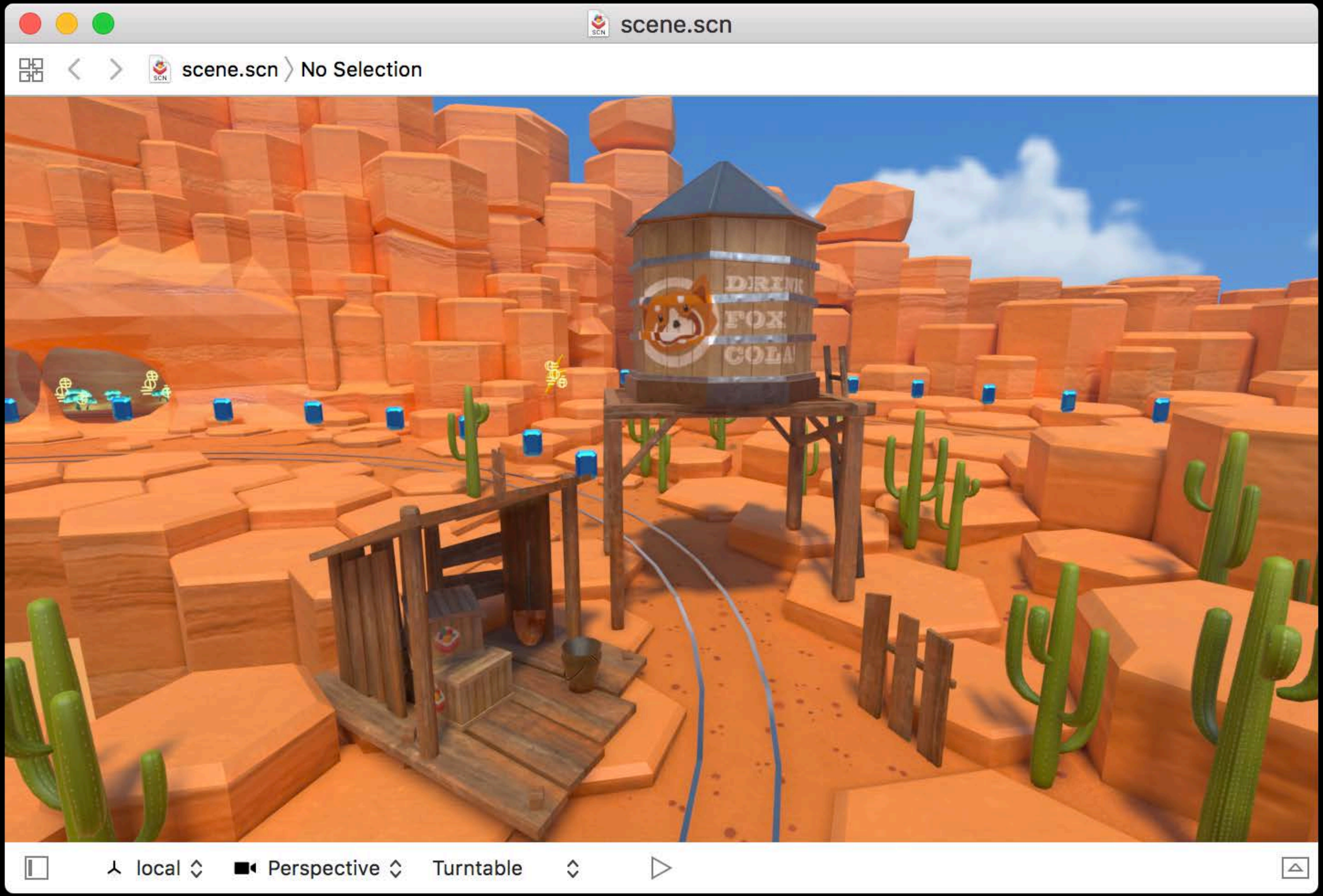
Directional light - Illuminates the scene in a specific direction.

