



# How to Create an Augmented Reality Experience

# Content

- ▶ XR Prototyping Tools
- ▶ XR Toolkits
- ▶ Top SDKs for AR
- ▶ Get Started with AR in Unity

Review

# Typical AR Experiences

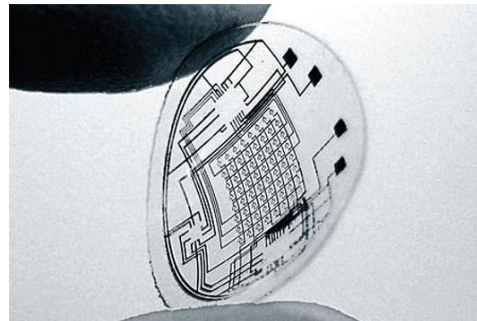
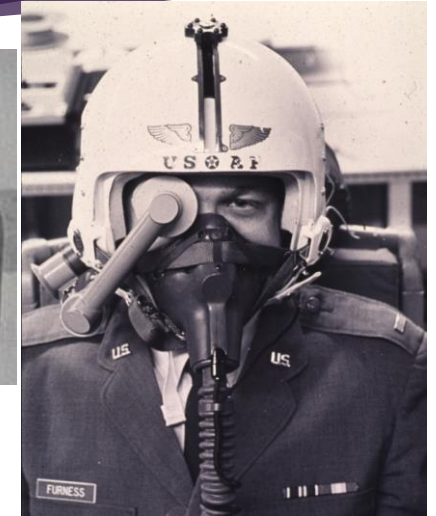
- ▶ Web based AR
  - ▣ Flash, HTML 5 based AR
  - ❖ Marketing, education
- ▶ Outdoor Mobile AR
  - ▣ GPS, compass tracking
  - ❖ Viewing Points of Interest in real world
  - Eg: Layar, Wikitude
- ▶ Handheld AR
  - ▣ Vision based tracking
  - ❖ Marketing, gaming
- ▶ Location Based Experiences
  - ▣ HMD, fixed screens
  - ❖ Museum, point of sale, advertising

# What You Need

- ▶ Smart Device
  - ❑ AR Glasses
  - ❑ Smart Phone (Android /iOS)
- ▶ Authoring Tools/SDK
  - ❑ Native SDK
  - ❑ Unity/Unreal game engine
  - ❑ Non programming tools
- ▶ Content
  - ❑ 3D models, videos, images, sounds ...

# AR Display Technology

- ▶ Past
  - Bulky Head Mounted Display
- ▶ Current
  - Handheld, lightweight head mounted
- ▶ Future
  - Wide FOV see through
  - Retinal displays
  - Contact lens



# AR Display



Vuzix M100



Vuzix M400



Vuzix Wrap 1200



Epson BT200



Google Glass



Lumus DK40



Recon Jet



Eybersight Raptor



Microsoft HoloLens



DAQRI



HRBox



Magic Leap One

# AR Display（国内）



Angleyes G7F



MAD GAZE VADER



ThinkReality A3



INMO AIR



HiAR G200



OPPO AR Glass



Shadow Creator



Nreal Light



# VR Display



# XR Prototyping Tools

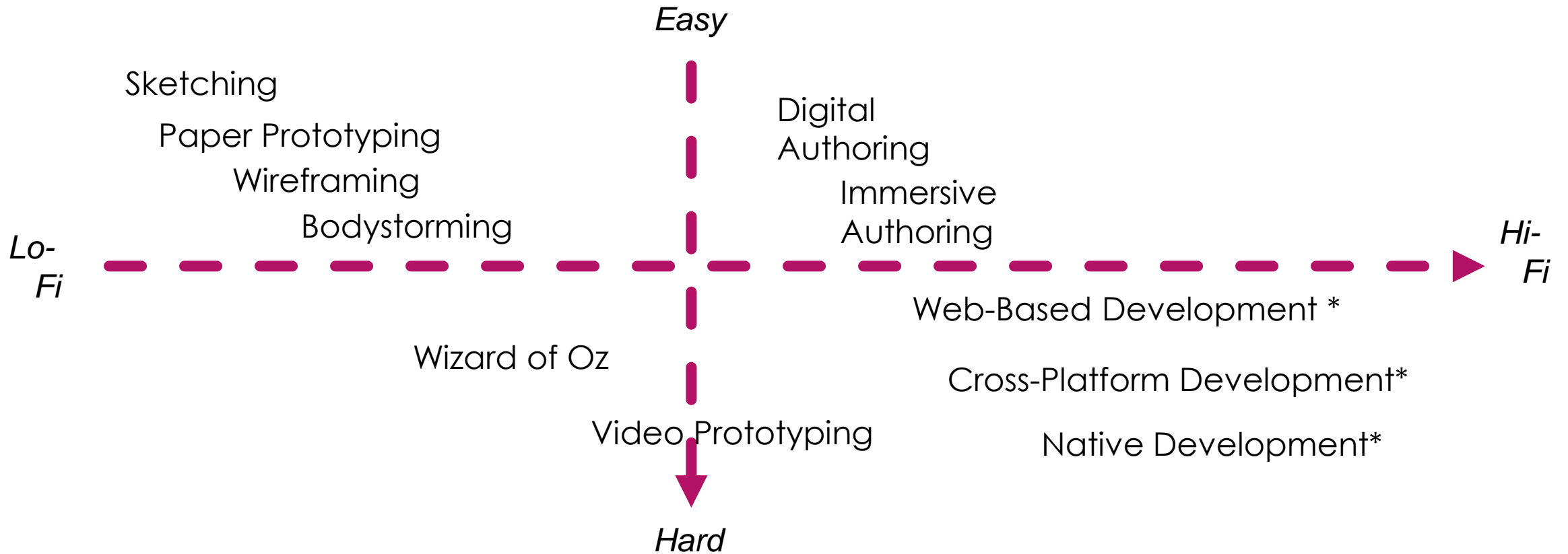
## ► Low Fidelity (Concept, visual design)

- Sketching
- Photoshop
- PowerPoint
- Video

## ► High Fidelity (Interaction, experience design)

- Interactive sketching
- Desktop & on-device authoring
- Immersive authoring & visual scripting
- XR development toolkits

# XR Prototyping Techniques



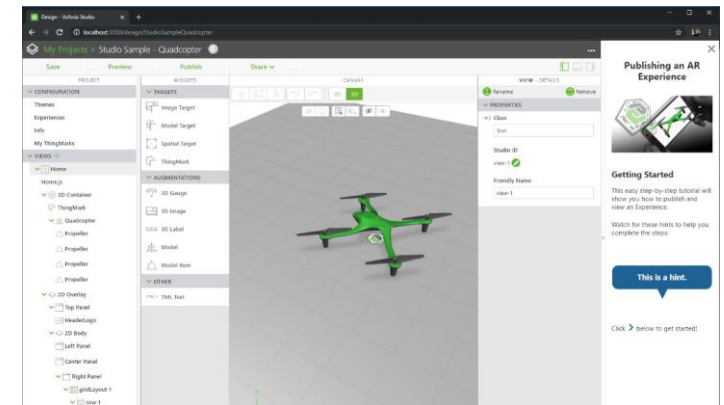
*\* Requires scripting and 3D programming skills*

# Digital Authoring Tools for AR

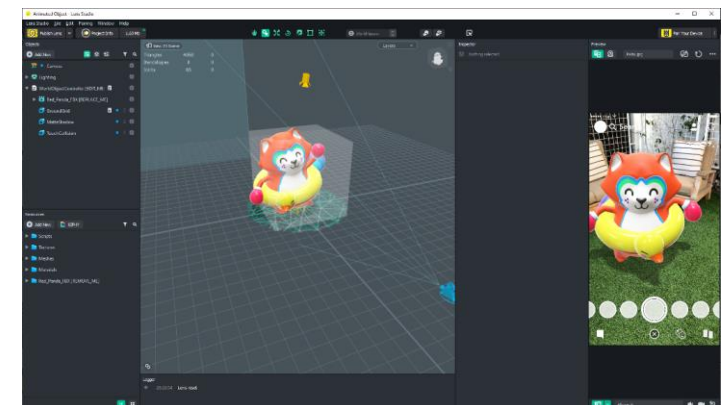
- ▶ Support visual authoring of marker-based and/or marker-less AR apps
- ▶ Provide default markers and support for custom markers
- ▶ Typically enable AR previews through emulator but need to deploy to AR device for testing

# Digital Authoring Tools for AR

- ▶ Vuforia Studio
- ▶ Lens Studio
- ▶ Zapworks Studio
- ▶ Snap LensStudio



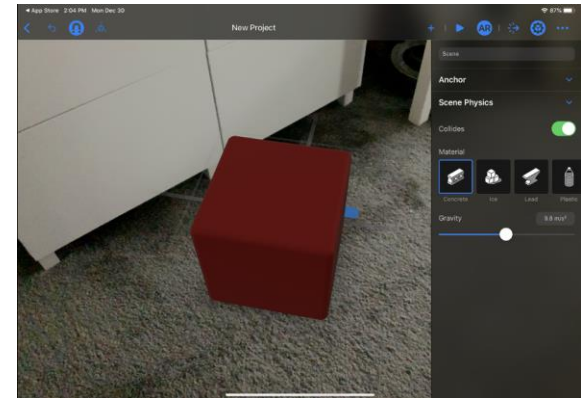
Vuforia Studio



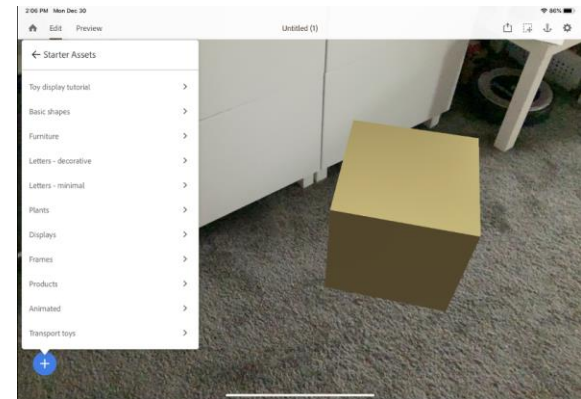
Lens Studio

# Immersive Authoring Tools for AR

- ▶ Enable visual authoring of 3D content in AR
- ▶ Make it possible to edit while previewing AR experience in the environment
- ▶ Provide basic support for interactive behaviors
- ▶ Sometimes support export to WebXR



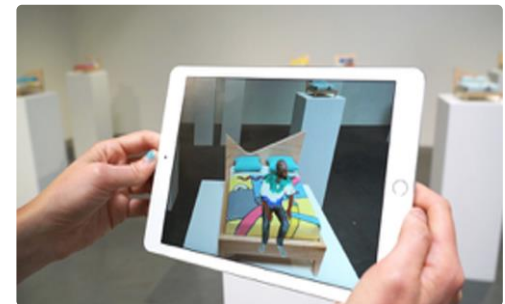
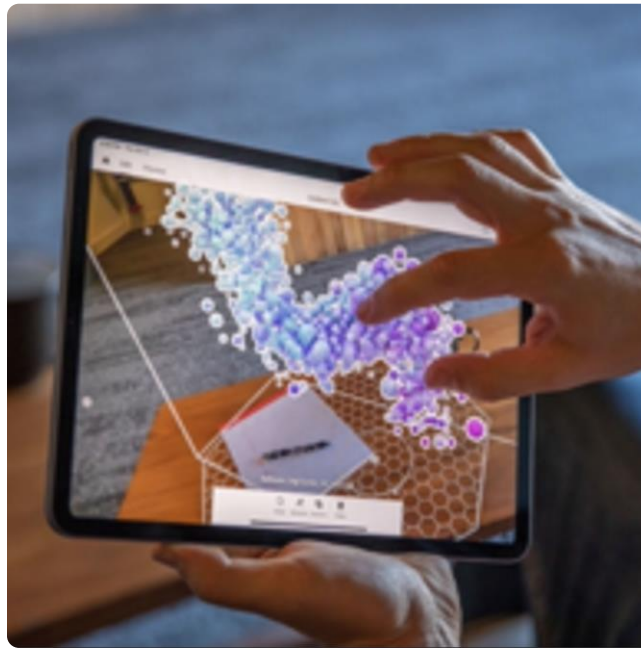
Apple Reality Composer