Spot light - Illuminates the scene

SceneKit Scene Editor

New features

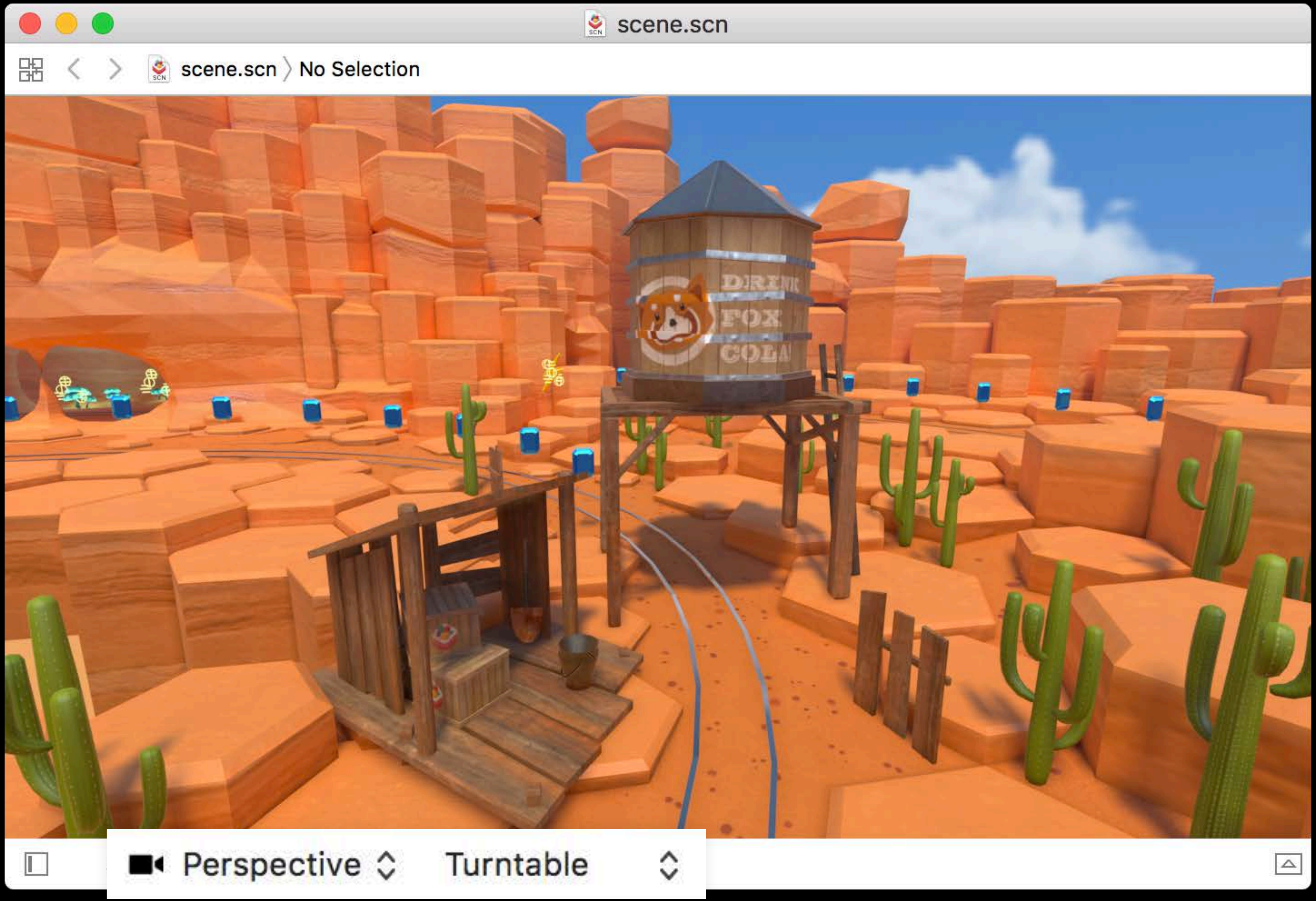
NEW



SceneKit Scene Editor

New features

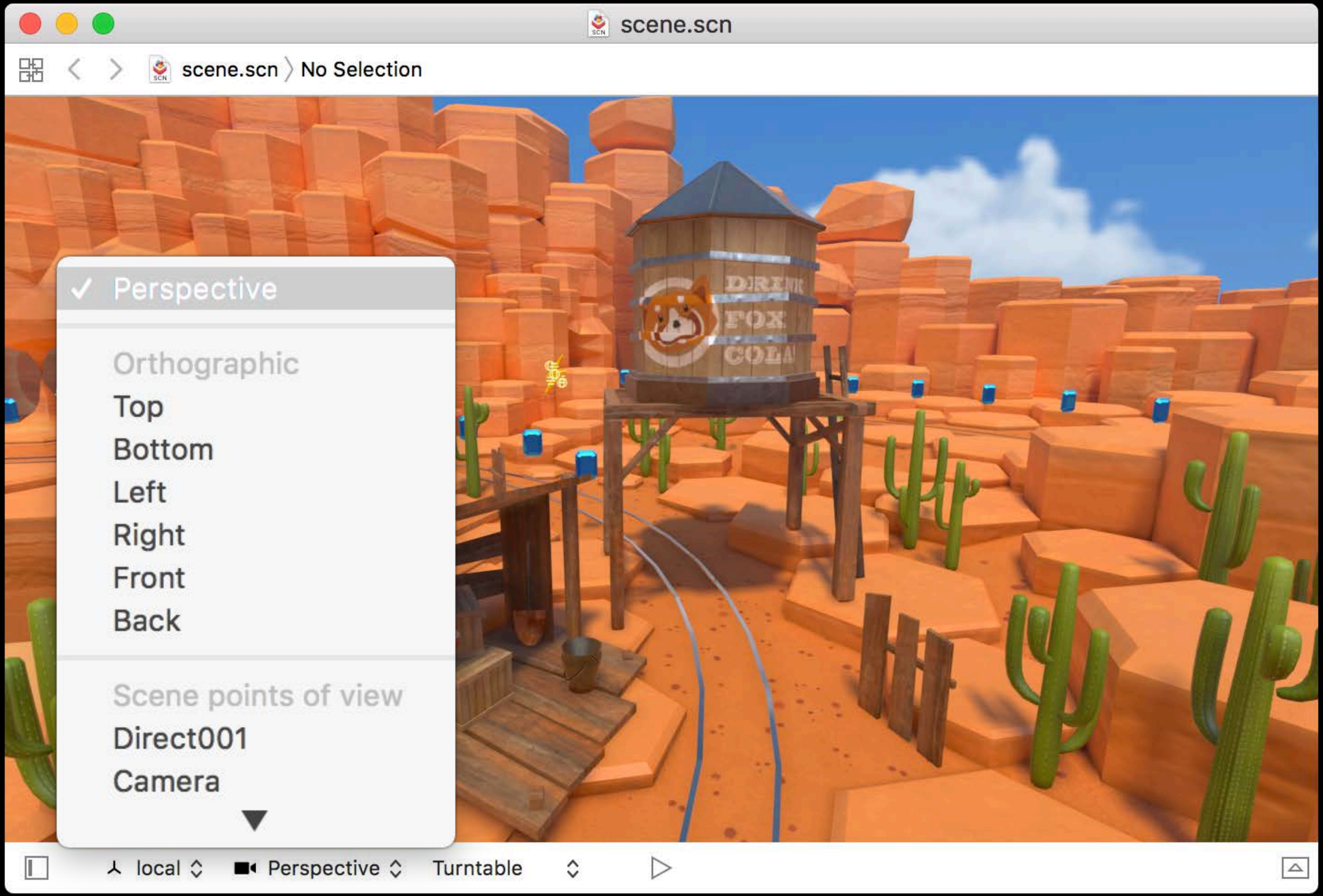
NEW



SceneKit Scene Editor

New features

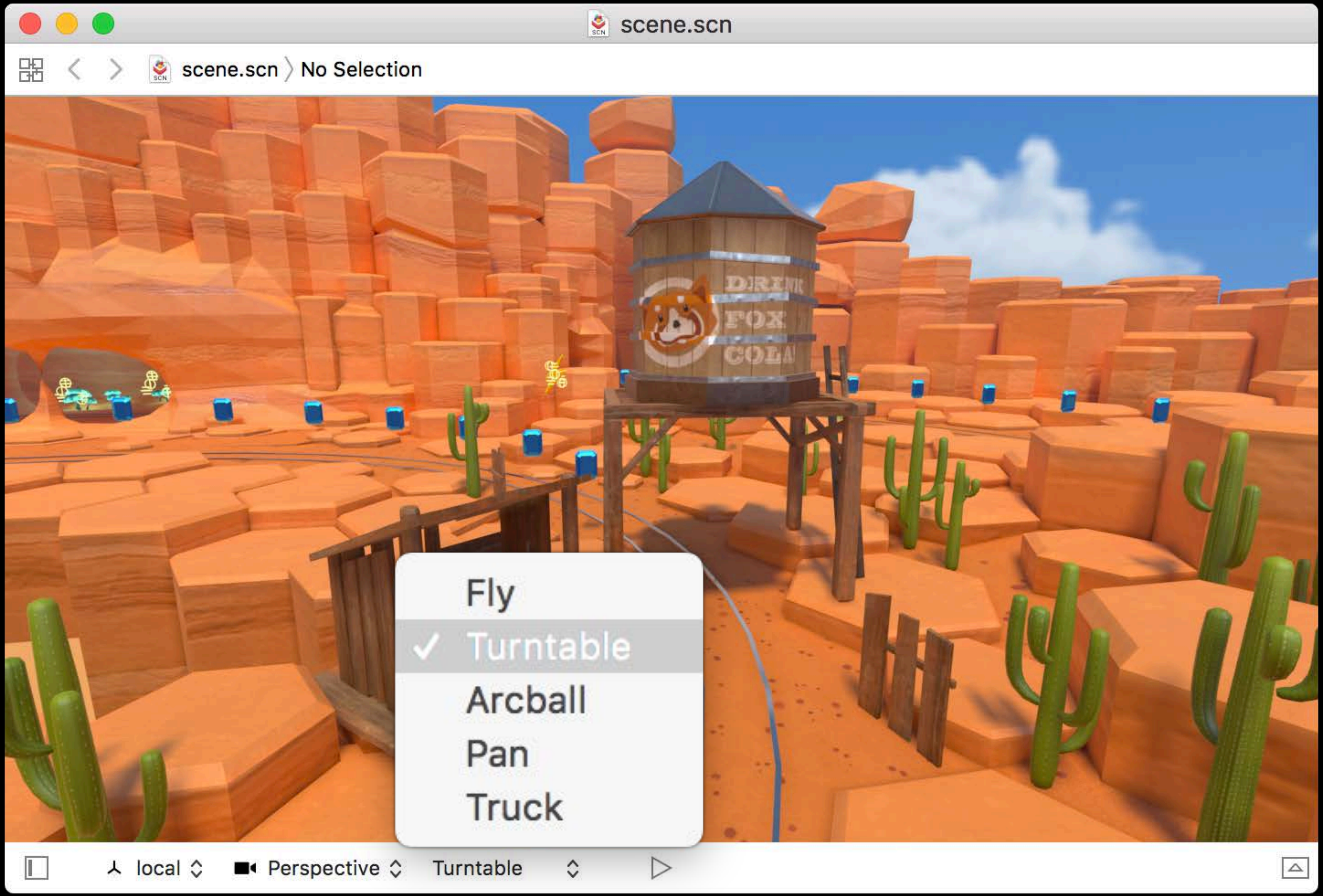
NEW



SceneKit Scene Editor

New features

NEW



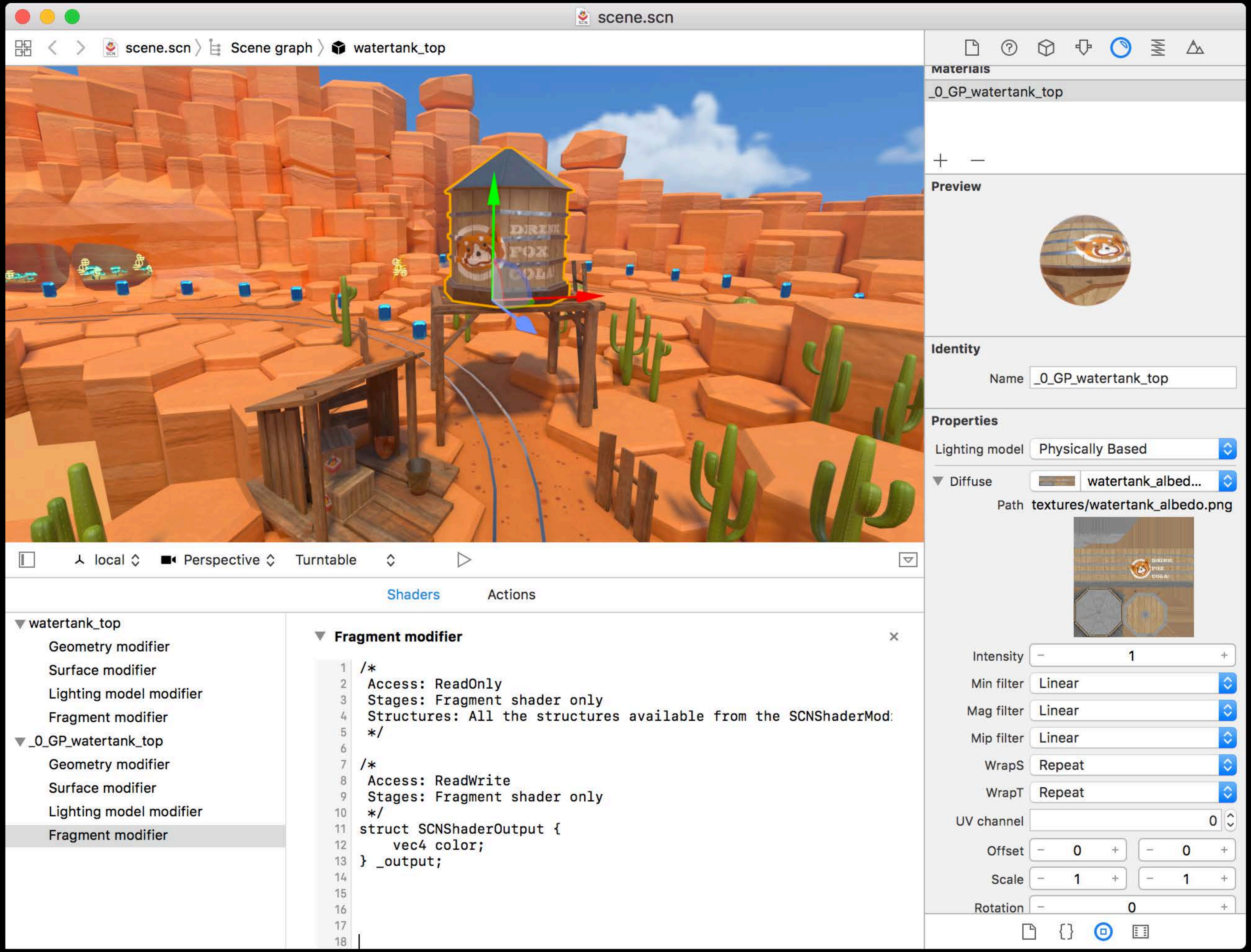
SceneKit Scene Editor

New features

New Shader Modifier Editor

Edit shader and material

Supports custom material properties



Fragment modifier

```
/*
 Access: ReadOnly
 Stages: Fragment shader only
 Structures: All the structures available from the SCNShaderMod
 */

/*
 Access: ReadWrite
 Stages: Fragment shader only
 */
struct SCNShaderOutput {
    vec4 color;
} _output;
```

Materials: _0_GP_watertank_top

Identity

Name: _0_GP_watertank_top

Properties

Lighting model: Physically Based

Diffuse: watertank_albed...

Path: textures/watertank_albedo.png

Intensity: 1

Min filter: Linear

Mag filter: Linear

Mip filter: Linear

WrapS: Repeat

WrapT: Repeat

UV channel: 0

Offset: 0 0

Scale: 1 1

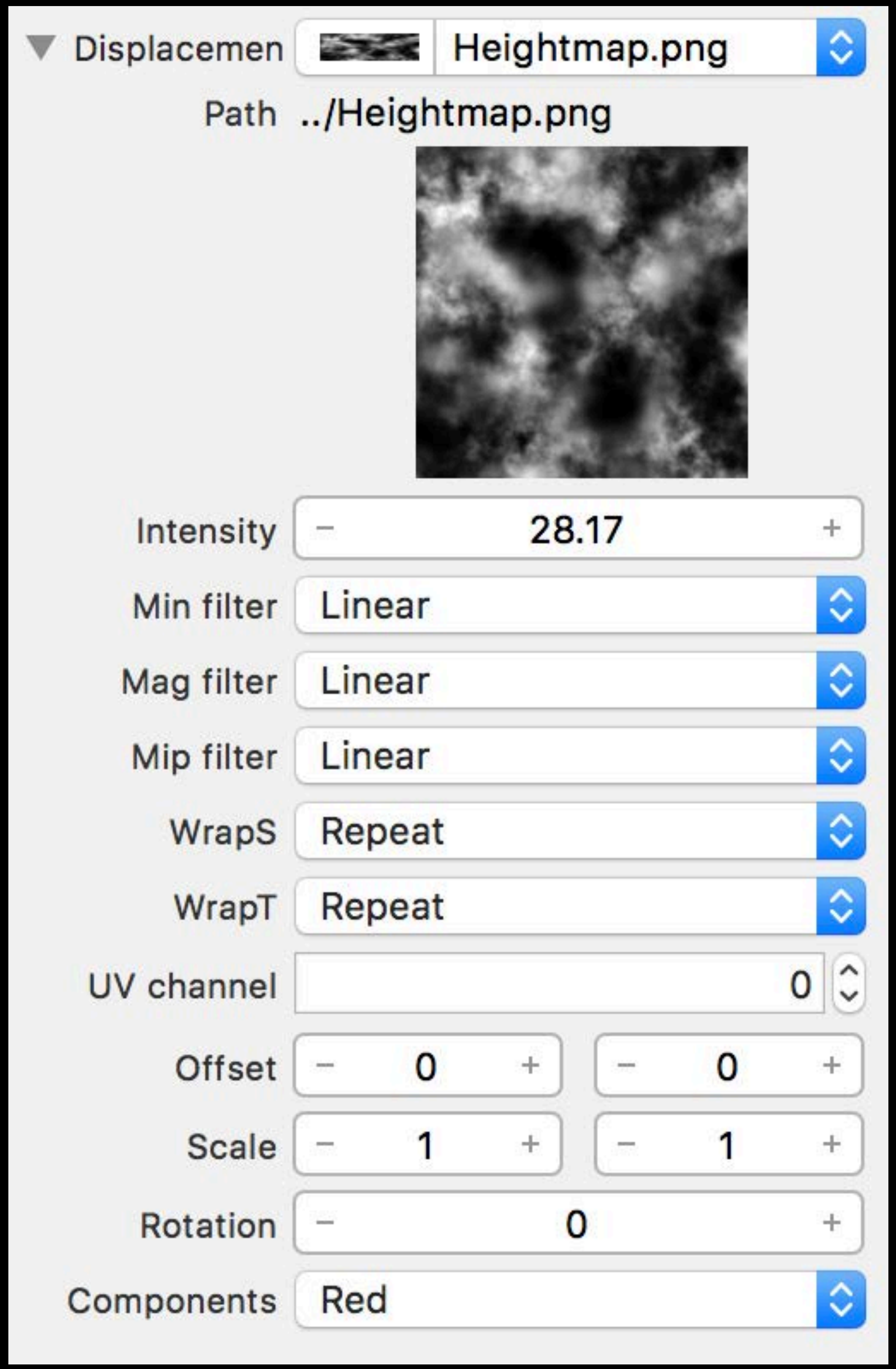
Rotation: 0

SceneKit Scene Editor

More features

NEW

- Displacement
- Tessellation
- Support for new constraints
- Cascaded shadows
- Procedural sky
- Override Materials for reference nodes



Displacemen	Heightmap.png
Path	../Heightmap.png
Intensity	28.17
Min filter	Linear
Mag filter	Linear
Mip filter	Linear
WrapS	Repeat
WrapT	Repeat
UV channel	0
Offset	0 0
Scale	1 1
Rotation	0
Components	Red

SceneKit Scene Editor

More features

NEW

Displacement

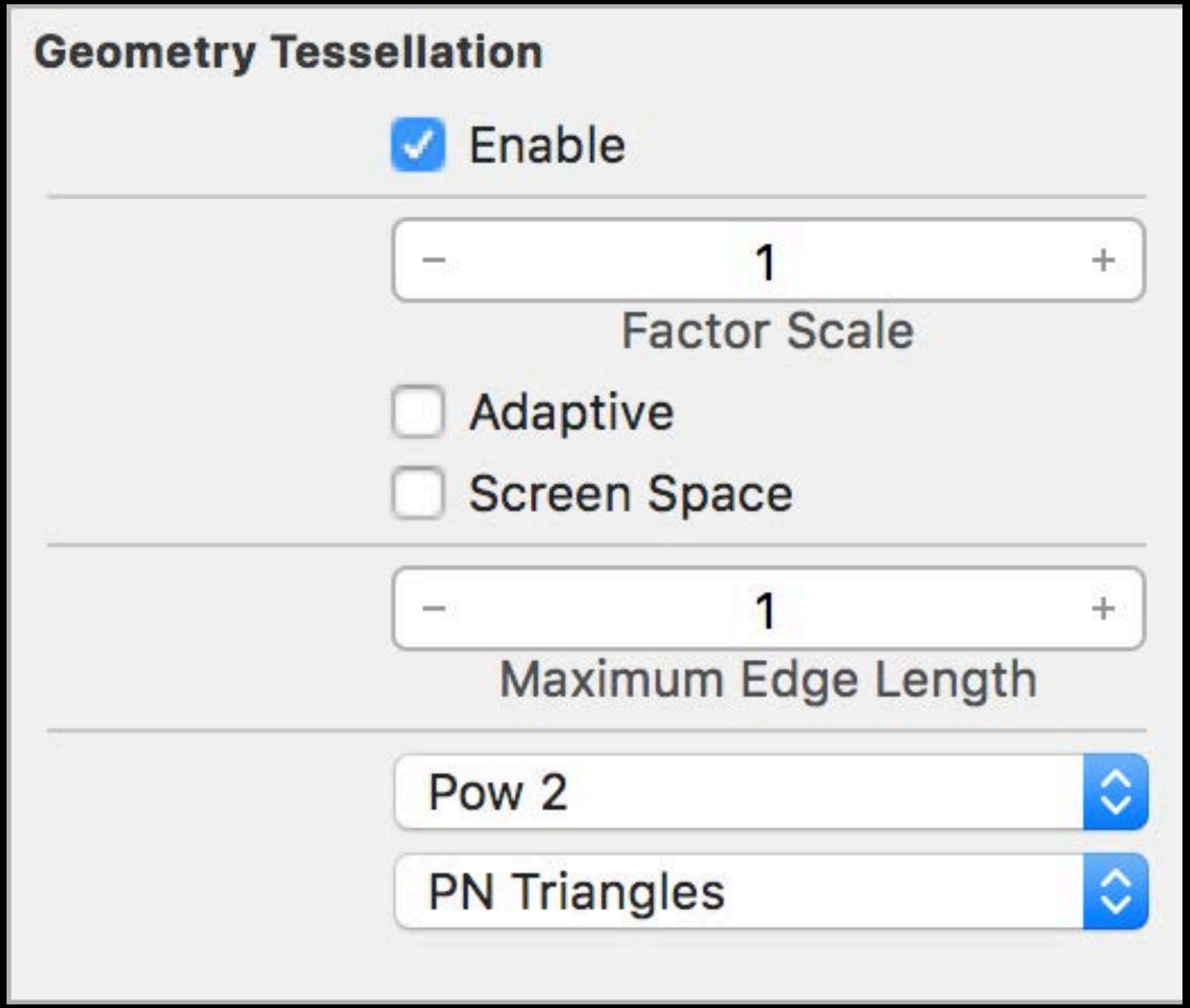
Tessellation

Support for new constraints

Cascaded shadows

Procedural sky

Override materials for reference nodes



Geometry Tessellation

☑ Enable

− 1 +

Factor Scale

□ Adaptive

□ Screen Space

− 1 +

Maximum Edge Length

Pow 2

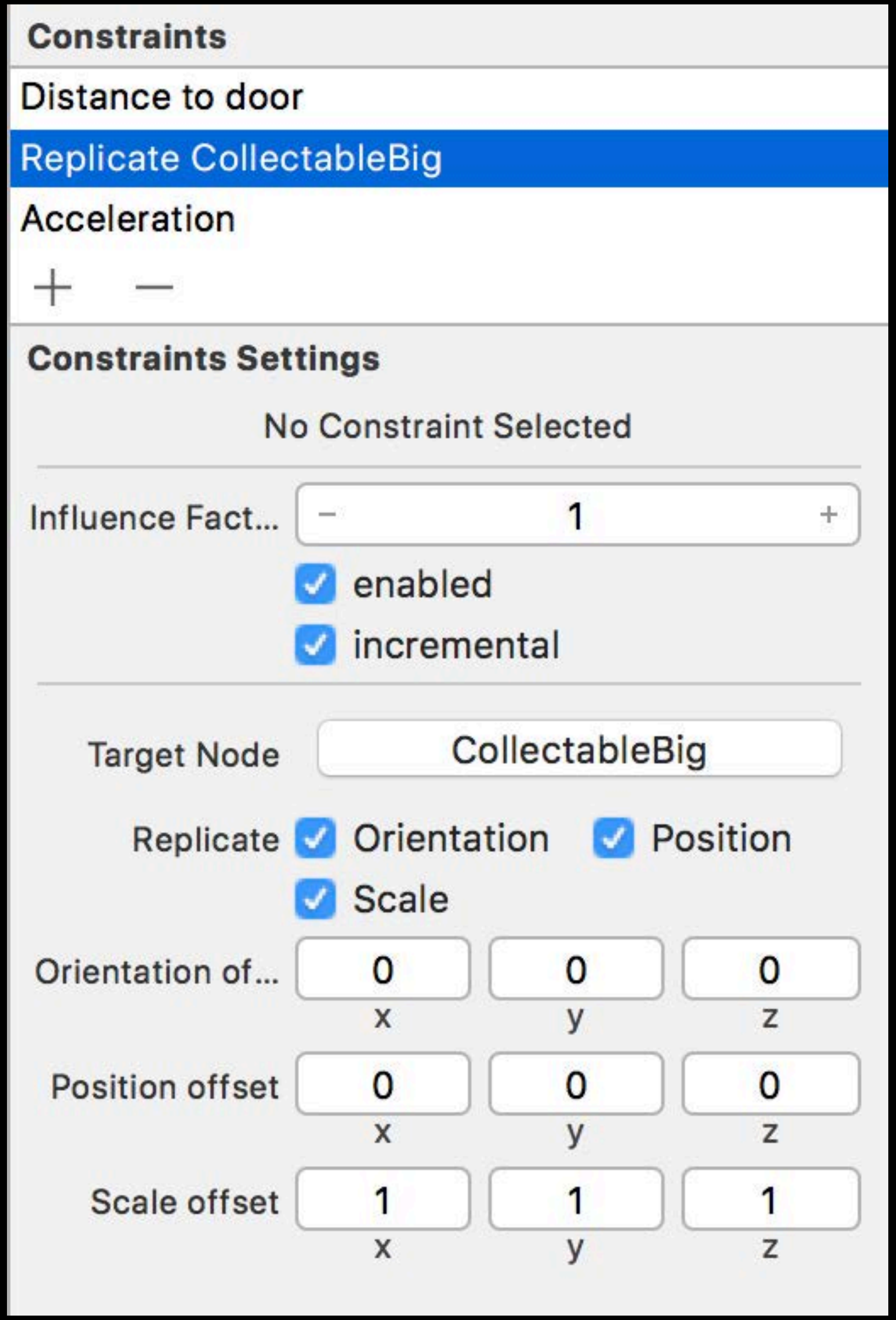
PN Triangles

SceneKit Scene Editor

More features

NEW

- Displacement
- Tessellation
- Support for new constraints
- Cascaded shadows
- Procedural sky
- Override materials for reference nodes