Adobe Aero

# Adobe Aero

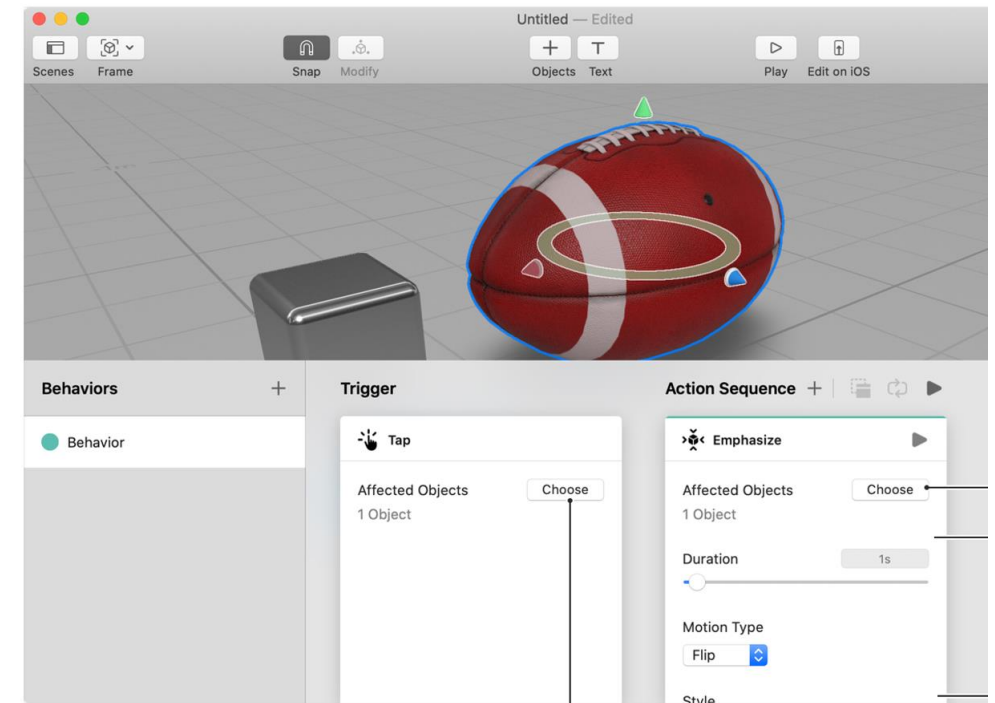
- ▶ Create AR on mobile devices
- ▶ Touch based interaction and authoring
- ▶ Only iOS support for now



<https://www.adobe.com/nz/products/aero.html>

# Apple Reality Composer

- ▶ **Rapidly create 3D scenes and AR experiences**
  - Creation on device (iPhone, iPad)
  - Drag and drop interface
  - Loading 2D/3D content
  - Simple interactivity – trigger/action
- ▶ **Anchor content in real world (AR view)**
  - Planes (vertical, horizontal), faces, images



Choose the object to tap



# XR Tools Landscape

- ▶ Digital & Immersive Authoring: Good for storyboarding but limited support for interactions
  - ▶ Proto.io, Tour Creator, ...
  - ▶ Tilt Brush, Blocks, Quill, ...
- ▶ Web-Based Development: Good for basic XR apps but often interactions feel unfinished
  - ▶ THREE.js, Babylon.js, ...
  - ▶ A-Frame, AR.js
- ▶ Cross-Platform Development: Good for full-fledged XR apps but usually high learning curve
  - ▶ Unity + SDKs
  - ▶ Unreal SDKs
- ▶ Native Development: Good for full-fledged XR apps but limited to a particular platform
  - ▶ Cardboard/Oculus/Vive/ ... SDK
  - ▶ Vuforia/ARCore/ARKit/... SDK

# XR Toolkits

A-Frame

AR.js

SteamVR

MRTK

Vuforia

AR Foundation

XR Interaction



WebXR



unity



UNREAL  
ENGINE

Cardboard

Oculus

VIVE

WMR

WebCam

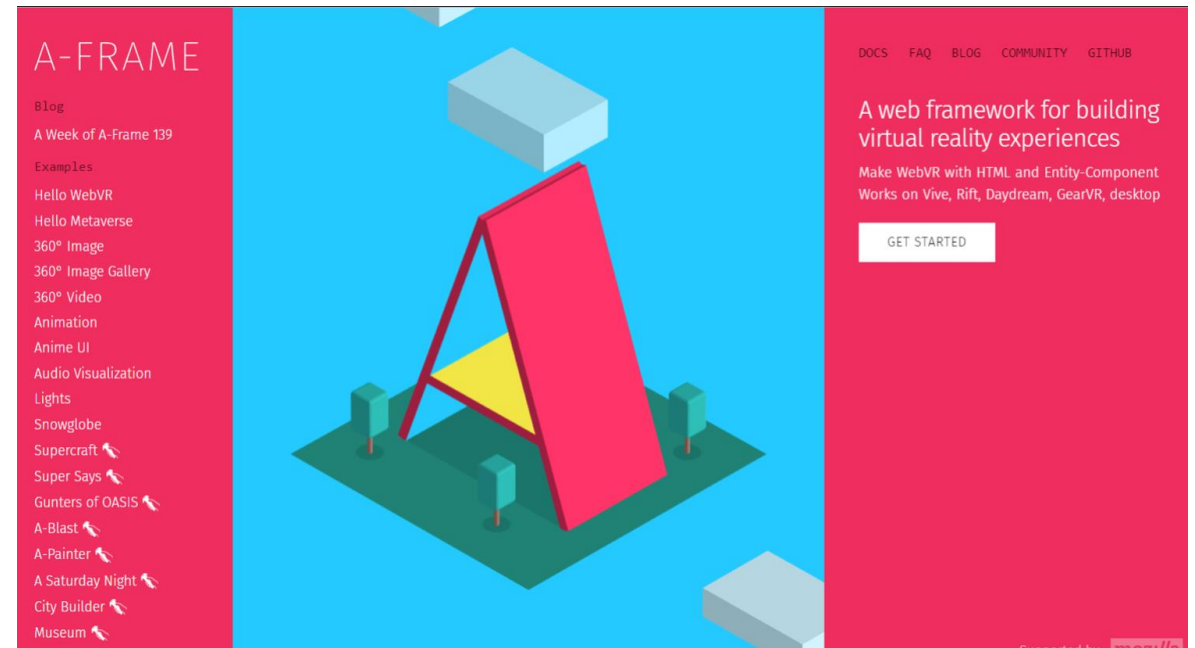
ARCore

ARKit

HoloLens

# WebXR: A-Frame

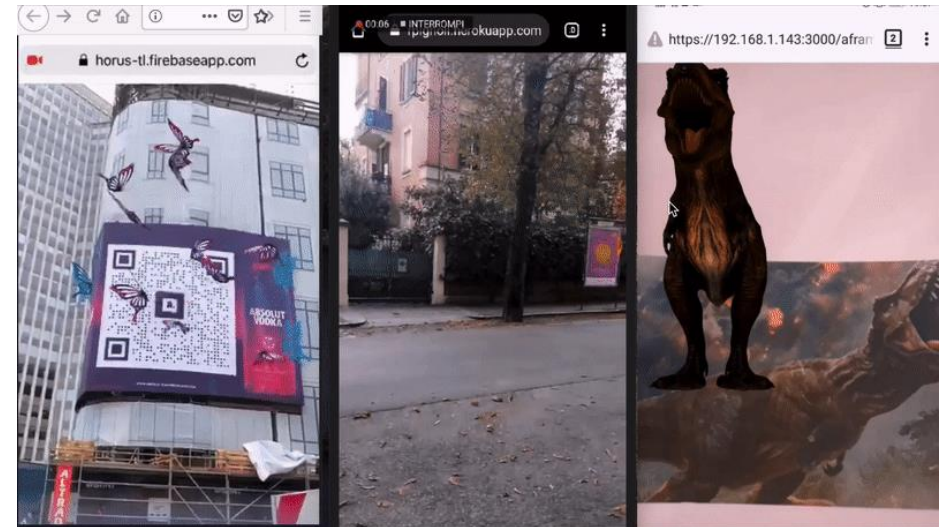
- ▶ Based on Three.js and WebGL
- ▶ New HTML tags for 3D scenes
- ▶ A-Frame Inspector(not editor)
- ▶ Asset management( image, video, audio & 3D models)
- ▶ ECS architecture with many open-source components
- ▶ Cross-platform XR



# AR.js – WebXR Tracking

- ▶ **Web based AR tracking library**
  - **Marker tracking:** ARToolkit markers
  - **Image tracking:** Natural feature tracking
  - **Location tracking:** GPS and compass
- ▶ **Key Features**
  - **Very fast:** It runs efficiently even on phones
  - **Web-based :** It is a pure web solution, so no installation required.
    - Full javascript based on three.js + A-Frame + jsartoolkit5
  - **Open Source :** It is completely open source and free of charge!
  - **Standards :** It works on any phone with webGL and webRTC

See <https://ar-js-org.github.io/AR.js-Docs/>



# AR.js Demo

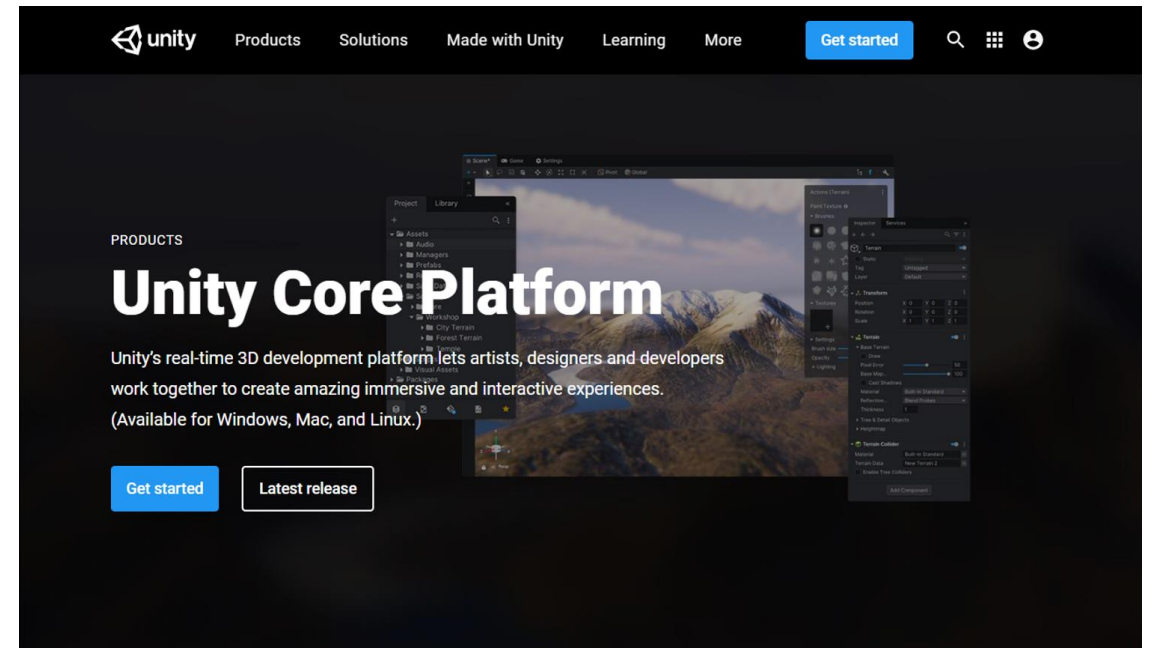
## ► Image Tracking Example

<https://ar-js-org.github.io/AR.js-Docs/#tutorials>

[trex-image-big.jpeg \(1984×1264\) \(raw.githubusercontent.com\)](#)

# Unity

- ▶ Started out as game engine
- ▶ Has integrated support for many types of XR apps
- ▶ Powerful scene editor
- ▶ Asset management & store
- ▶ Basically, all XR device vendors provide Unity SDKs



# Vuforia

- ▶ Highly optimized computer vision tracking
- ▶ Multiple types of tracking
  - Image tracking, object tracking, model tracking, area tracking, etc.
- ▶ Interaction features
  - Virtual buttons, occlusion, visual effects,
- ▶ Multi-platform
  - Mobile AR, AR headsets

See <https://www.vuforia.com/>





# AR Foundation

## ► A unified Framework for AR

- Multi-platform API
- Includes core features from ARKit, ARCore, Magic Leap, and HoloLens
- Set of behaviours and API with following features
  - Tracking, light estimation, occlusion, meshing , video pass-through, etc.