Constraints

Distance to door

Replicate CollectableBig

Acceleration

+ —

Constraints Settings

No Constraint Selected

Influence Fact... − 1 +

☑ enabled

☑ incremental

Target Node CollectableBig

Replicate ☑ Orientation ☑ Position

☑ Scale

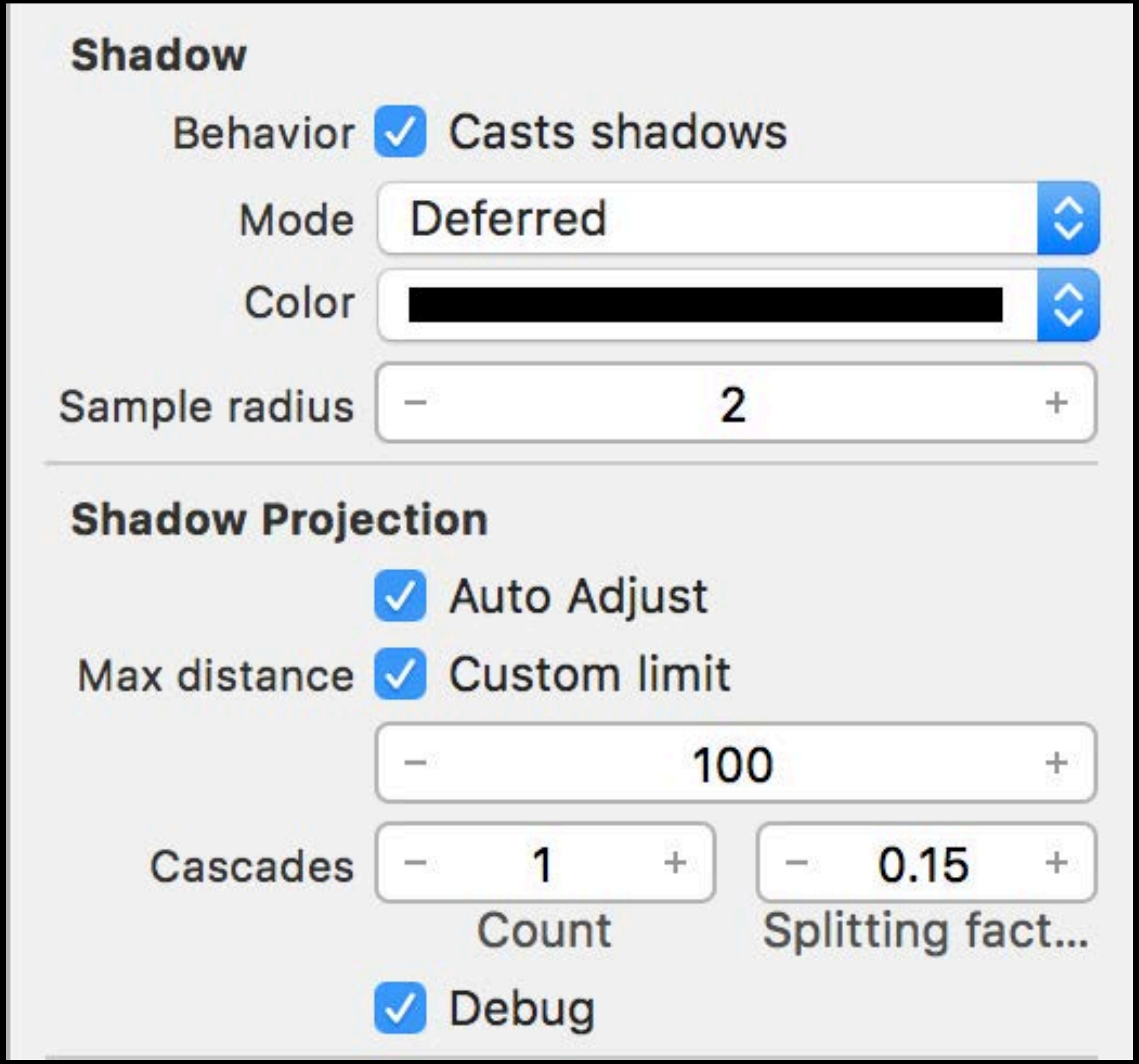
	x	y	z
Orientation of...	0	0	0
Position offset	0	0	0
Scale offset	1	1	1

SceneKit Scene Editor

More features

NEW

- Displacement
- Tessellation
- Support for new constraints
- Cascaded shadows
- Procedural sky
- Override materials for reference nodes



Shadow

Behavior ☑ Casts shadows

Mode: Deferred

Color: ■

Sample radius: 2

Shadow Projection

☑ Auto Adjust

Max distance ☑ Custom limit

100

Cascades: 1 (Count), 0.15 (Splitting fact...)

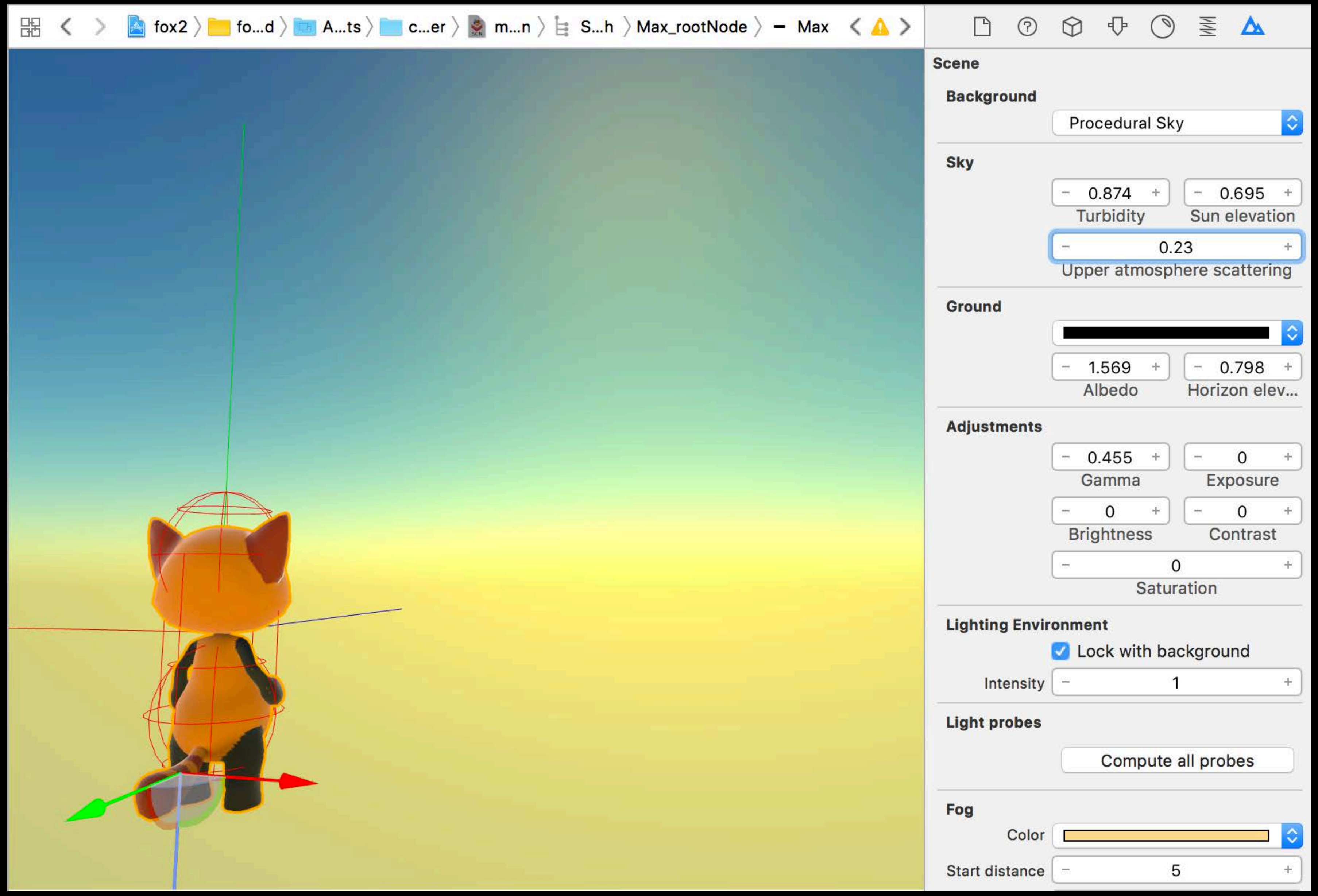
☑ Debug

SceneKit Scene Editor

More features

NEW

- Displacement
- Tessellation
- Support for new constraints
- Cascaded shadows
- Procedural sky
- Override materials for reference nodes


fox2 〉 fo...d 〉 A...ts 〉 c...er 〉 m...n 〉 S...h 〉 Max_rootNode 〉 Max

Scene

Background: Procedural Sky

Sky
- Turbidity: 0.874
- Sun elevation: 0.695
- Upper atmosphere scattering: 0.23

Ground
- Albedo: 1.569
- Horizon elev...: 0.798

Adjustments
- Gamma: 0.455
- Exposure: 0
- Brightness: 0
- Contrast: 0
- Saturation: 0

Lighting Environment
- ☑ Lock with background
- Intensity: 1

Light probes

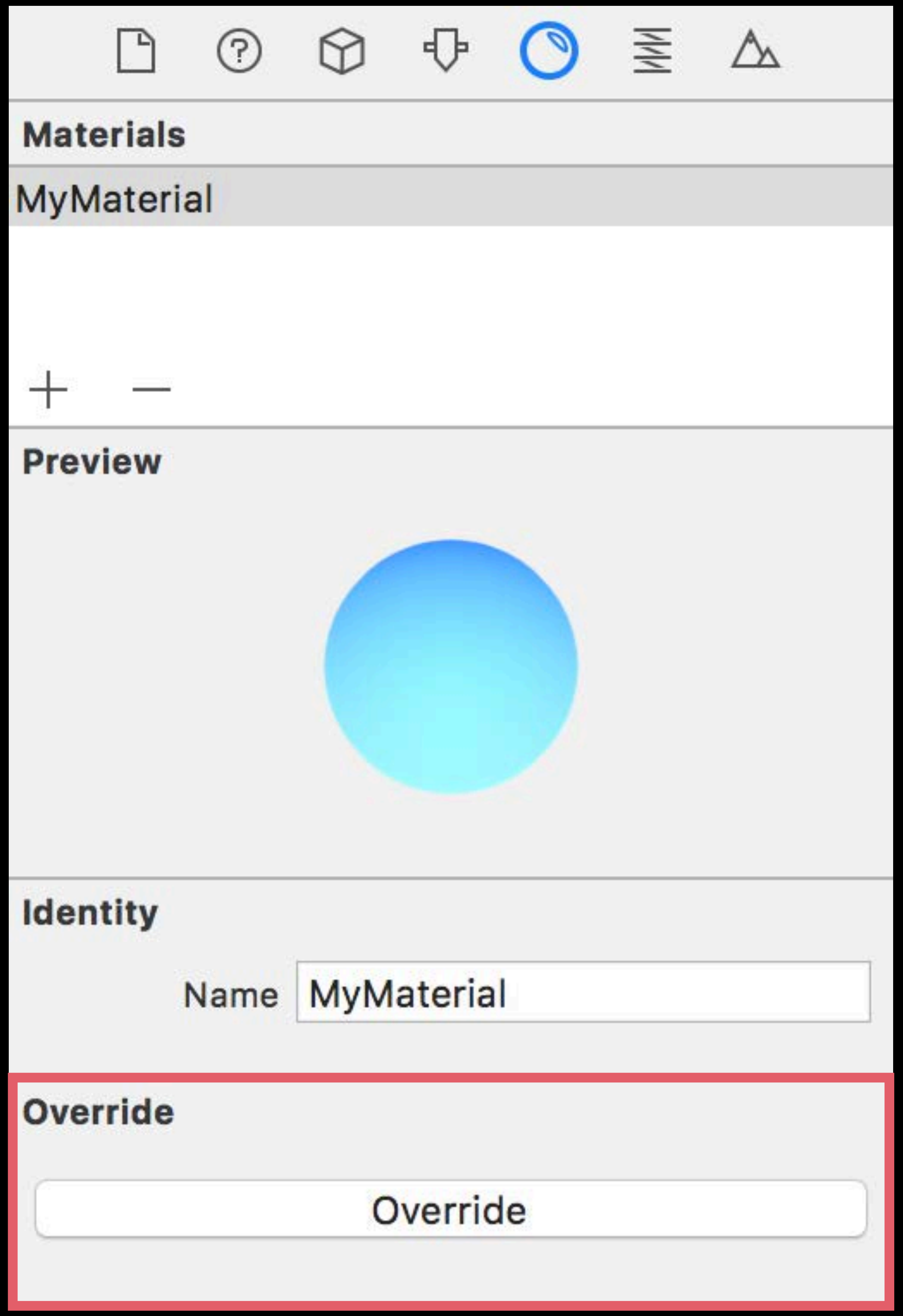
Fog
- Color
- Start distance: 5

SceneKit Scene Editor

More features

NEW

- Displacement
- Tessellation
- Support for new constraints
- Cascaded shadows
- Procedural sky
- Override materials for reference nodes