## ► Integrates with Unity MARS

See  
<https://unity.com/unity/features/arfoundation>

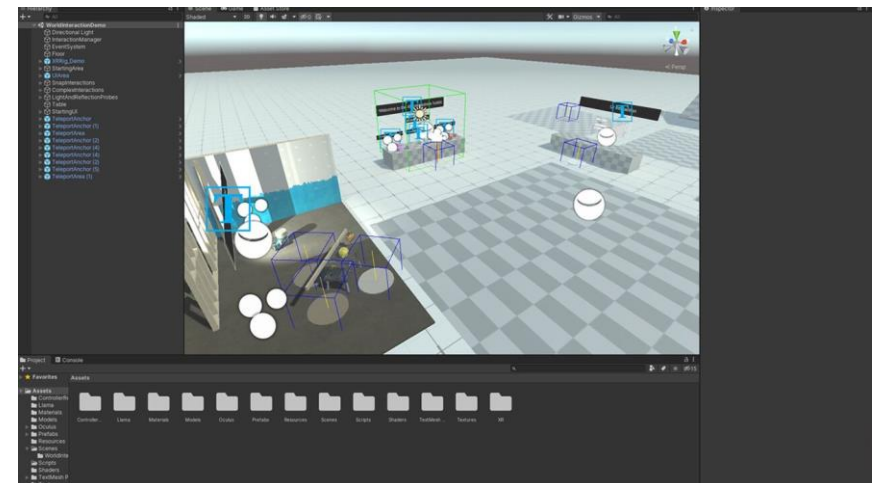
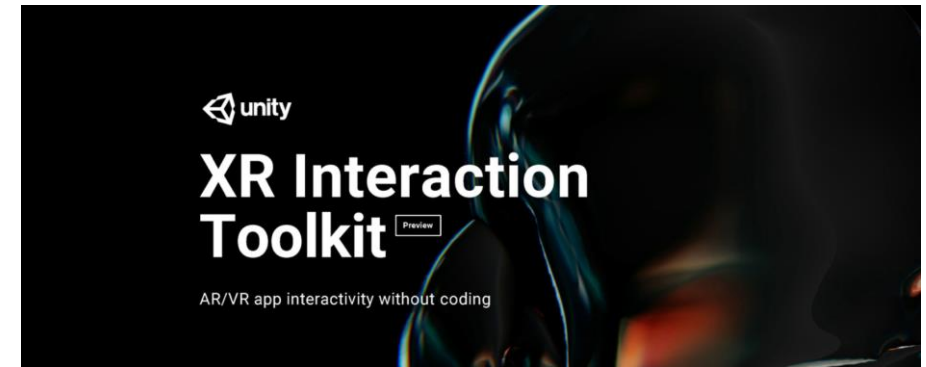




# Unity XR Interaction Toolkit(Preview package)

- ▶ Easy way to add interactivity to AR/VR experience
  - Object interactions
  - UI interactions
  - Locomotion
- ▶ Enabling common interactions without writing code
  - AR gesture, object placement, annotations

<https://docs.unity3d.com/Packages/com.unity.xr.interaction.toolkit@1.0/>



# Unity MARS

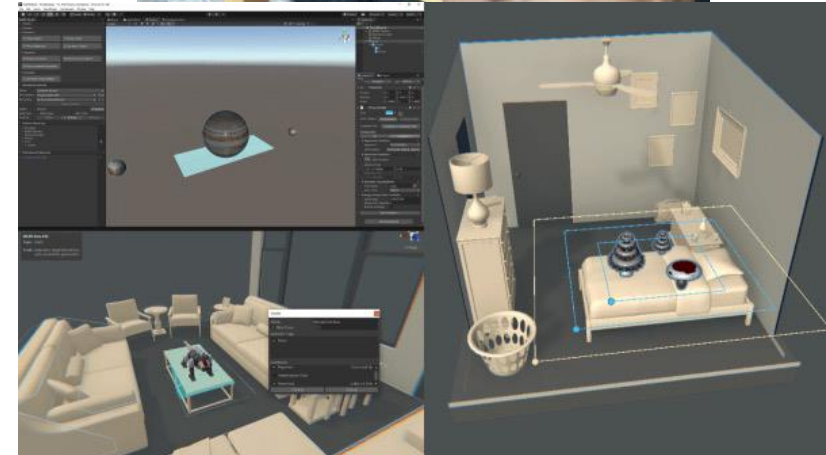
## ► Features

- Visually author AR apps (WYSIWYG)
- Test apps in Unity editor
- Develop apps that can interact with real world
- Intelligent real-world recognition

## ► Multi-platform development

- Based on ARFoundation
- ARKit, ARCore, Magic Leap and Hololens

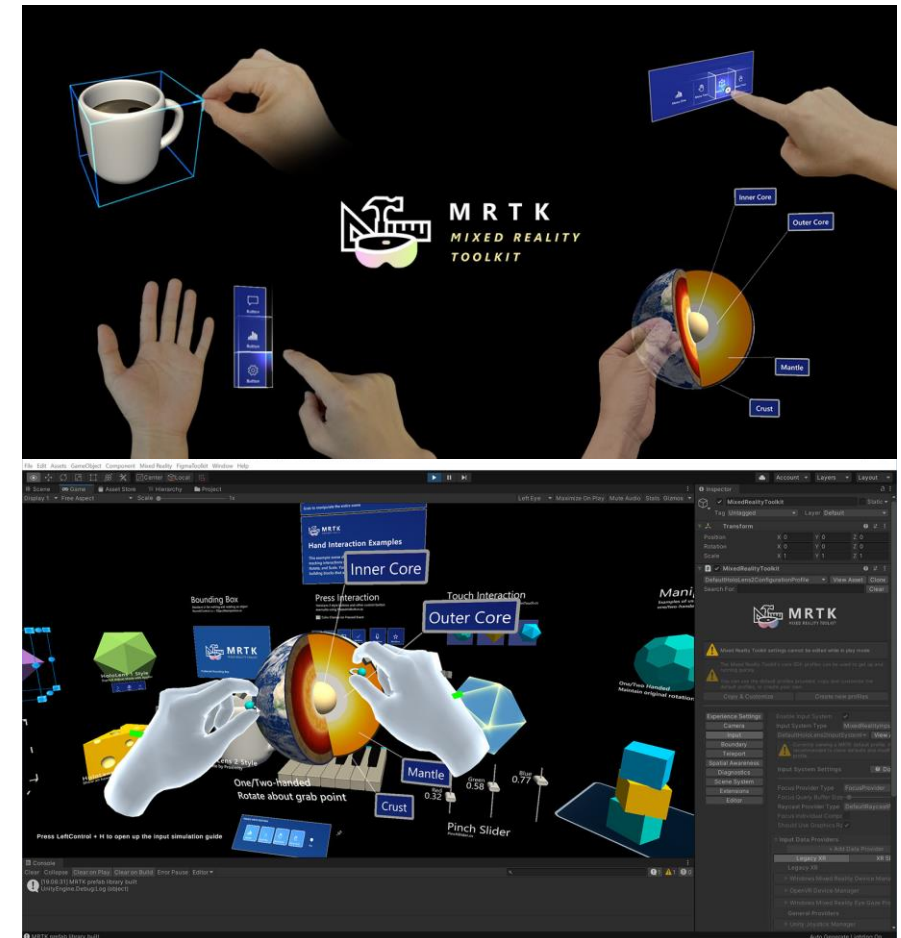
See [unity.com/mars](https://unity.com/mars)



# Mixed Reality Toolkit (MRTK)

- ▶ **Open-Source Mixed Reality Toolkit**
  - Set of Unity modules/Unreal plugin
- ▶ **Interaction Models**
  - Controllers, gesture, gaze, voice, etc.
- ▶ **UX elements**
  - Foundational elements
    - Material, text, light, etc.
  - Controls and behaviours
    - Button, menu, slider, etc.
- ▶ **Tutorials, documentation, guidelines**

See <https://github.com/microsoft/MixedRealityToolkit-Unity>



# Top SDKs for AR

- ▶ ARKit

<https://developer.apple.com/documentation/arkit>

- ▶ ARCore

<https://developers.google.com/ar>

- ▶ PTC Vuforia

<https://www.ptc.com/en/products/augmented-reality/vuforia>

- ▶ Wikitude

<https://www.wikitude.com/>

- ▶ Maxst (KOR)

<https://developer.maxst.com/?lang=en>

# Top SDKs for AR

- ▶ DeepAR

<https://www.deepar.ai/>

- ▶ EasyAR

<https://www.easyar.com/>

- ▶ Xzimg

<https://www.xzimg.com/>

- ▶ Kudan

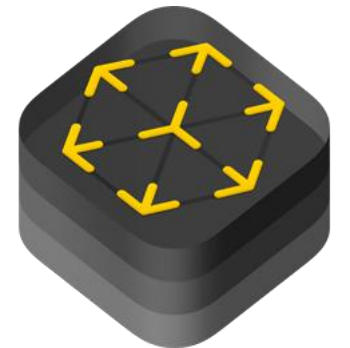
<https://www.kudan.io/>

- ▶ ARToolKit

<https://github.com/artoolkit/artoolkit5>

# ARKit

- ▶ Current ARKit 5 (2021)
- ▶ Supported platforms: iOS 14/15 and above
- ▶ Pricing: free/\$99 USD annual developer program for distribution.
- ▶ Key Features:
  - ▶ Depth API
  - ▶ Scene Geometry
  - ▶ Instant AR
  - ▶ People Occlusion
  - ▶ Motion Capture
  - ▶ Simultaneous front back camera



# ARKit

► Examples:

- AirMeasure (2017)

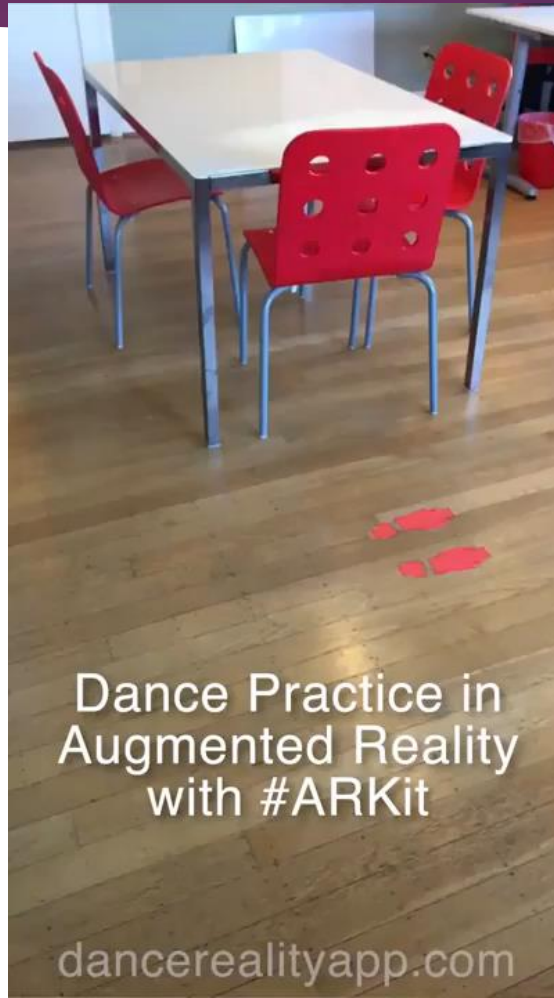
## AirMeasure

the AR Measuring ToolKit for iOS 11



# ARKit

- ▶ Examples:
  - Dance Reality (2017)