Materials

MyMaterial

Preview

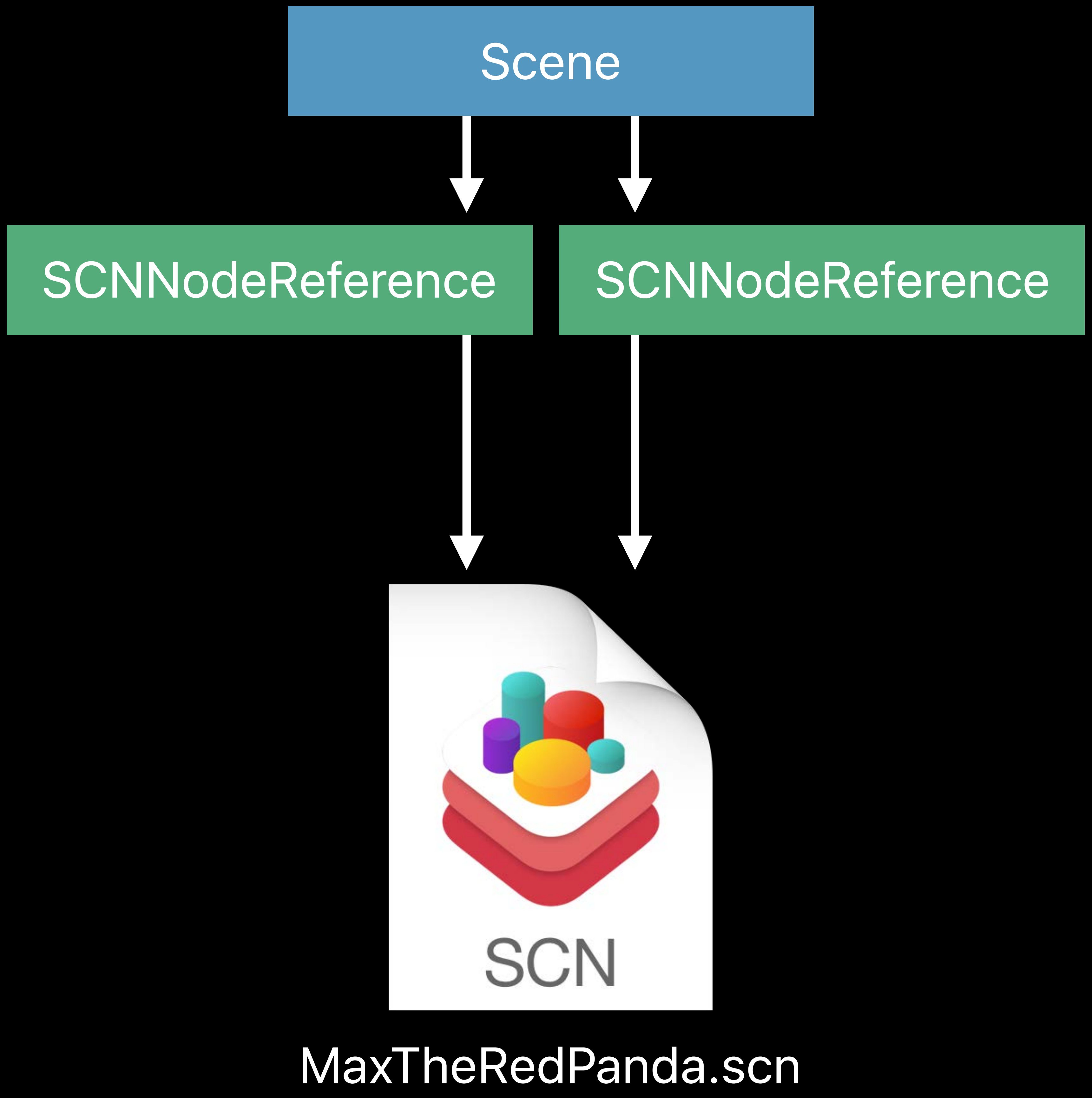
Identity

Name MyMaterial

Override

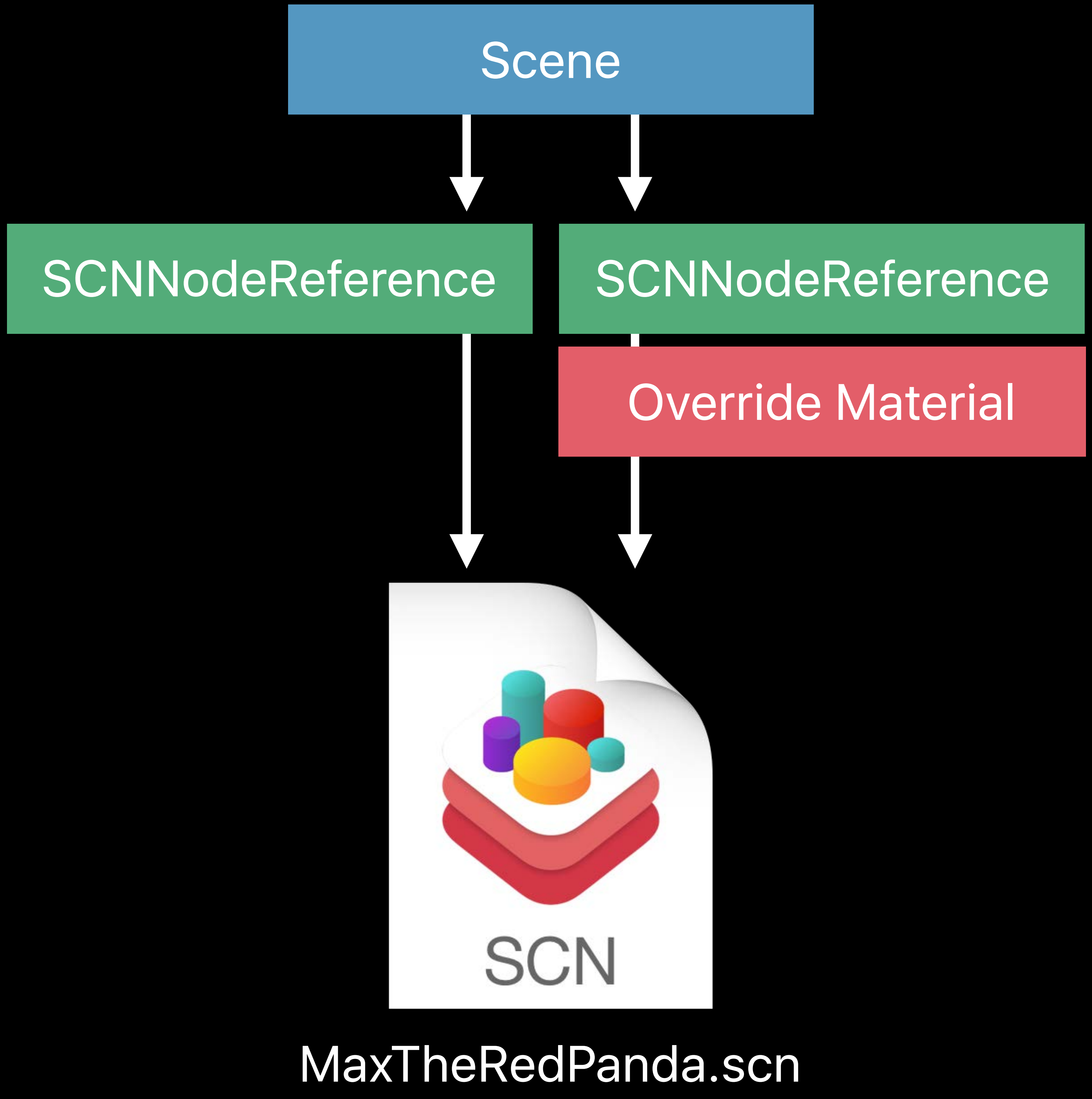
SceneKit Scene Editor

Material overrides



SceneKit Scene Editor

Material overrides



Scene

SCNNodeReference

SCNNodeReference

Override Material

MaxTheRedPanda.scn

Related Technologies

Thomas Goossens, SceneKit engineer

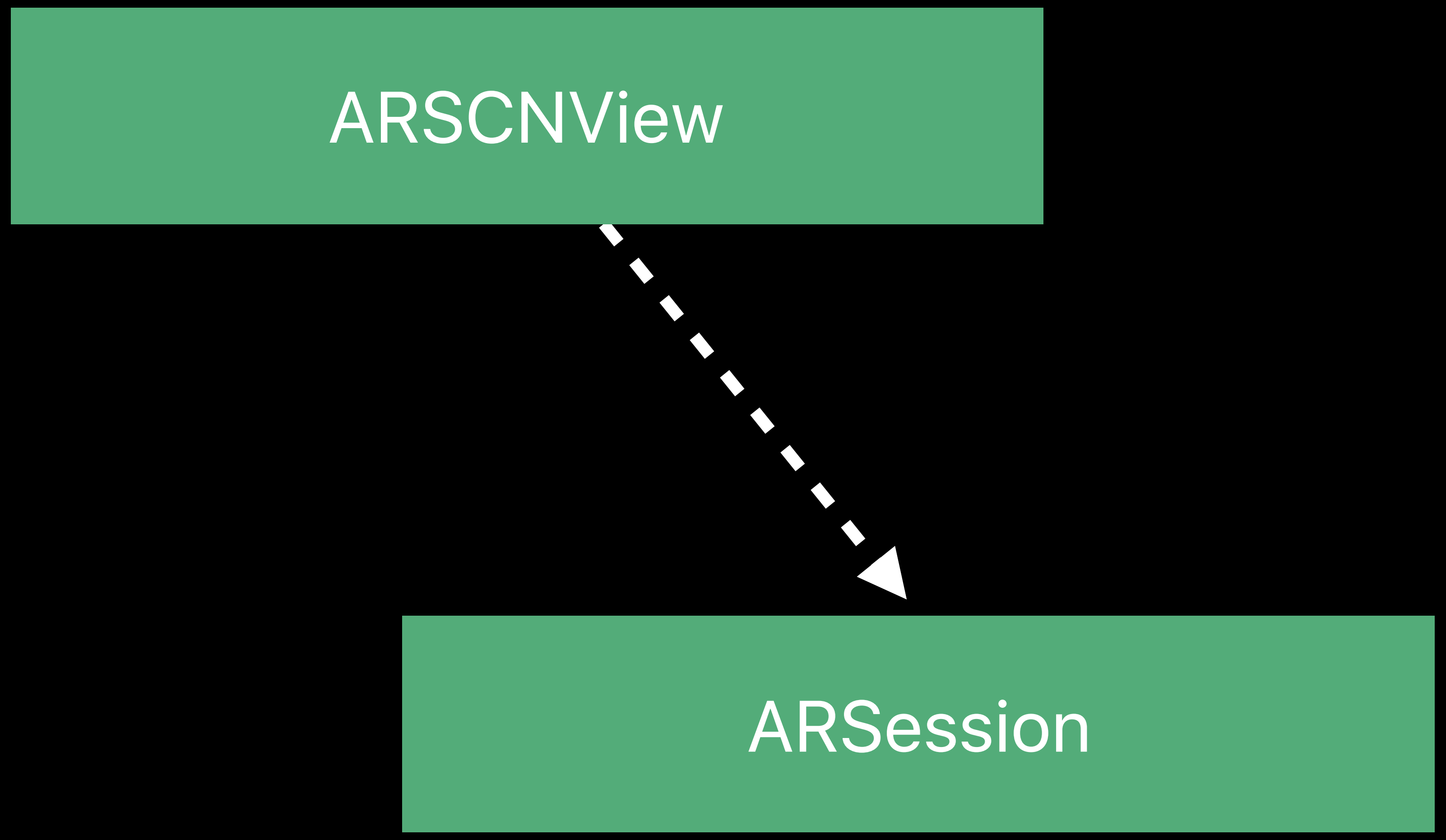
AR

Augmented Reality

ARKit

ARSCNView

'Out of the box' solution for AR

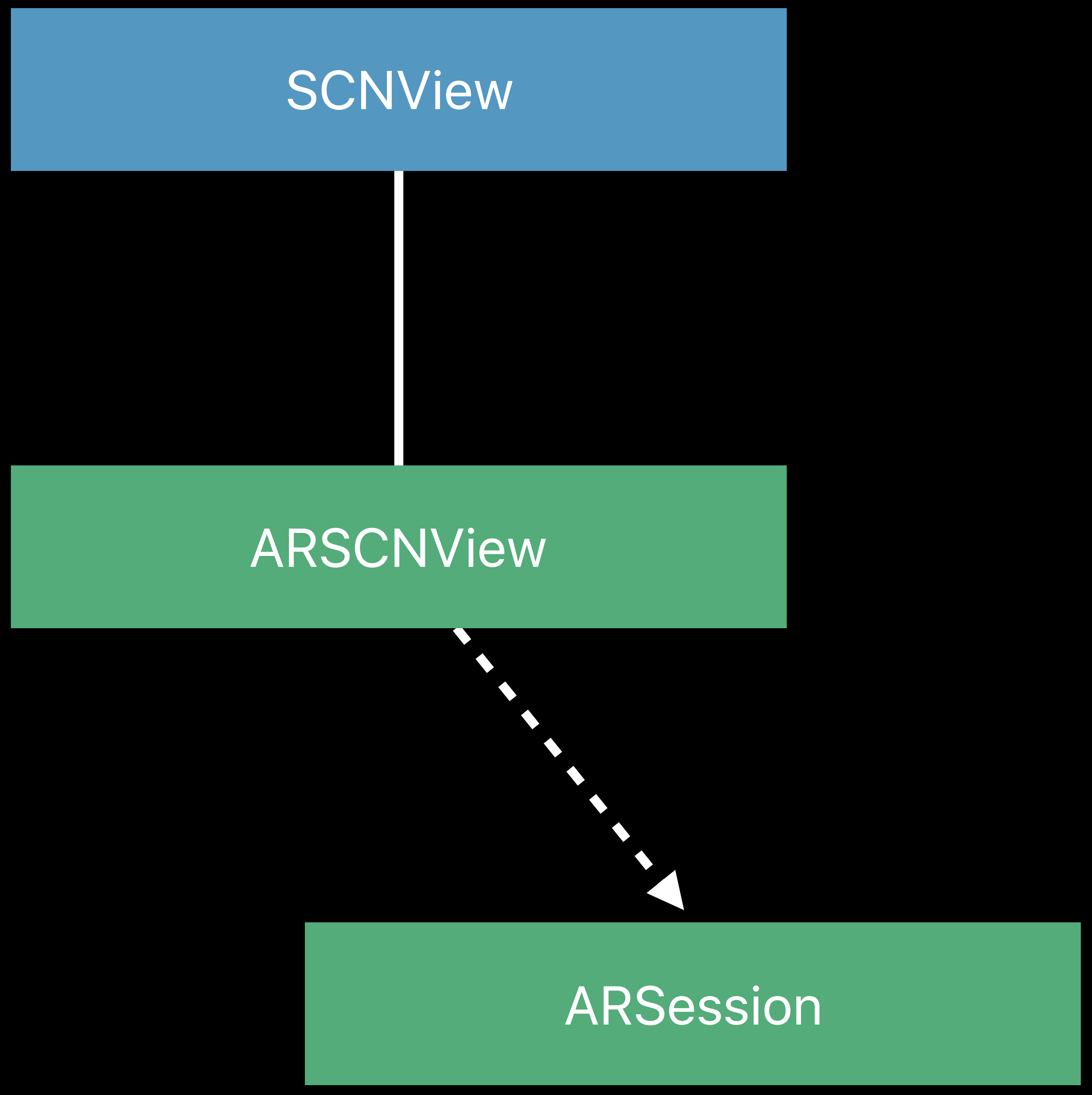


Augmented Reality

ARKit

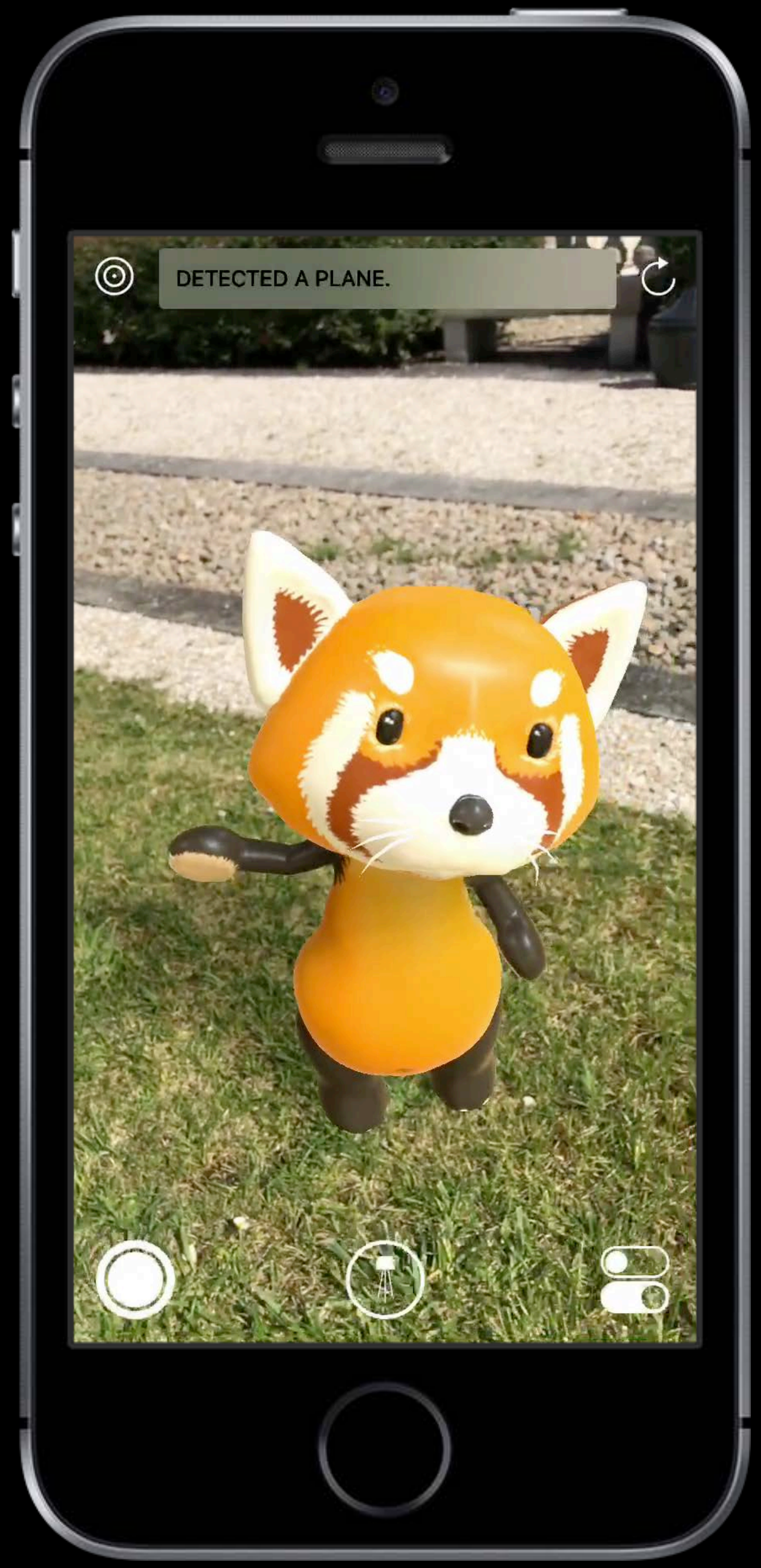
All SceneKit available via `ARSCNView`

- Scene graph
- Camera
- Post process
- Particles…



Augmented Reality

```
// Run the AR session
arView.session.run(configuration)

// Called on the view's delegate
// when a new anchor is found by ARKit
func renderer(_ renderer: SCNSceneRenderer,
              didAdd node: SCNNode,
              for anchor: ARAnchor)
{
   // attach a 3D node to the anchor node
   node.addChildNode(maxTheRedPanda)
}
```



Augmented Reality

ARKit

New support for background video

- Camera feed using `AVCaptureDevice`
- Video using `AVPlayer`
- Automatic with `ARSCNView`

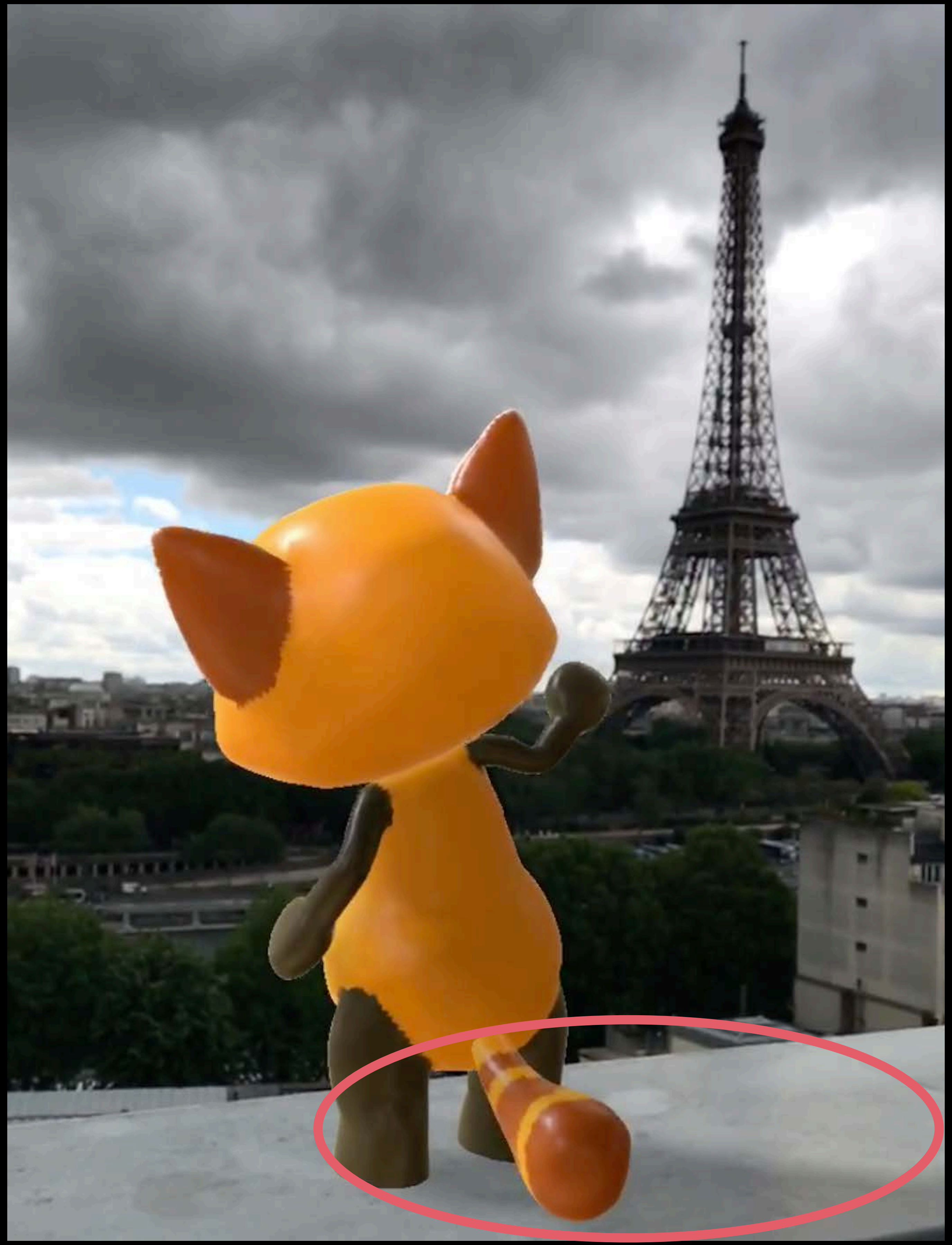
```
// Setup background video
let captureDevice: AVCaptureDevice = …
scene.background.contents = captureDevice
```