# ARKit

- ▶ Examples:
  - WiTag (2017)



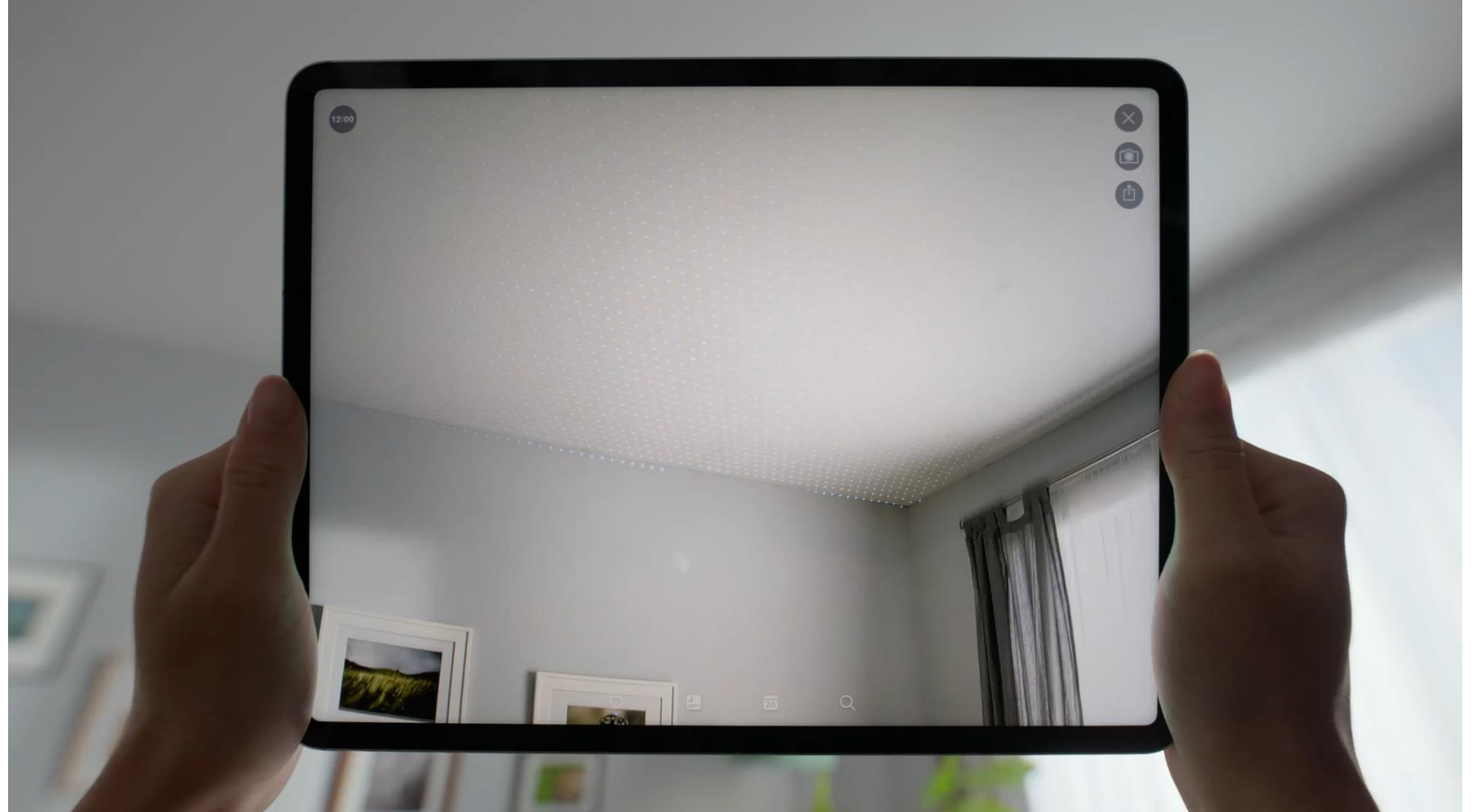
# ARKit

- ▶ Examples:
  - Solarscene (2017)



# ARKit

- Examples:
  - Skyguid (2021)



# RealityKit

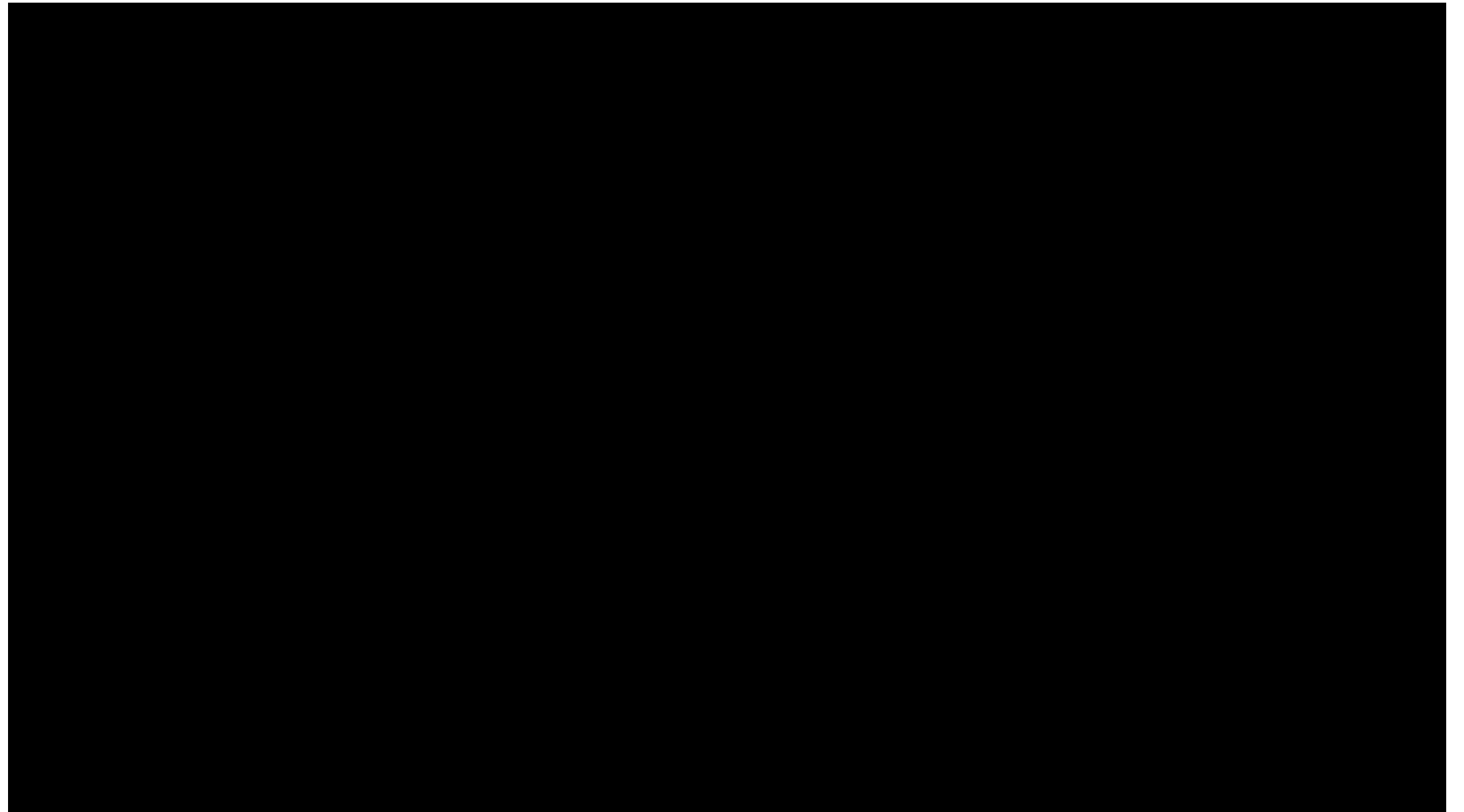
- ▶ Current RealityKit 2 (2021)
- ▶ Key features:
  - ▶ Object capture
  - ▶ Custom shaders
  - ▶ Custom systems
  - ▶ Dynamic assets
  - ▶ Character controller
  - ▶ ...



RealityKit

# RealityKit

► Examples:



# Reality Composer

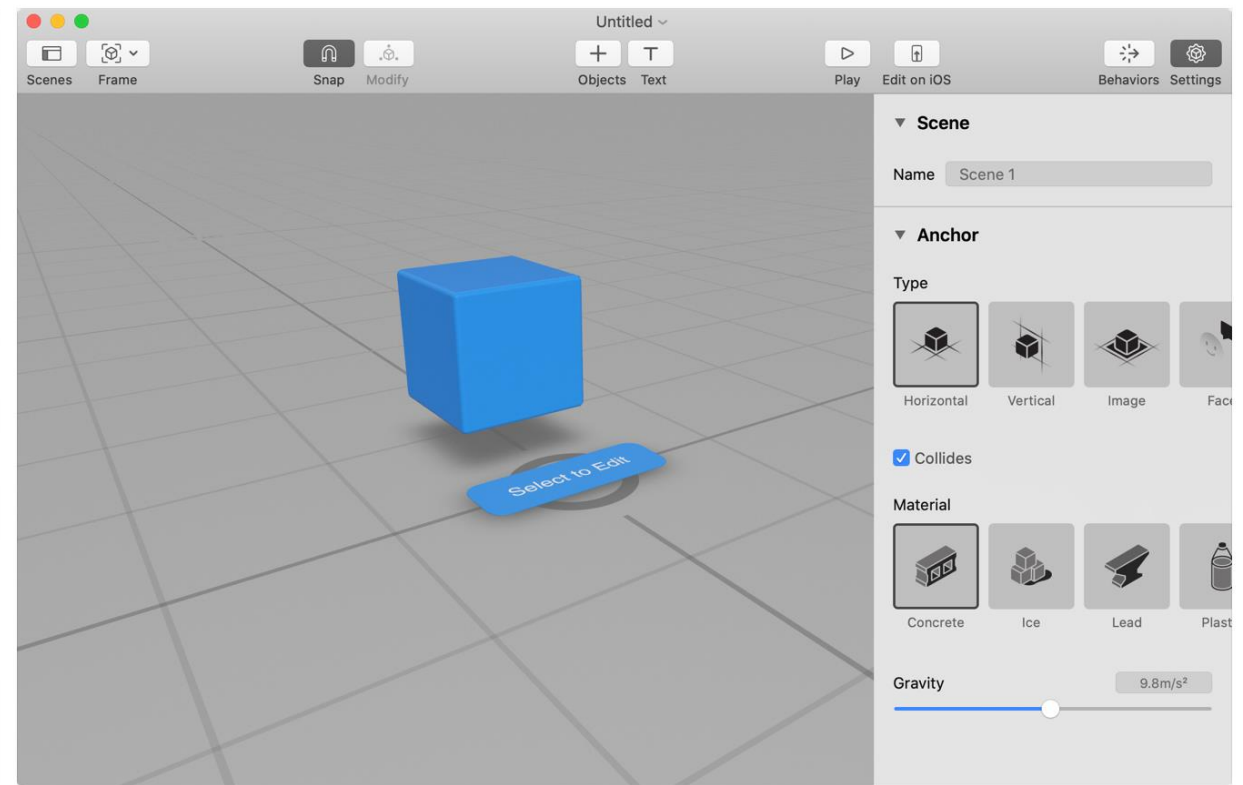
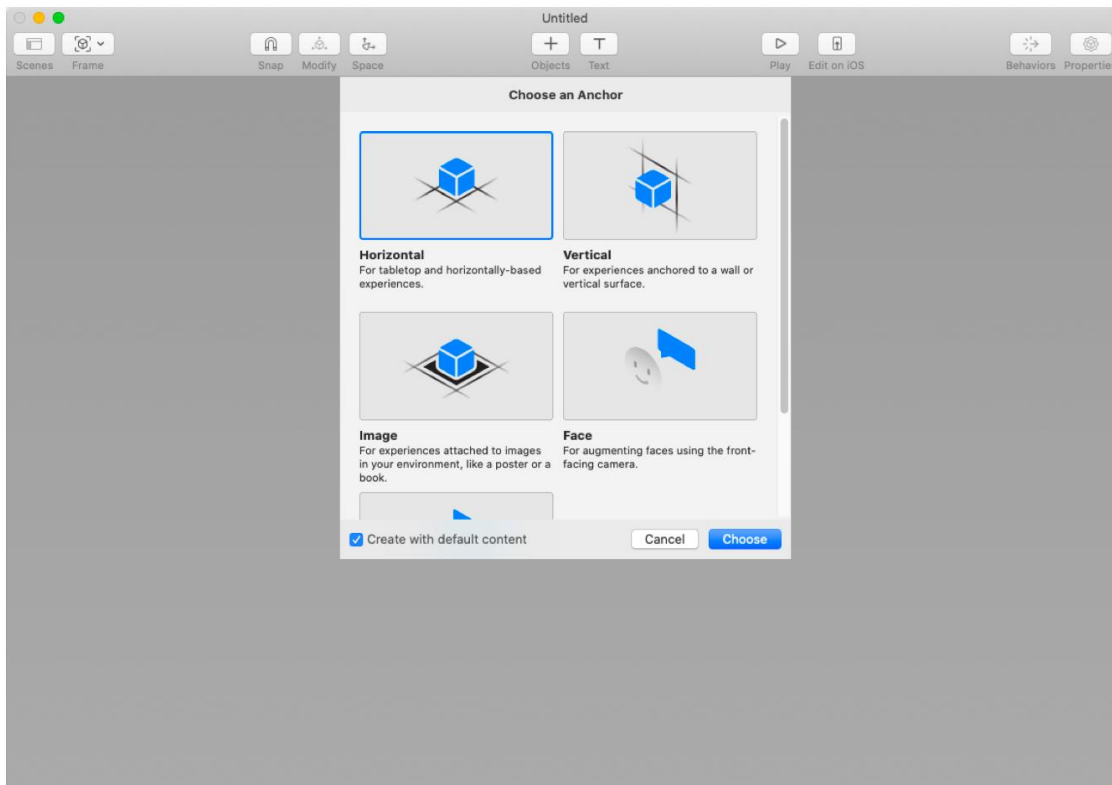
- ▶ Reality Composer is a code-less AR scene editor. Its essentially like Powerpoint in AR; you can import assets and animate them, trigger events with input, do basic image recognition, etc. Its built on top of ARKit and possibly the other APIs mentioned here.
- ▶ [https://developer.apple.com/documentation/realitykit/creating\\_3d\\_content\\_with\\_reality\\_composer](https://developer.apple.com/documentation/realitykit/creating_3d_content_with_reality_composer)





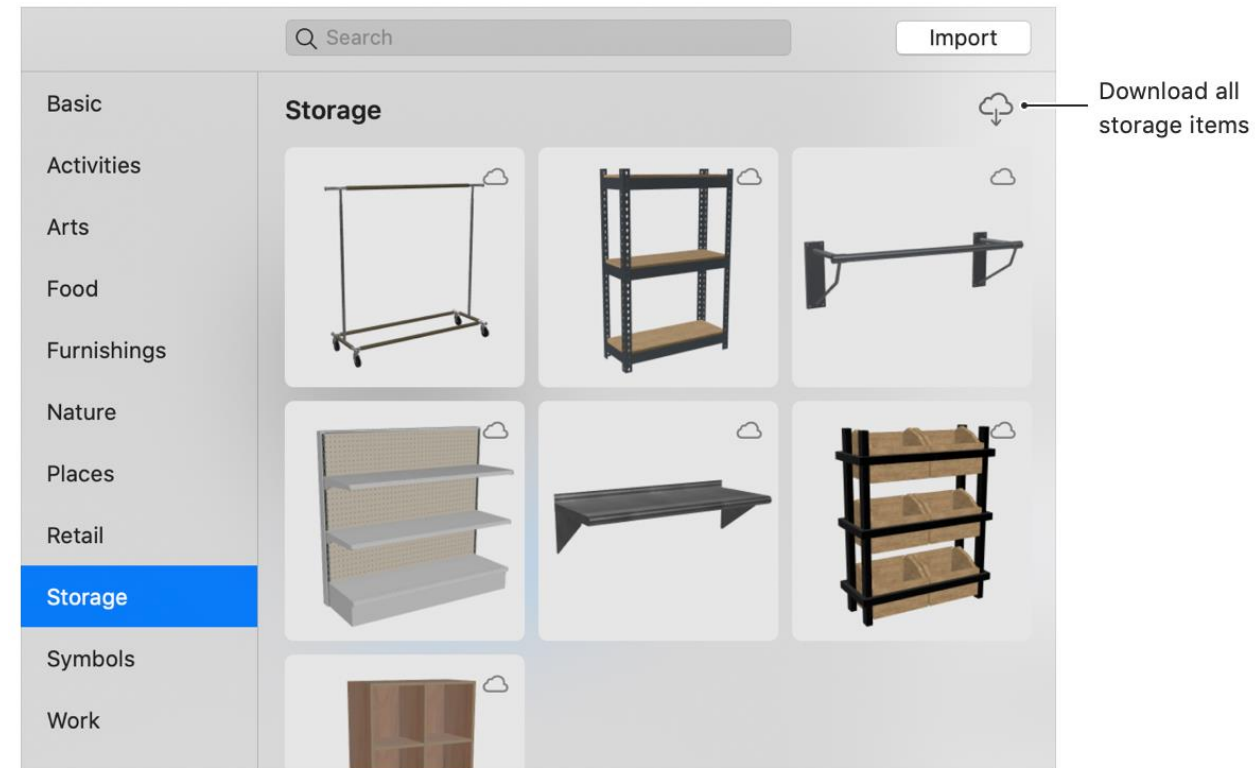
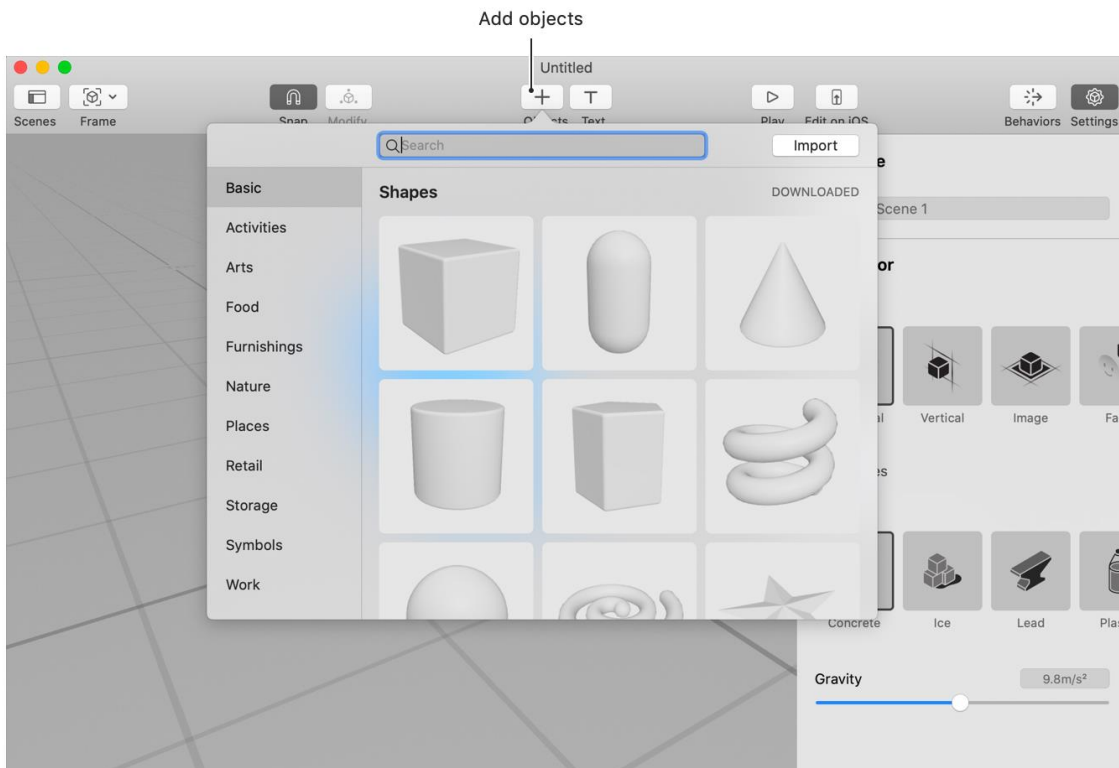
# Reality Composer