Augmented Reality

Drop shadow trick

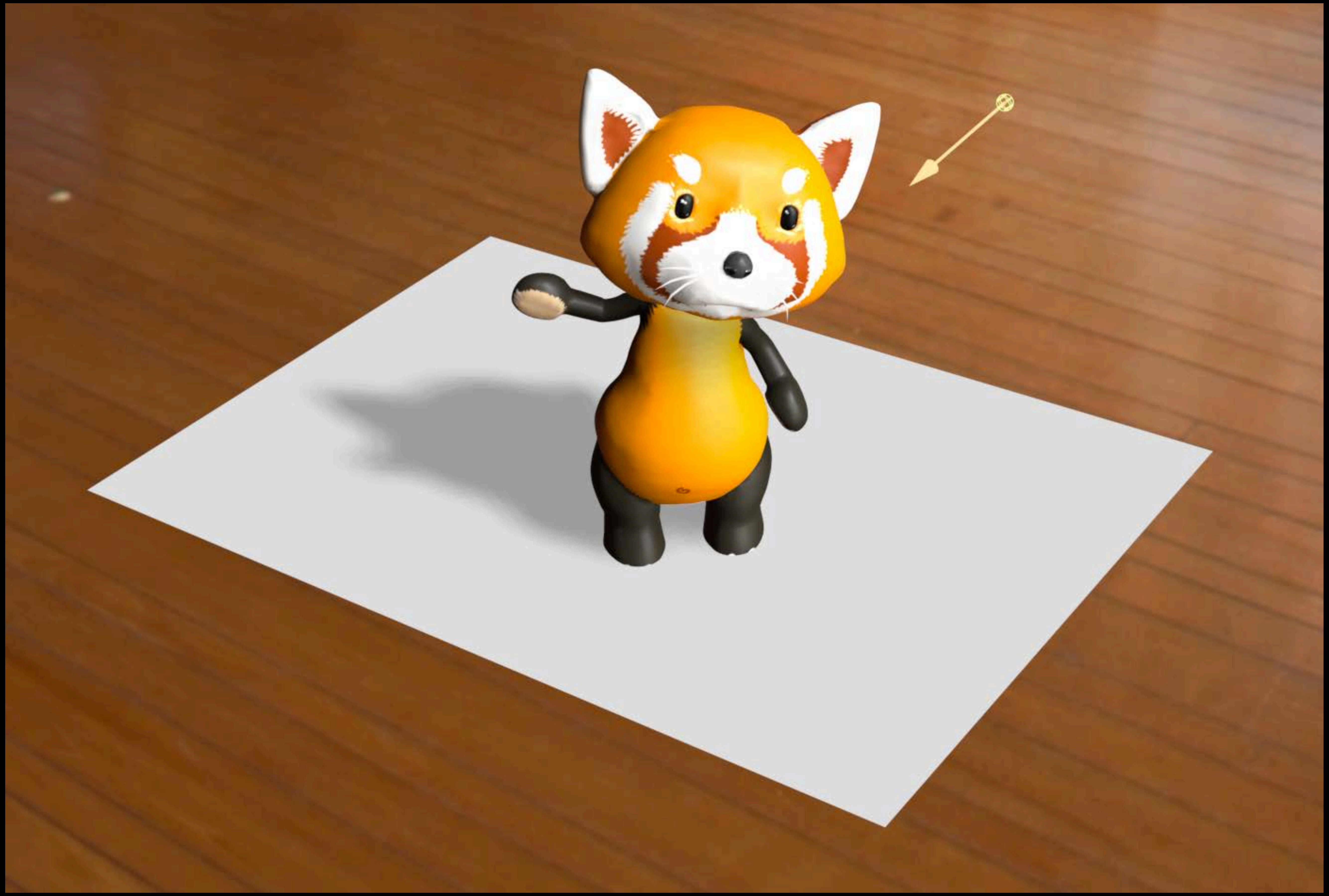
Augmented Reality

Drop shadow trick



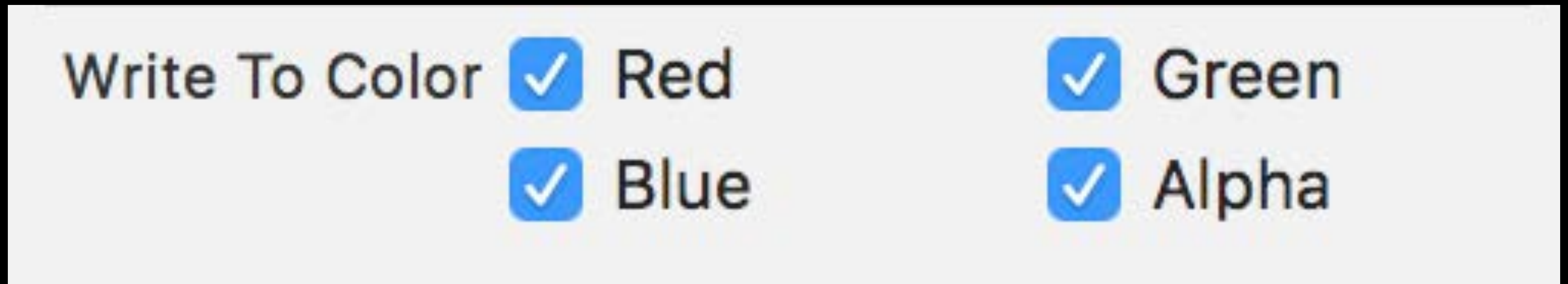
Augmented Reality

Drop shadow trick



Augmented Reality

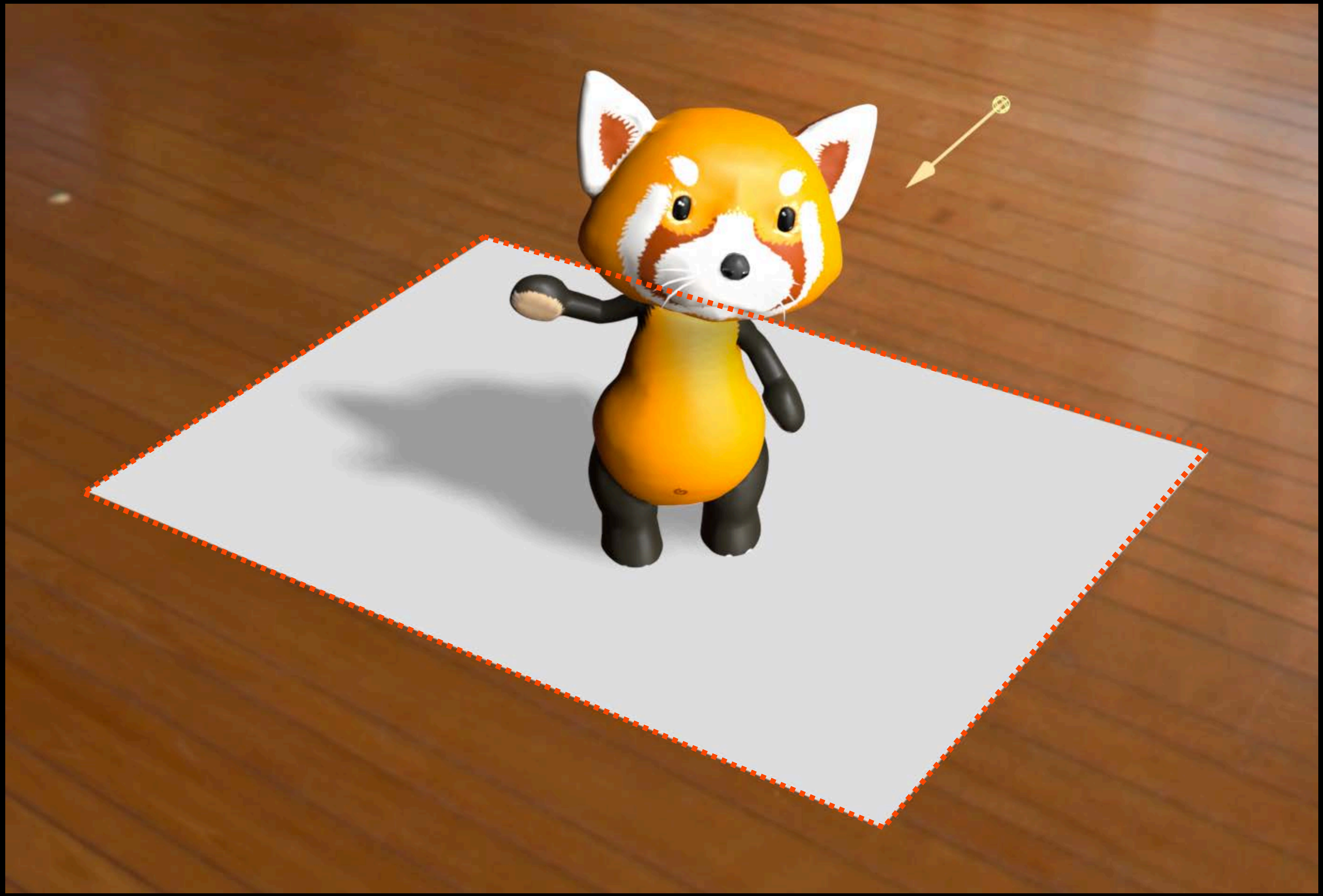
Drop shadow trick



Write To Color ☑ Red ☑ Green

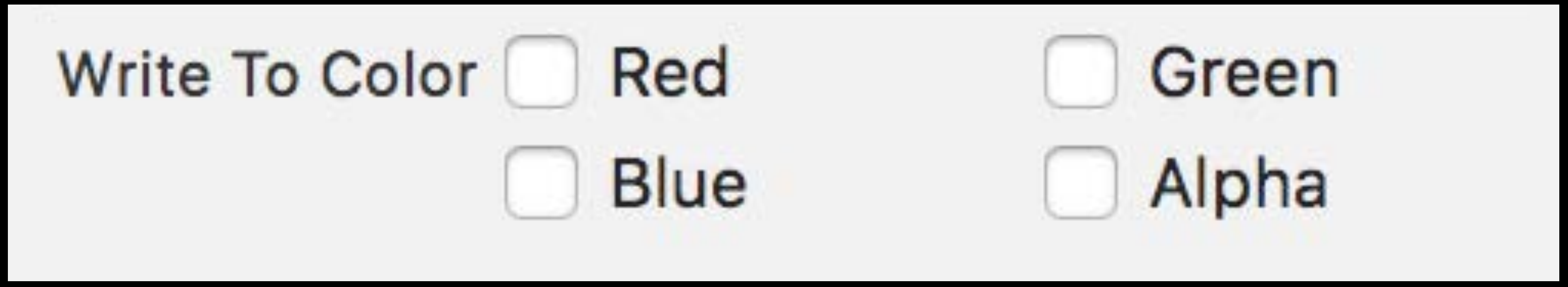
☑ Blue ☑ Alpha

Material Inspector



Augmented Reality

Drop shadow trick

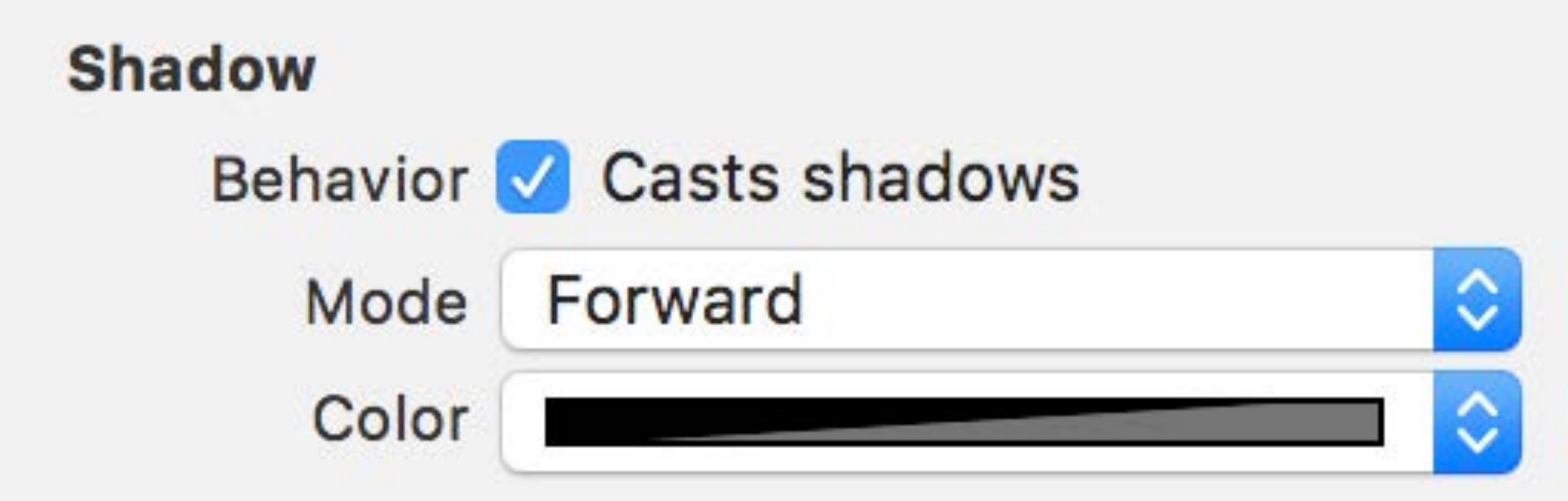


Write To Color □ Red □ Green
□ Blue □ Alpha

Material Inspector

Augmented Reality

Drop shadow trick



Shadow

Behavior ☑ Casts shadows

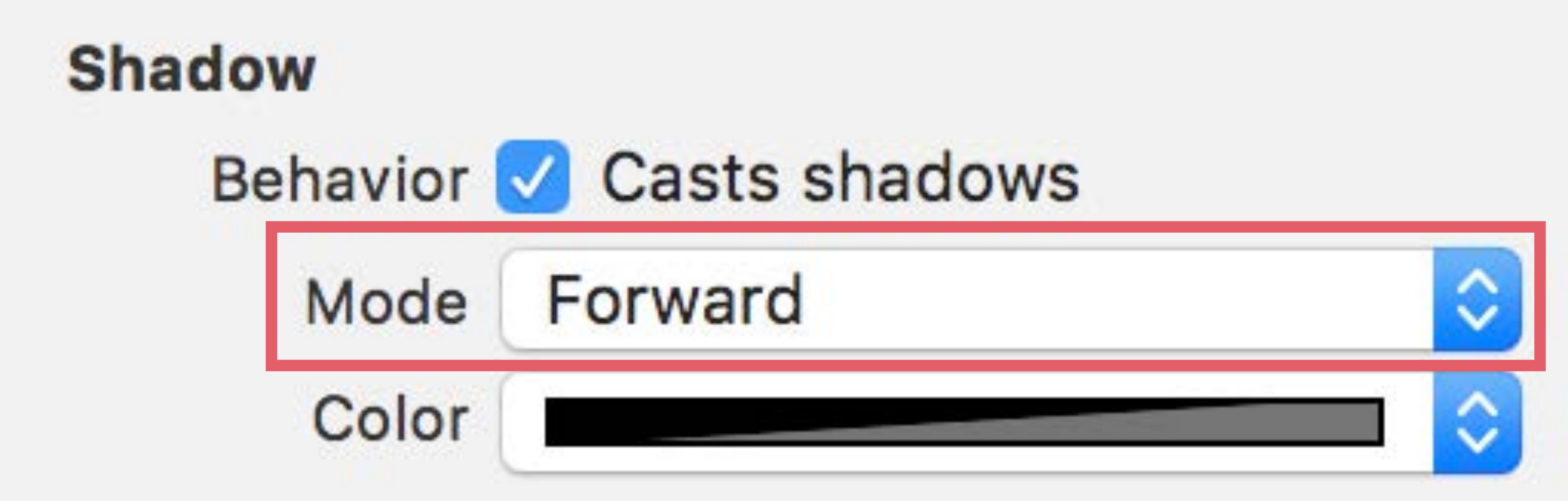
Mode Forward

Color

Light Inspector

Augmented Reality

Drop shadow trick



Shadow

Behavior ☑ Casts shadows

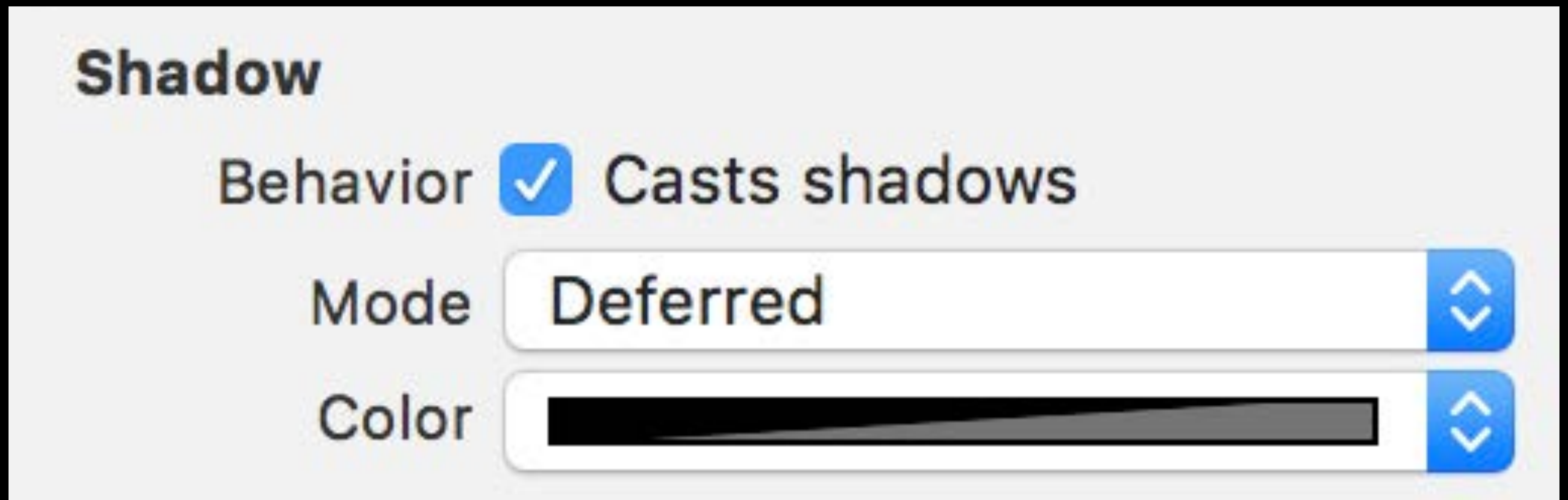
Mode: Forward

Color

Light Inspector

Augmented Reality

Drop shadow trick



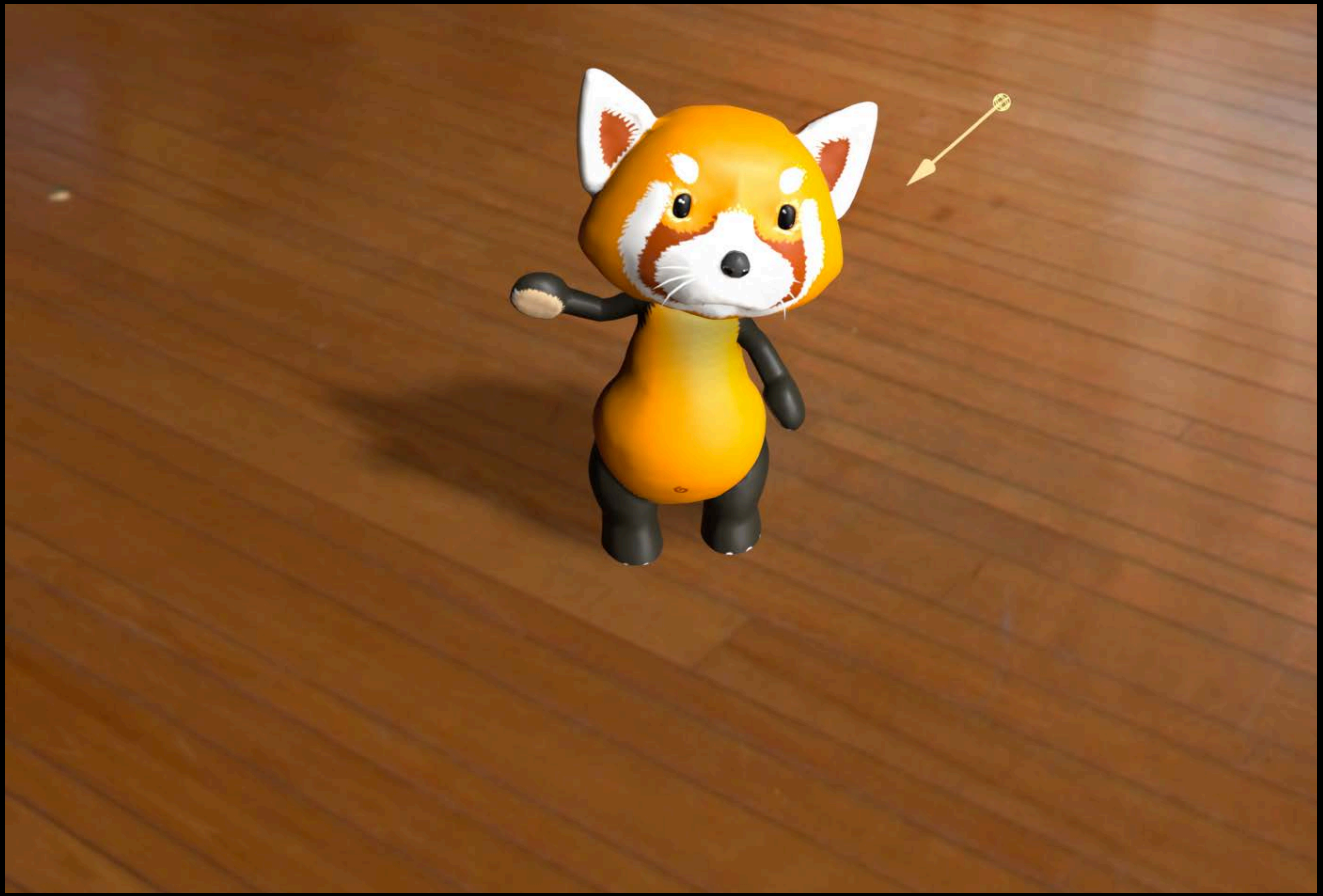
Shadow

Behavior ☑ Casts shadows

Mode Deferred

Color

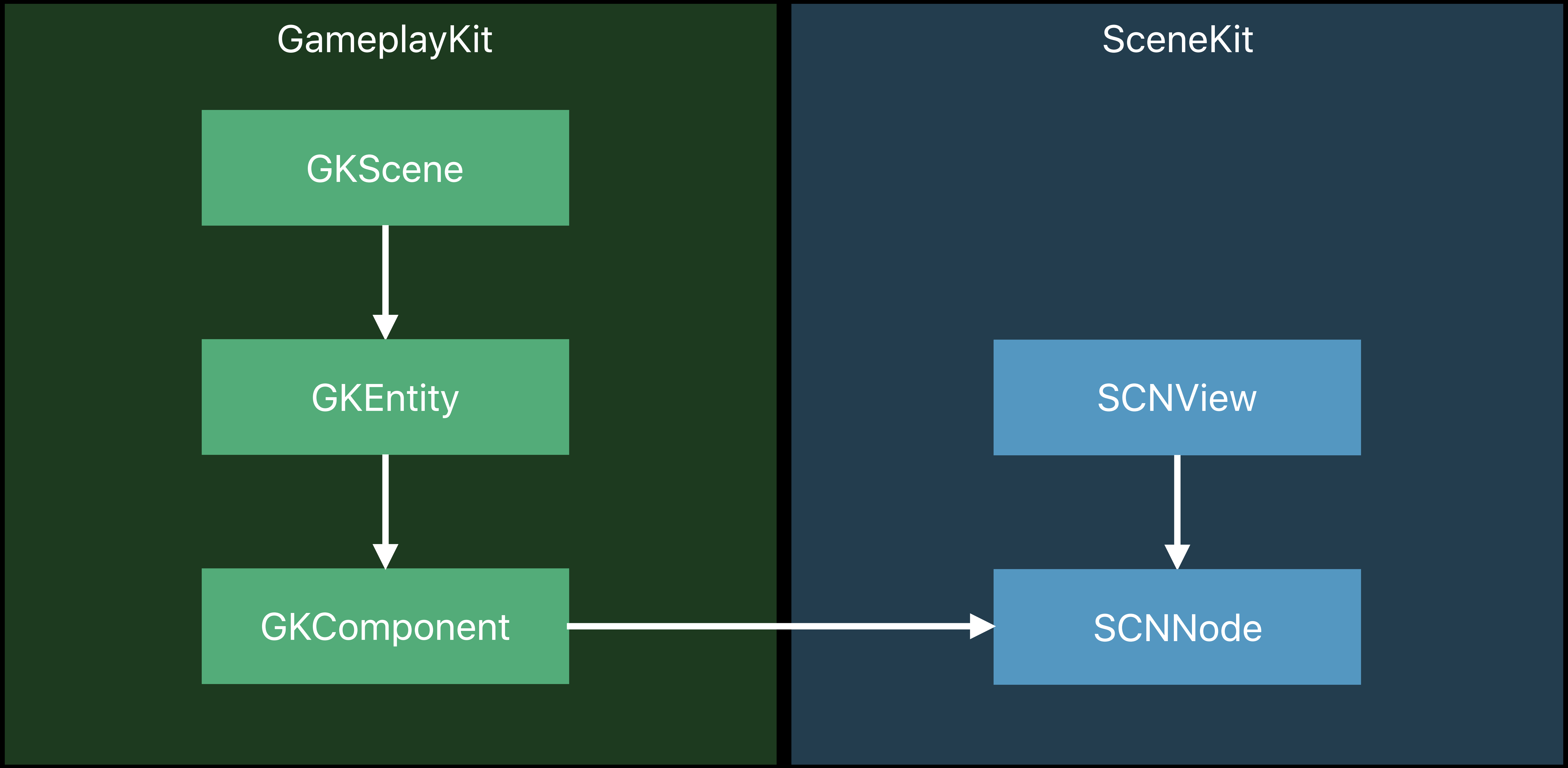
Light Inspector



Related Technologies

GameplayKit entity/components

NEW

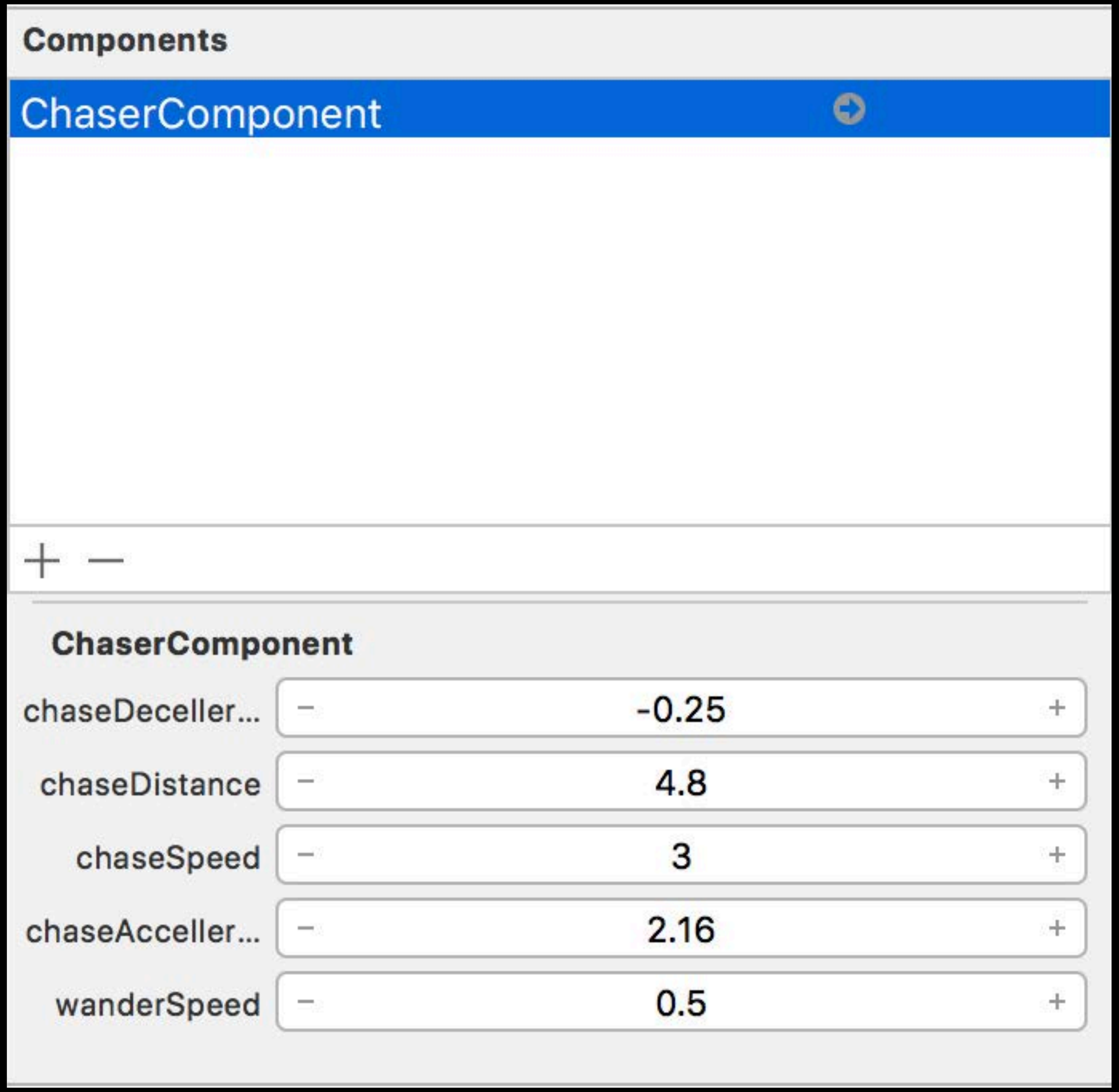


GameplayKit Entity/Components

NEW