- Anchor Your Composition to Something in the Real World



# Reality Composer

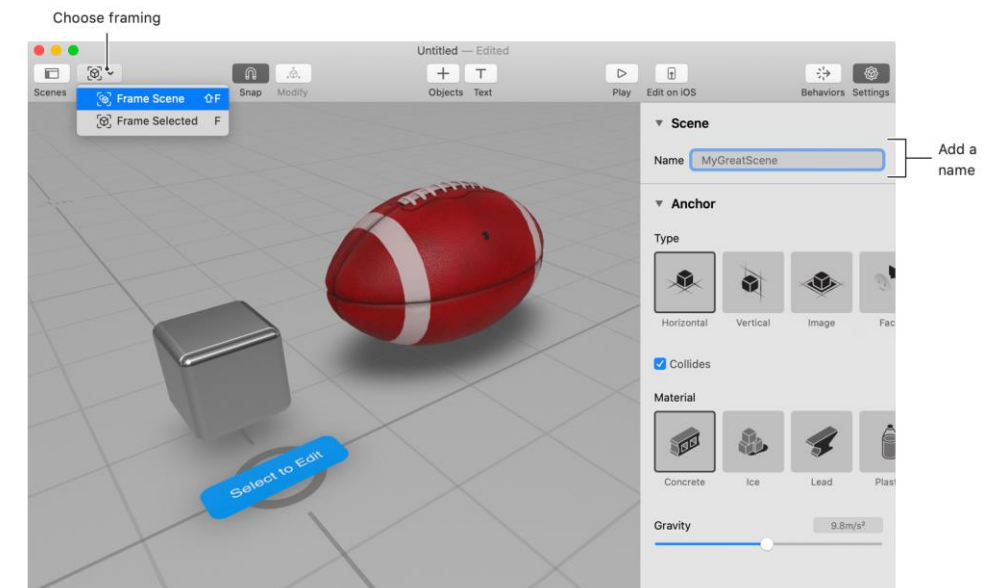
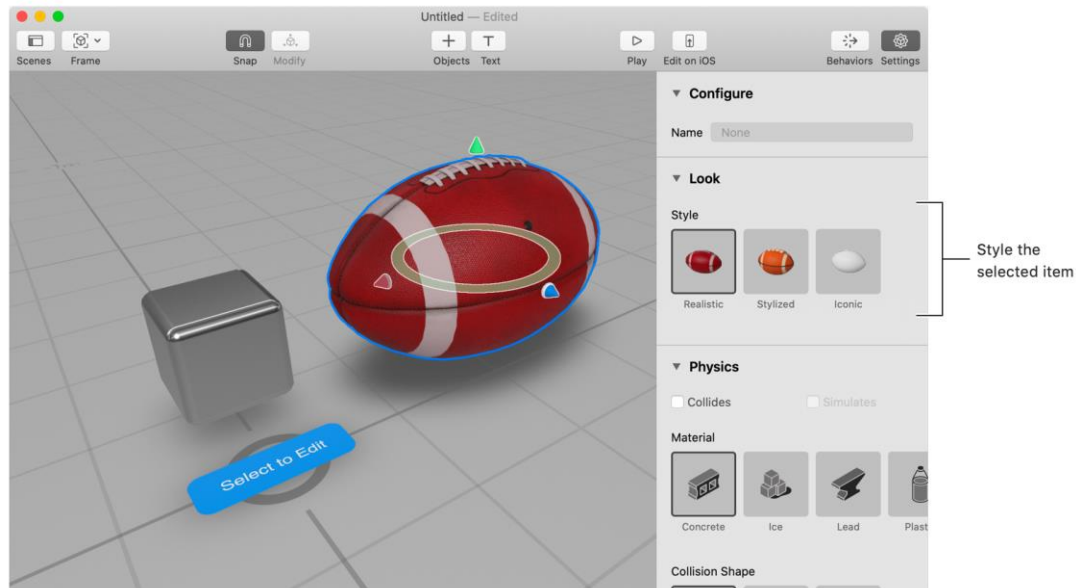
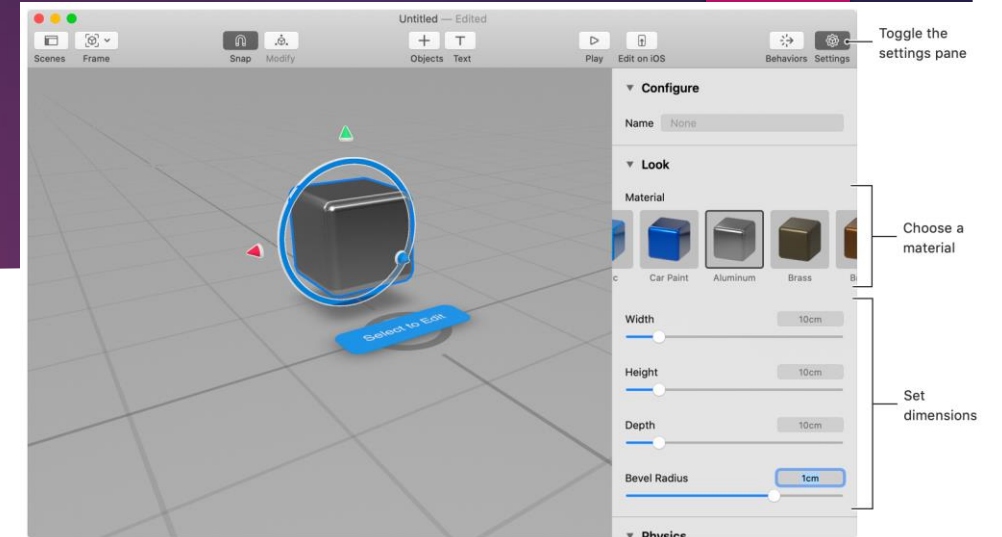
## ► Add Content to Your Composition





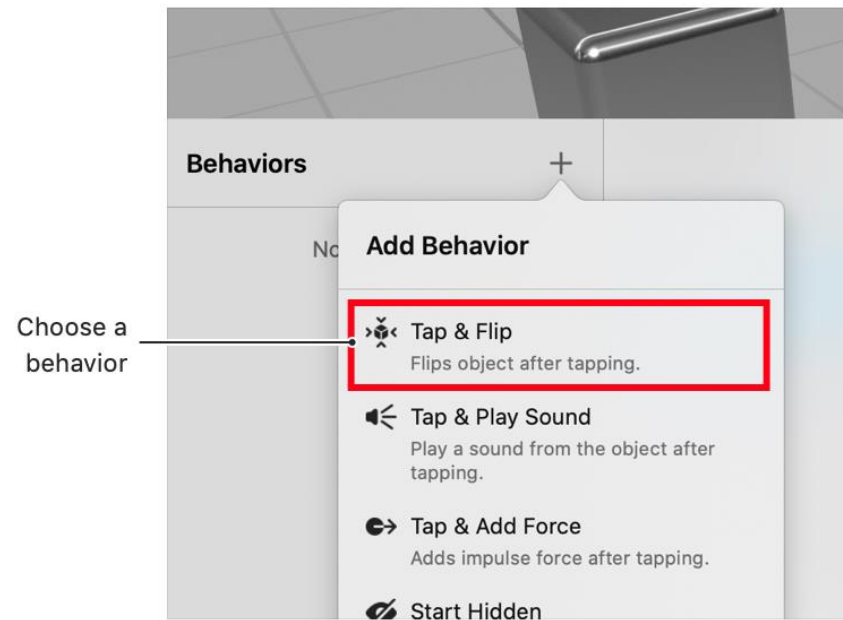
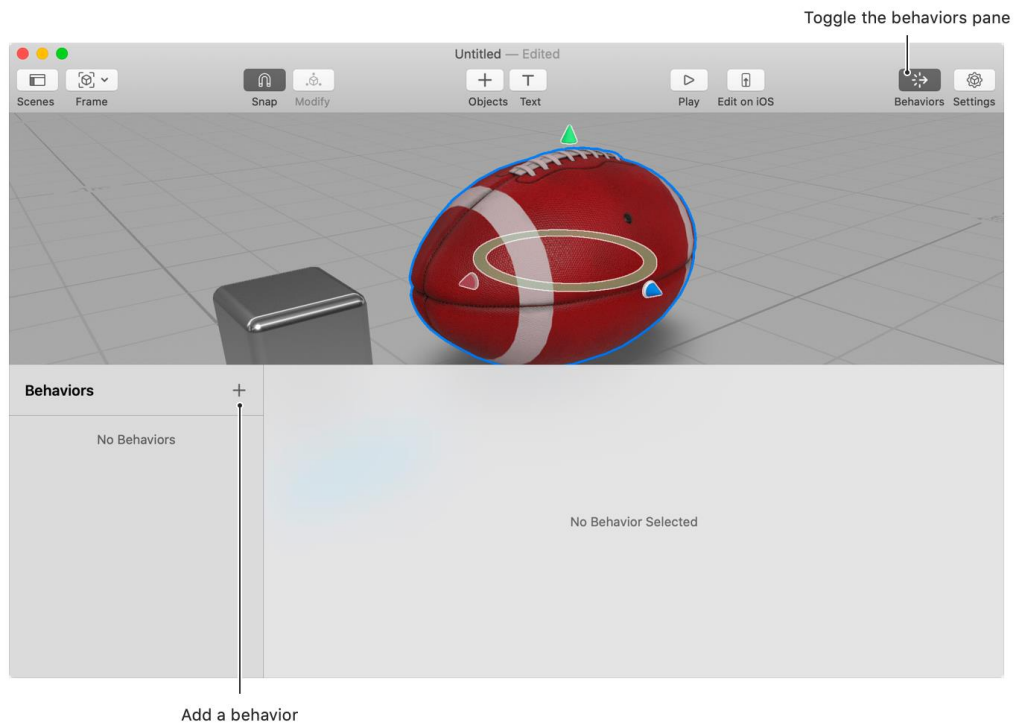
# Reality Composer

## ► Configure an object



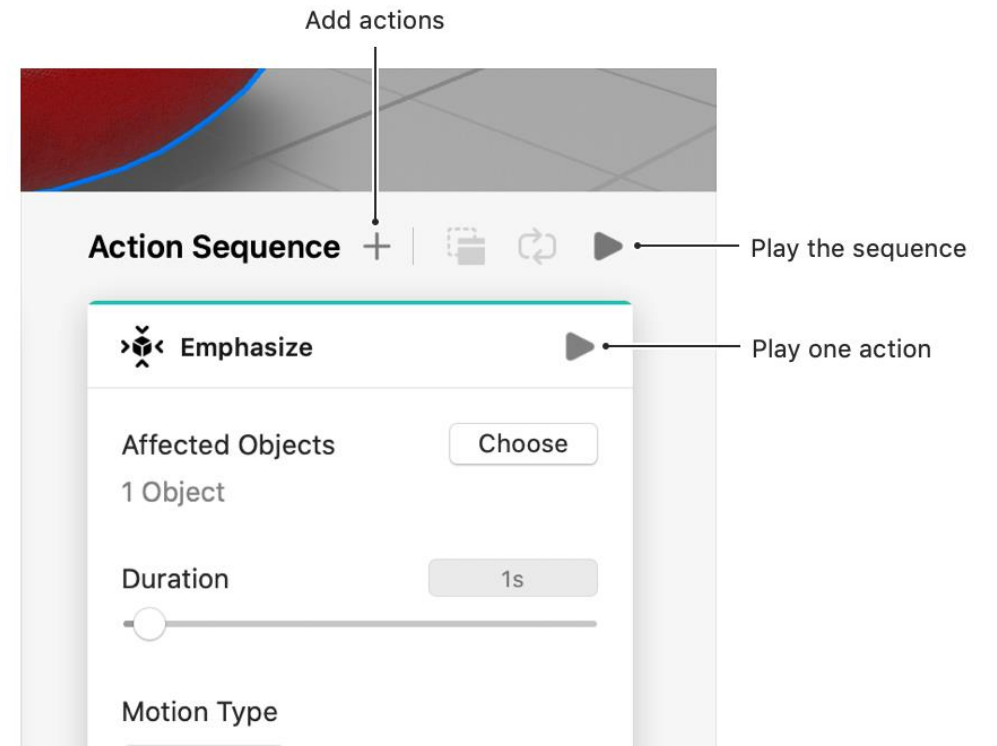
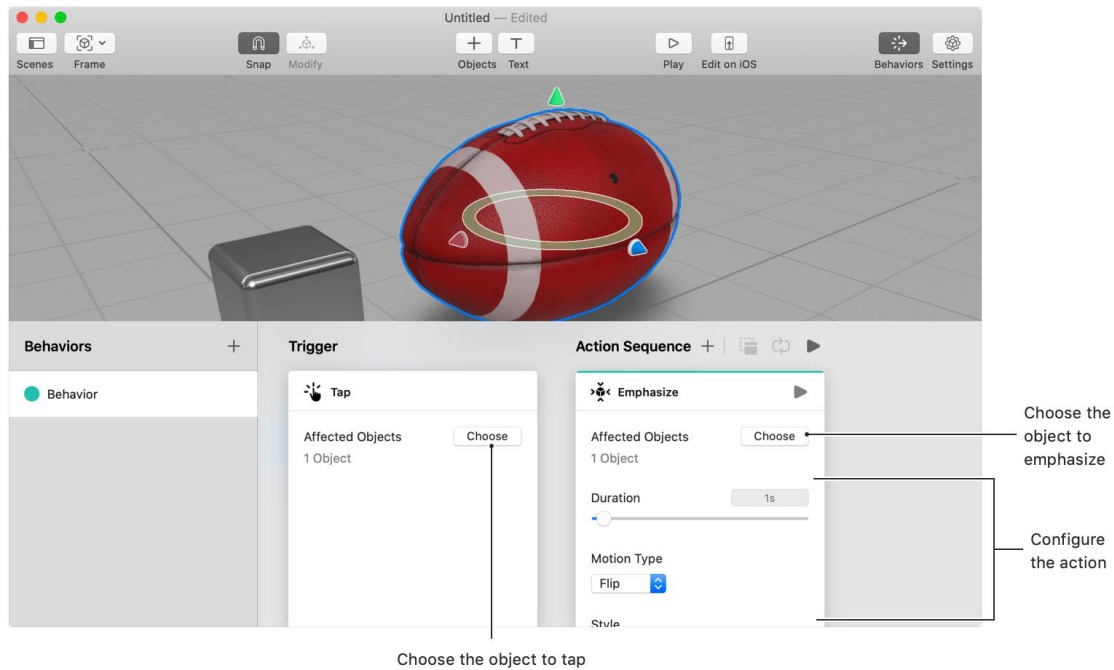
# Reality Composer

## ► Trigger Movement and Sound with Behaviours



# Reality Composer

## ► Trigger Movement and Sound with Behaviours



# Reality Composer

- See Your Content in the Real World

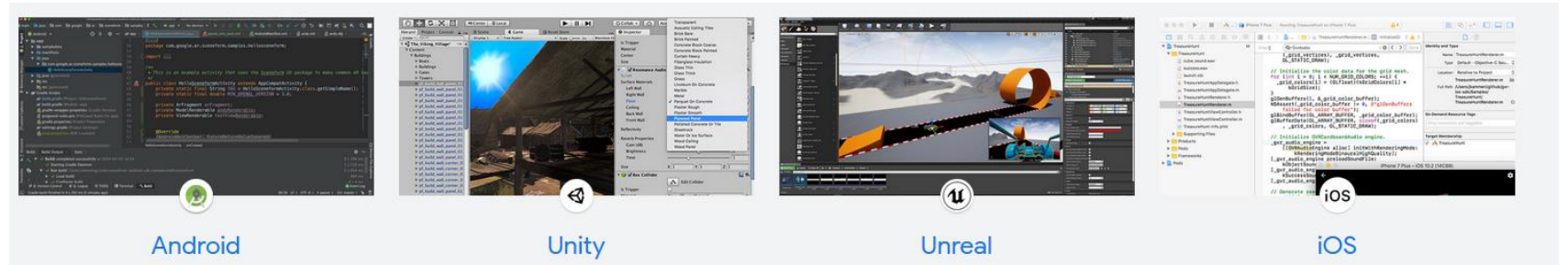


# ARKit vs RealityKit vs Reality Composer

- ▶ ARKit is a software SDK that essentially provides and processes sensor data necessary for AR experiences to work.
- ▶ RealityKit is a higher level SDK that provides some game engine functionality for AR apps (input, multiplayer, audio, etc)
- ▶ Reality Composer is a code-less AR scene editor. Its essentially like Powerpoint in AR; you can import assets and animate them, trigger events with input, do basic image recognition, etc. Its built on top of ARKit and possibly the other APIs mentioned here.

# ARCore

- ▶ Supported platforms: Android 7.0 and Higher, iOS 11 or higher
- ▶ Pricing: free/\$25 USD one-time registration fee.
- ▶ Examples:
  - Measure App,
  - Just a Line,
  - AR Stickers,
  - Molecatch,
  - Stack Tower,
  - Beer Pong.

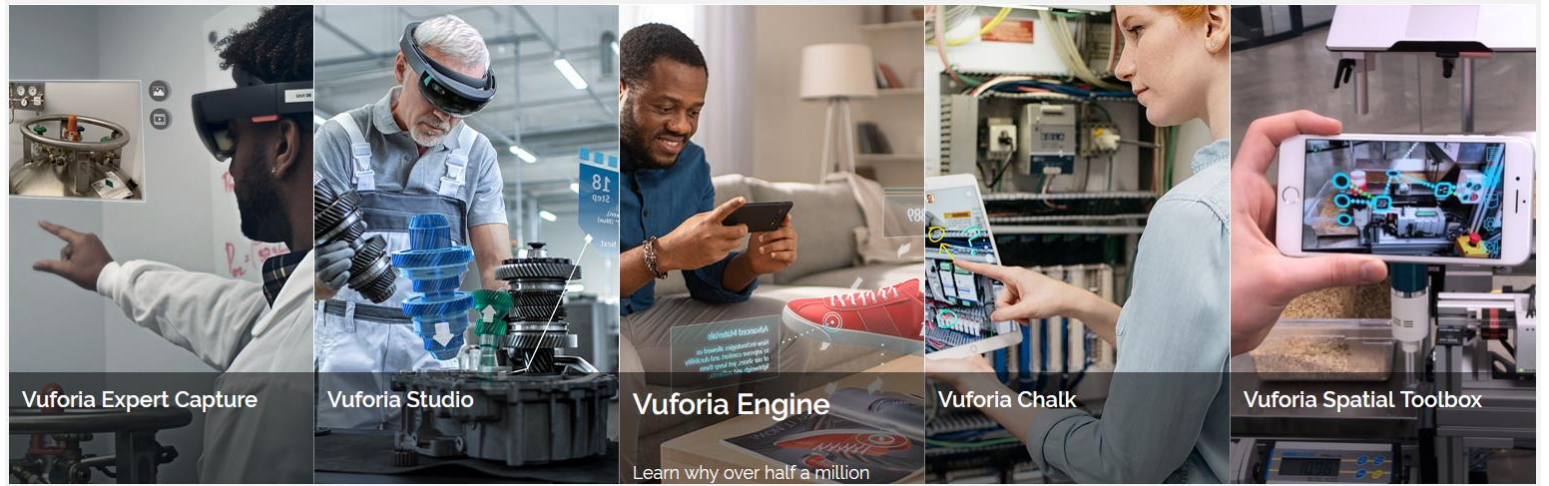




# PTC Vuforia

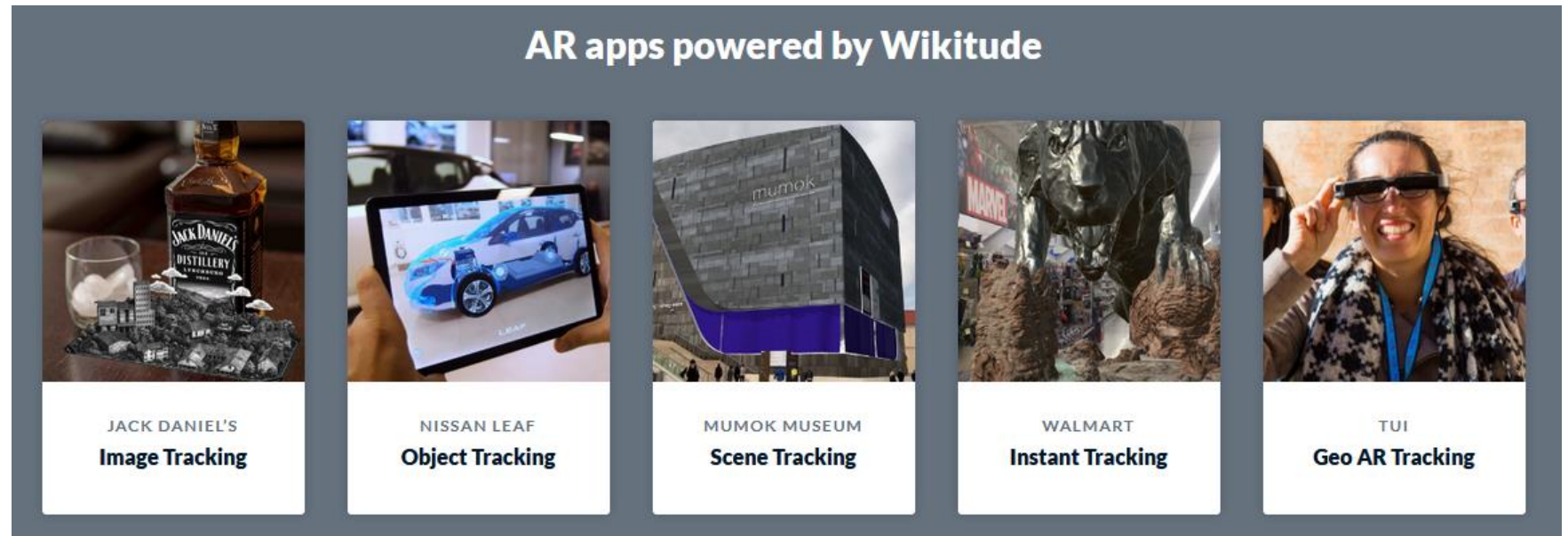
- ▶ Supported platforms: Android, iOS, UWP and Unity Editor
- ▶ Pricing: tier-based starting at \$99/month.
- ▶ Examples:

- Ask Mercedes
- LEGO Nexo Knights
- Fujitsu



# Wikitude

- ▶ Supported platforms: Android, iOS, Windows for tablets, smart glasses (Epson Moverio, Vuzix M100, ODG R-7).
- ▶ Pricing: free + tier-based.
- ▶ Examples:





# Maxst

- ▶ Supported platforms: Android, iOS, Windows, Mac OS, Unity
- ▶ Pricing: tier-based starting at \$50/month.
- ▶ Examples:
  - Canada AR,
  - Volvo AR Stories,
  - AR Money

# DeepAR

- ▶ Supported platforms: PC, Android, iOS, Windows, WebGL
- ▶ Pricing: Flexible plans – pay as you grow.



# EasyAR

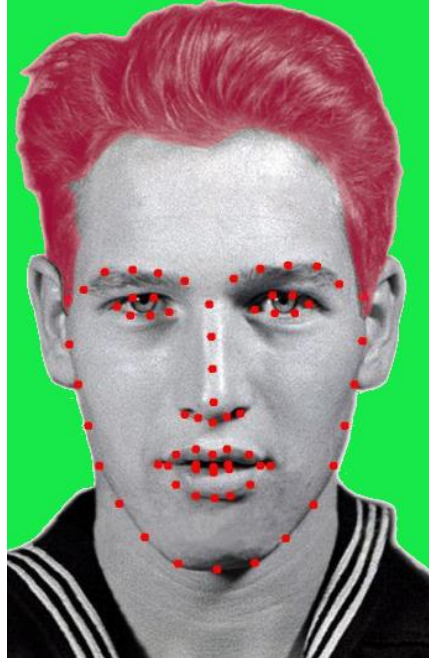
- ▶ Supported platforms: Android, iOS, UWP, Windows, Mac and Unity Editor
- ▶ Pricing: free.
- ▶ Examples:

Apps powered by EasyAR



# Xzing

- ▶ Supported platforms: Android, iOS, Windows
- ▶ Pricing: Free trial version for non-commercial use/2200 Euro for unlimited number of apps.



# Kudan

- ▶ Supported platforms: Android, iOS, Unity.
- ▶ Pricing: free and commercial licences.