Use GameplayKit to drive SceneKit

Integrated in Xcode



Components

ChaserComponent

ChaserComponent

chaseDeceller...	-0.25
chaseDistance	4.8
chaseSpeed	3
chaseAcceller...	2.16
wanderSpeed	0.5

Related Technologies

Model I/O

Improved support for USD

Better material bridging

Support for animations

From Art to Engine with Model I/O	Executive Ballroom	Friday 2:50PM

Related Technologies

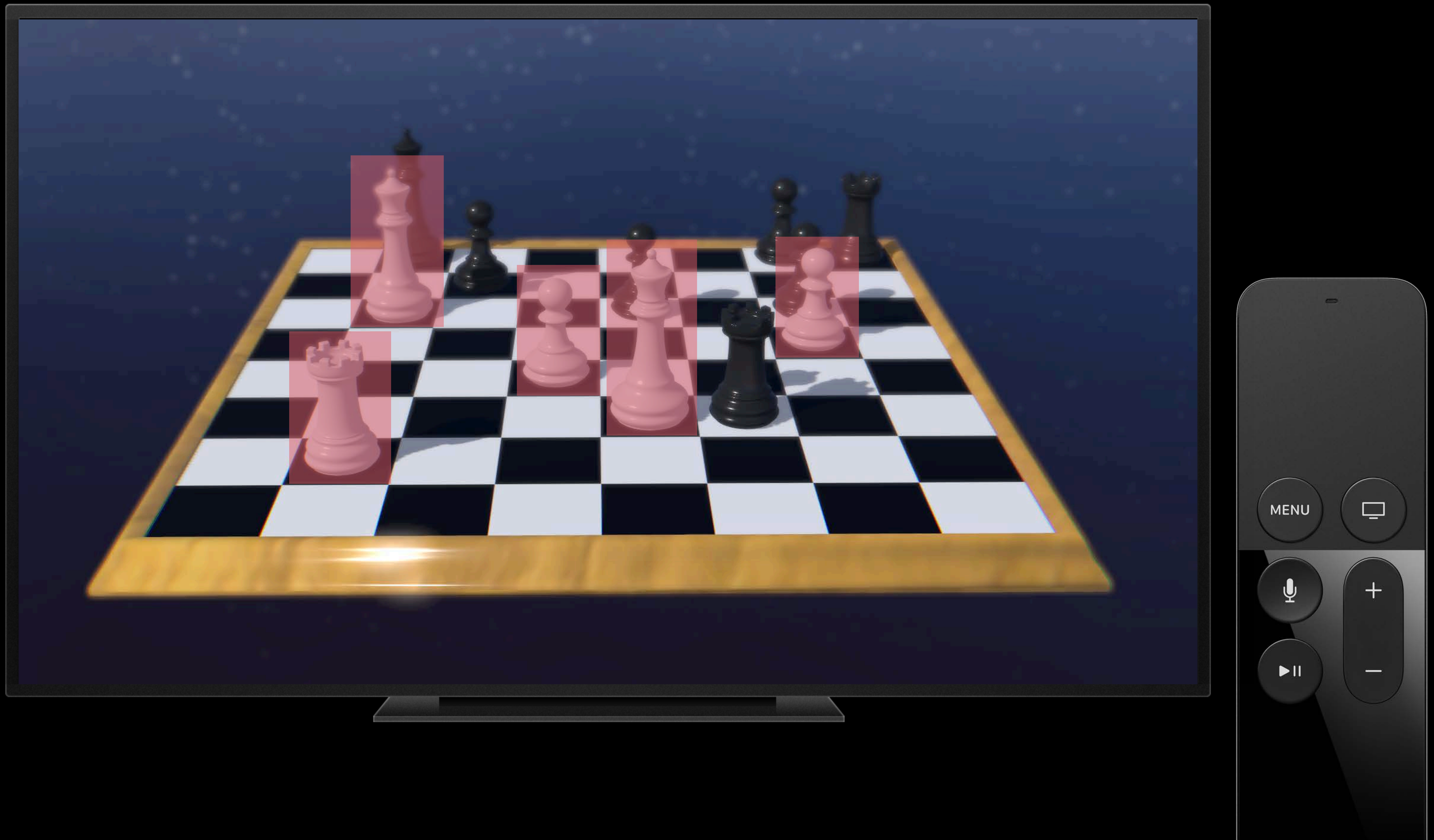
UIFocus support

`SCNNode` conforms to `UIFocusItem`

```
node.focusBehavior = .none // or .occluding or .focusable
// in ViewController
override func didUpdateFocus(in context: UIFocusUpdateContext,
                             with coordinator: UIFocusAnimationCoordinator) {
    if let node = context.nextFocusedItem as? SCNNode {
        // …
    }
}
```

UIFocus Support

UIFocus Support



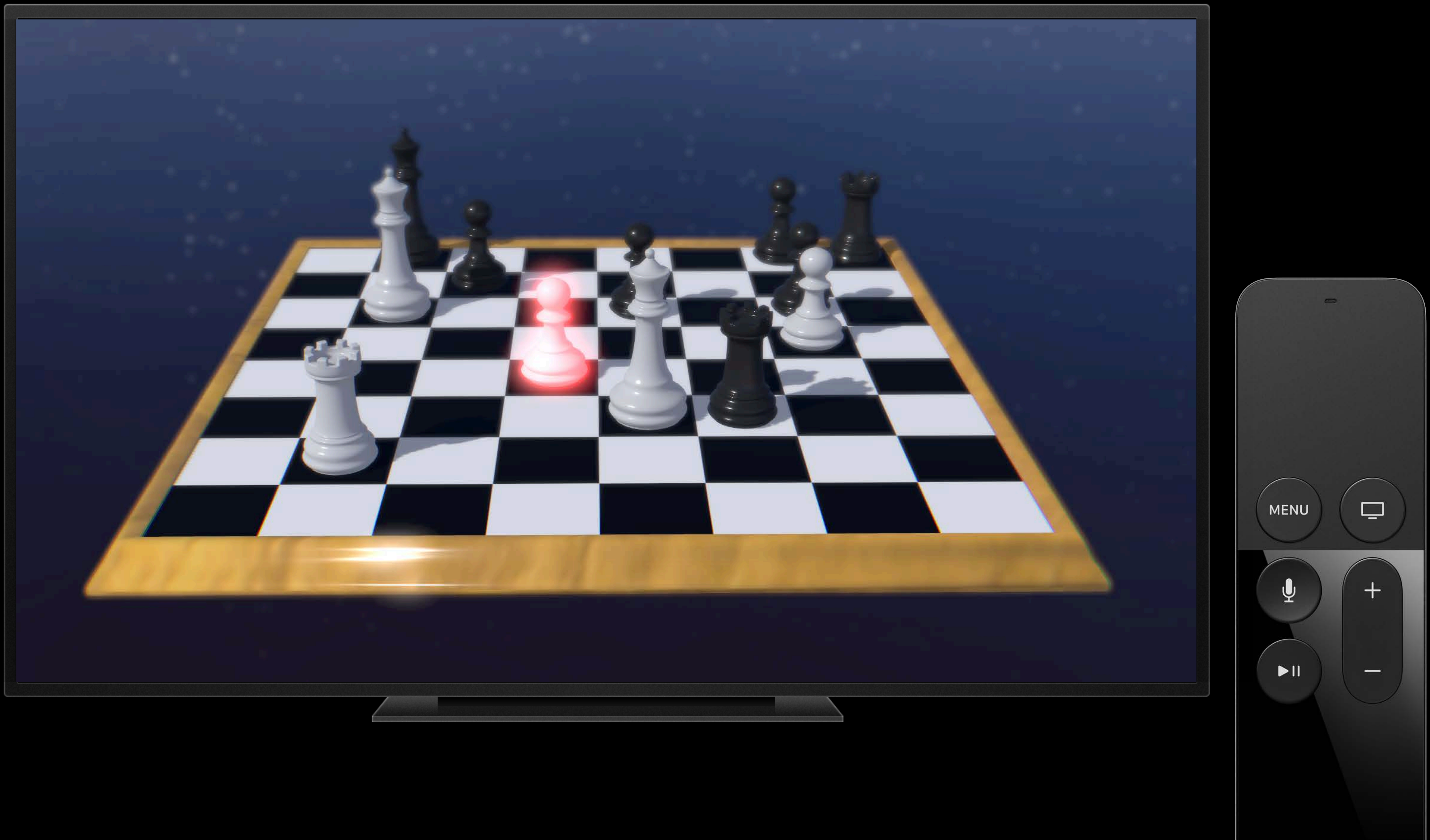
UIFocus Support

UIFocus Support

UIFocus Support

UIFocus Support

UIFocus Support



UIFocus Support

UIFocus Support

UIFocus Support

Rendering Additions

Point Cloud Rendering

NEW

```
geometry.pointSize = size
geometry.minimumPointScreenSpaceRadius = 5.0
geometry.maximumPointScreenSpaceRadius = 1.0
```

Point Cloud Rendering

NEW

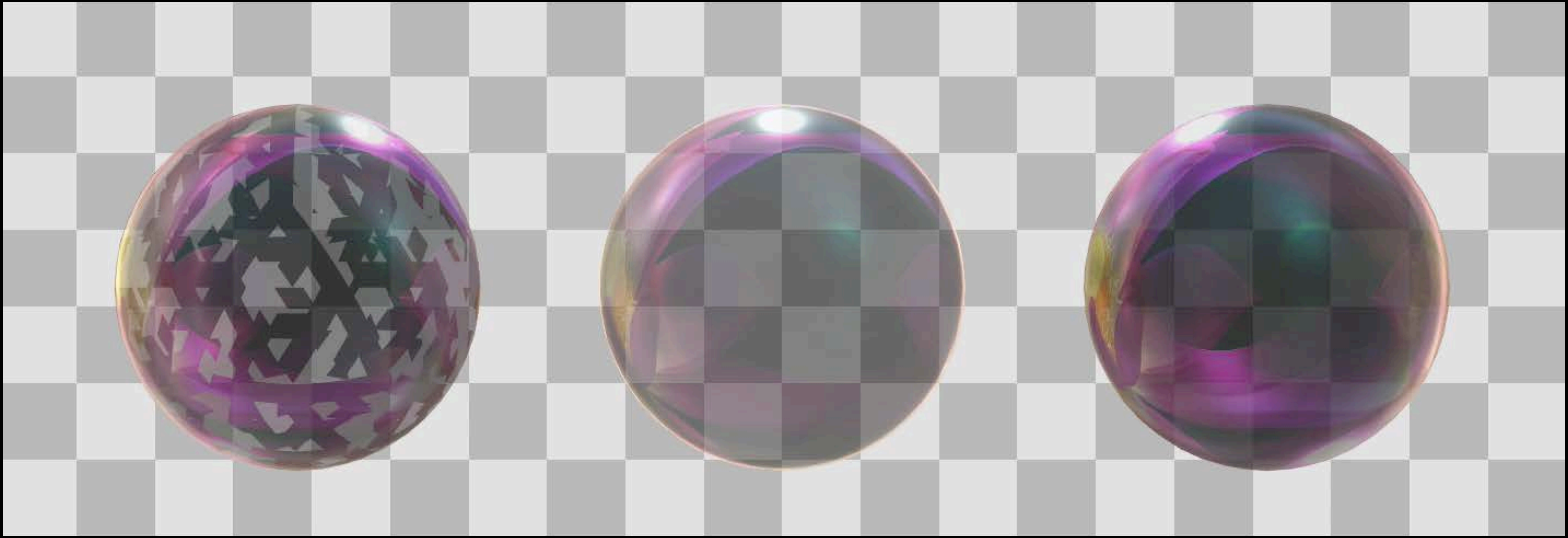
```
geometry.pointSize = size
geometry.minimumPointScreenSpaceRadius = 5.0
geometry.maximumPointScreenSpaceRadius = 1.0
```

Transparency Modes

Single layer, dual layer

NEW

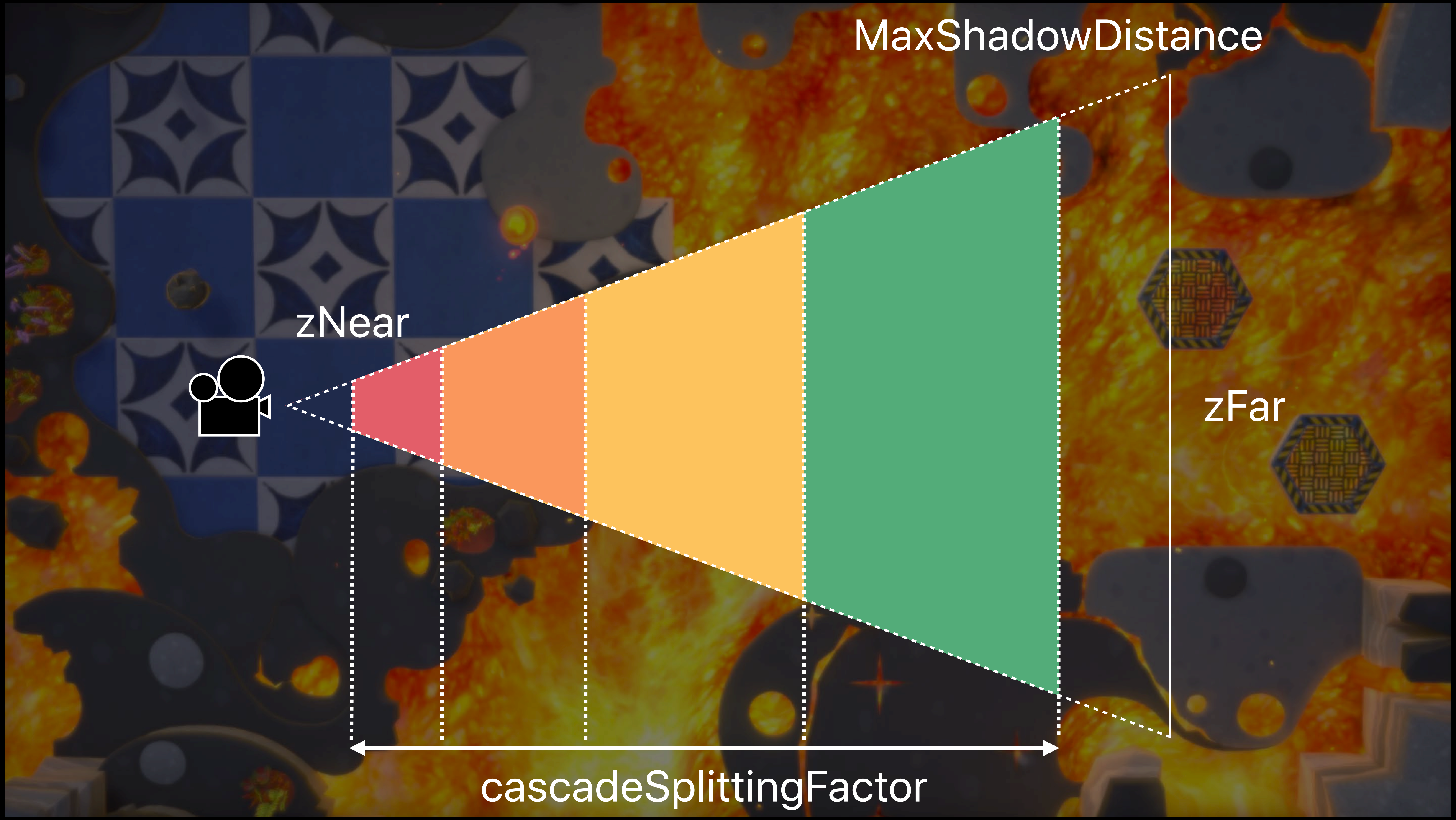
`.default` `.singleLayer` `.dualLayer`



Transparency Modes

Dual layer

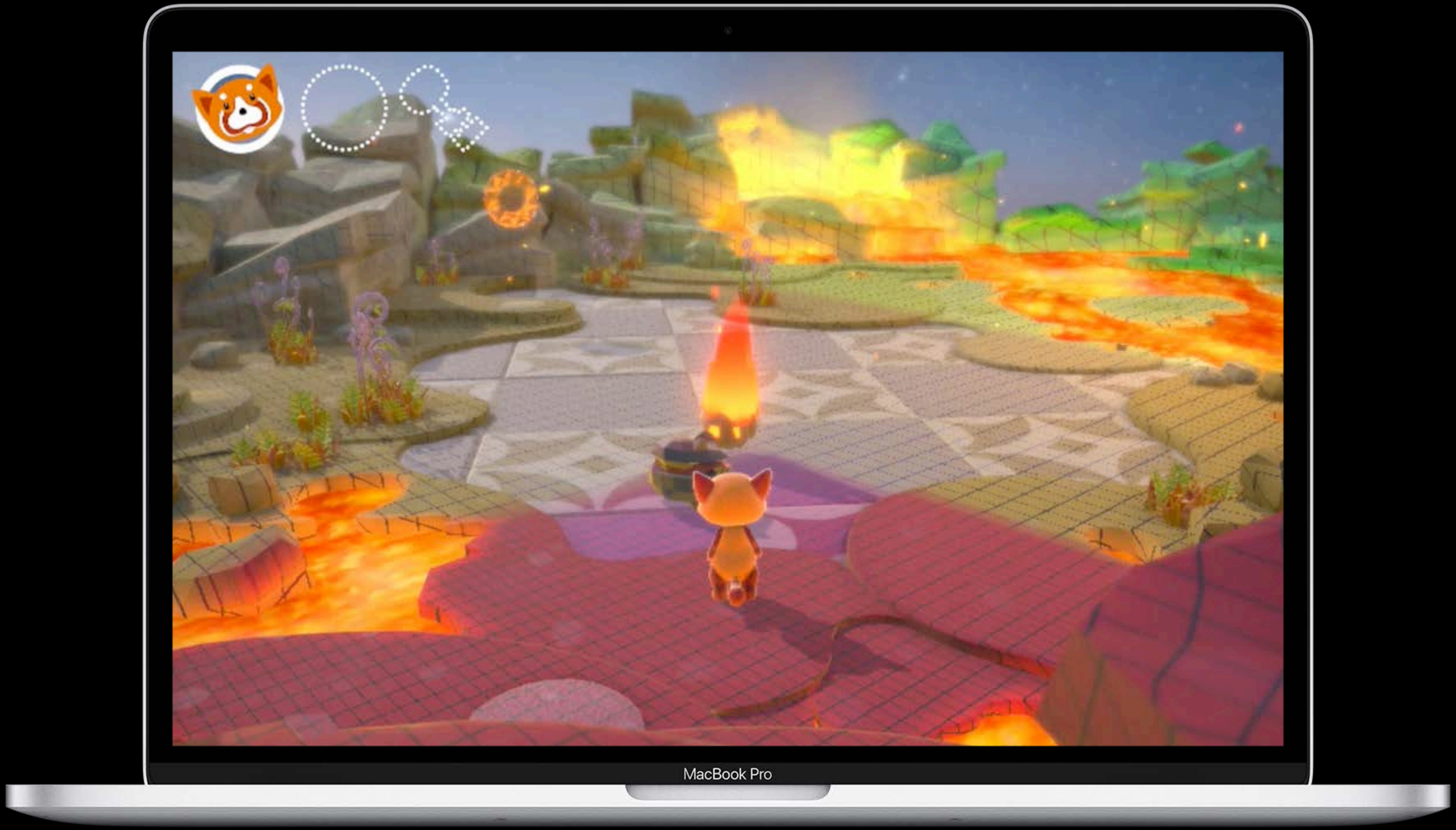
Cascaded Shadow Maps



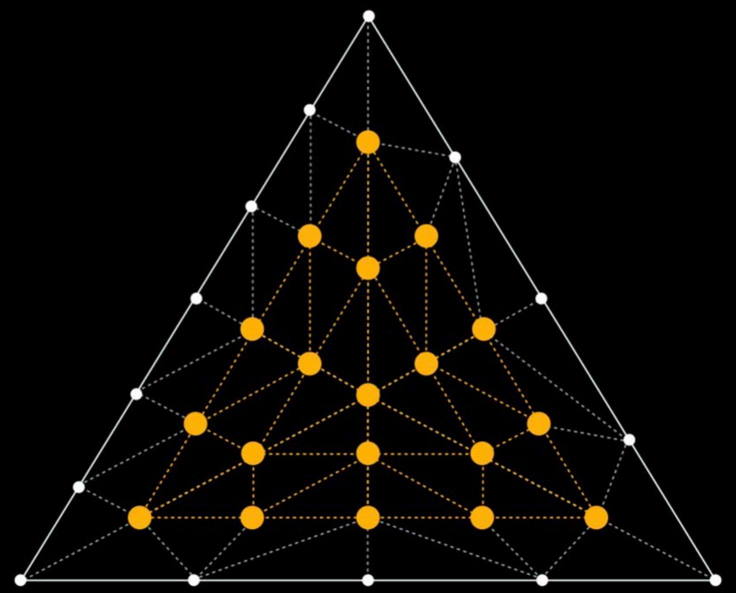
NEW

```
// Cascaded Shadow Maps
// Cascades

// activate shadow cascade
light.shadowCascadeCount = 4

// configure shadow map sizes and cascade splitting
light.shadowMapSize = CGSize(width: 512, height: 512)
light.shadowCascadeSplittingFactor = 0.25
```

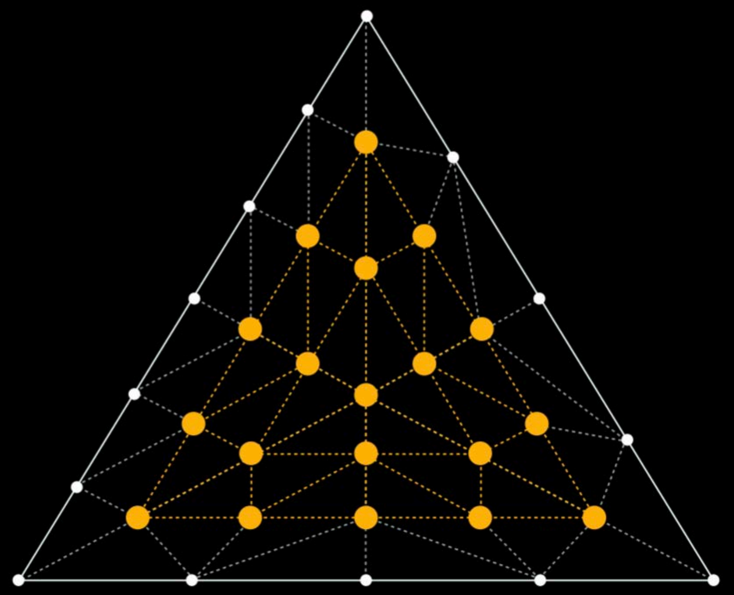
Cascaded Shadow Maps



Summary



Summary



More Information

https://developer.apple.com/wwdc17/604

Related Sessions

Introducing Metal 2	Executive Ballroom	Tuesday 1:50PM
Introducing ARKit: Augmented Reality for iOS	Hall 3	Tuesday 5:10PM
Debugging with Xcode 9	Hall 2	Wednesday 10:00AM
SceneKit in Swift Playgrounds	Grand Ballroom B	Thursday 9:00AM
Focus Interaction in tvOS 11	Grand Ballroom A	Thursday 9:00AM
Metal 2 Optimizing and Debugging	Grand Ballroom B	Thursday 3:10PM
Going Beyond 2D with SpriteKit	Executive Ballroom	Friday 10:00AM
From Art to Engine with Model I/O	Executive Ballroom	Friday 2:50PM

Labs

Model I/O and GameplayKit lab	Technology Lab G	Tues 9:00AM–12:00PM
SceneKit Lab	Technology Lab G	Wed 1:00PM–4:10PM
ARKit Lab	Technology Lab A	Wed 1:00AM–3:10PM
ARKit Lab	Technology Lab A	Thur 12:00PM–3:10PM

WWDC17