# ARToolKit

- ▶ Supported platforms: Android, iOS, Windows, Mac OS, Linux
- ▶ Pricing: Free

Note: ARToolKit5 available on github (ARToolKit6 owns by DAQRI)

# Augmented Reality Tools Comparison

	ARKit	ARCore	PTC Vuforia	Wikitude	Maxst	DeepAR	EasyAR	Xzimg
Maximum distance capture, m	1.5/5	1.0/3	1.2/3.7	2.4/5	0.5/0.9	0.7/5	0.9/2.7	0.5/1
Recognition stability of immovable marker	9	9	10	6	7	8	7	4
Recognition stability of movable marker	7	6	6	6	2	7	3	3
Minimum angle recognition	30	50	30	10	50	35	35	45
Minimum visibility for recognition overlapped marker, %	50	75	20	100	50	10	10	25
2D recognition	+	+	+	+	+	+	+	+
3D recognition	+	+	+	+	+	–	–	+
Geo-location	+	+	–	+	–	–	–	–
Cloud recognition	+	+	+	+	–	–	–	–
SLAM (Simultaneous Localization and Mapping)	+	+	+	+	+	–	–	–
Rating	7.5	7.7	7.7	8	5.2	4.7	4.4	3.1

# 国内AR技术平台

- ▶ 视+AR (<http://www.sightp.com/> )
- ▶ 百度AR (<https://ar.baidu.com/home#/>)
- ▶ 腾讯AR (<https://tar.qq.com/>)
- ▶ QQ-AR (<https://ar.qq.com/#/> )
- ▶ 阿里巴巴AR平台
- ▶ 网易AR (<https://ar.163.com> )
- ▶ 京东AR (<https://ar.jd.com/> )
- ▶ 亮风台 (<https://www.hiscene.com/> )



# AR产品开发流程



# AR Foundation Requirement

- ▶ Developer
  - Unity Editor with iOS/Android Platform support
  - AR Foundation & ARCore / ARKit packages
  - Mac OS X (for iOS)
  - Android/iOS device for testing on device
- ▶ End User
  - Android 7.0 or Higher
  - iOS 11.0 or higher
  - iPhone X or newer for face tracking

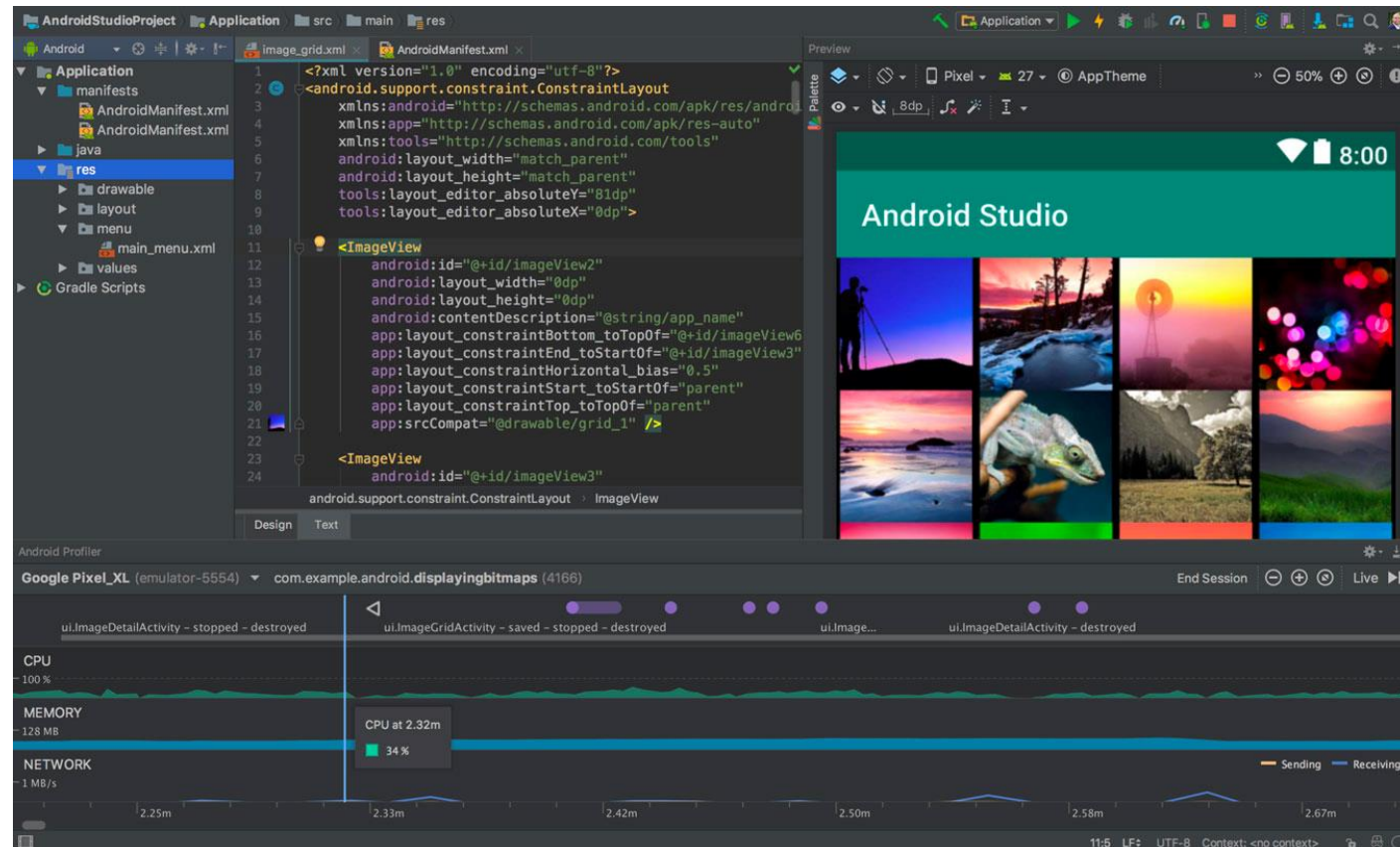
# Installation

## ► ARCore SDKs:

SDK	Release Notes	Download SDK	GitHub repo
ARCore SDK for Android	<a href="#">Android release notes</a>	<a href="#">arcore-android-sdk-1.24.0.zip</a>	<a href="#">arcore-android-sdk</a>
ARCore SDK for iOS	<a href="#">iOS release notes</a>	<a href="#">arcore-ios-sdk-1.24.0.zip</a>	<a href="#">arcore-ios-sdk</a>
ARCore SDK for Unity	<a href="#">Unity release notes</a>	<a href="#">arcore-unity-sdk-1.24.0.unitypackage</a>	<a href="#">arcore-unity-sdk</a>
ARCore Extensions for AR Foundation	<a href="#">ARCore Extensions for AR Foundation release notes</a>	<a href="#">arcore-unity-extensions-1.24.0.tgz</a>	<a href="#">arcore-unity-extensions</a>
ARCore SDK for Unreal	<a href="#">Unreal release notes</a>	<a href="#">arcore-unreal-sdk-1.7.0.zip</a>	<a href="#">arcore-unreal-sdk</a>

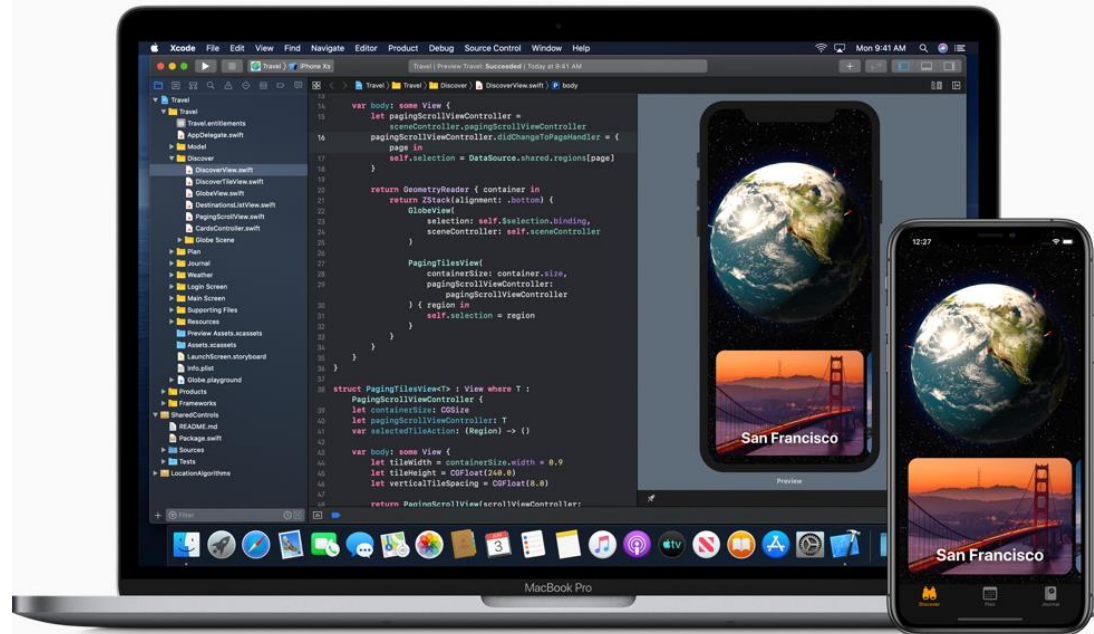
# Installation

- ▶ ARCore
  - Android
  - Android studio



# Installation

- ▶ ARKit
  - Xcode



# Installation

► Unity

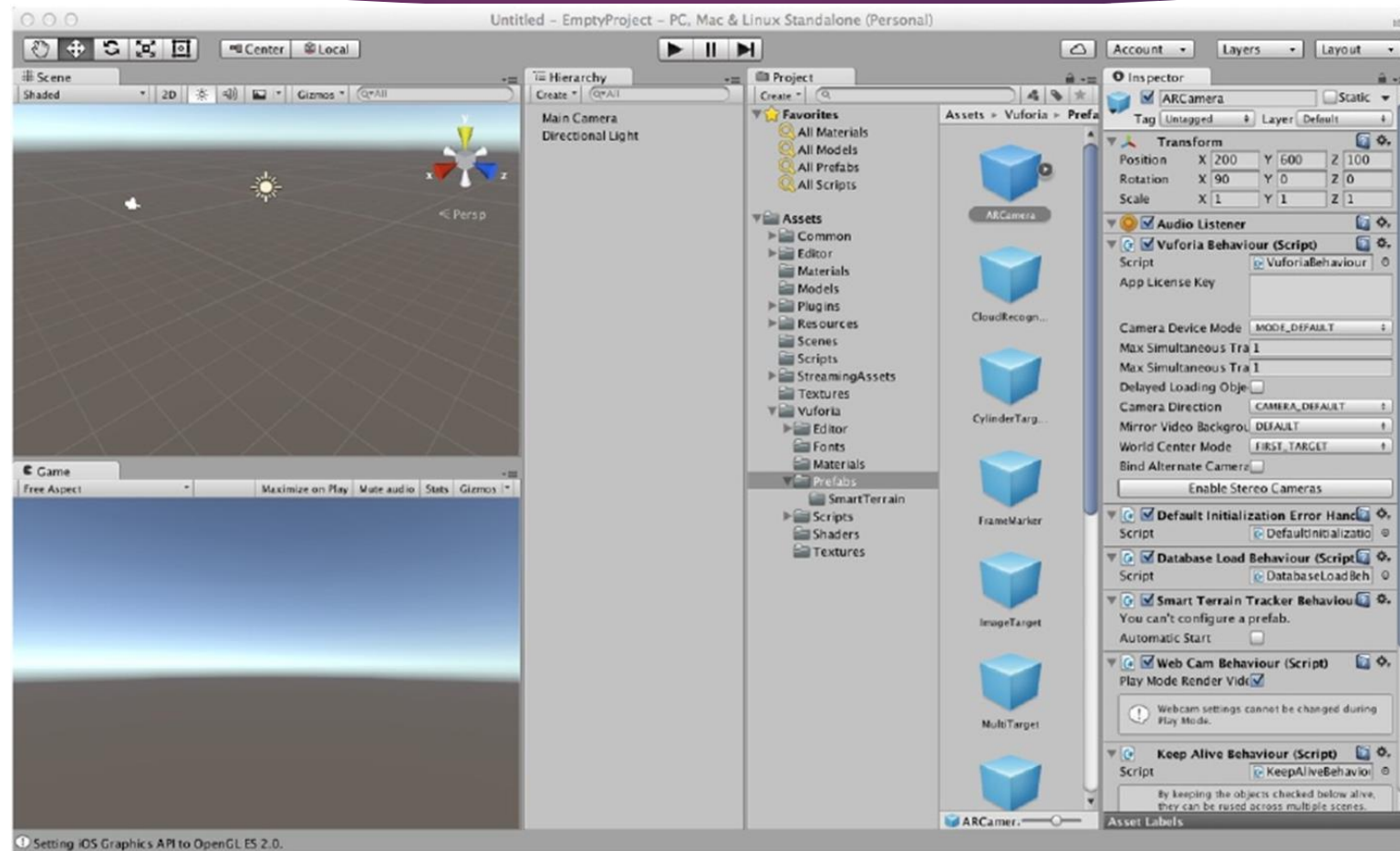
# Unity Interface

- Toolbar, Scene, Hierarchy, Project, Inspector





# Customizable Interface



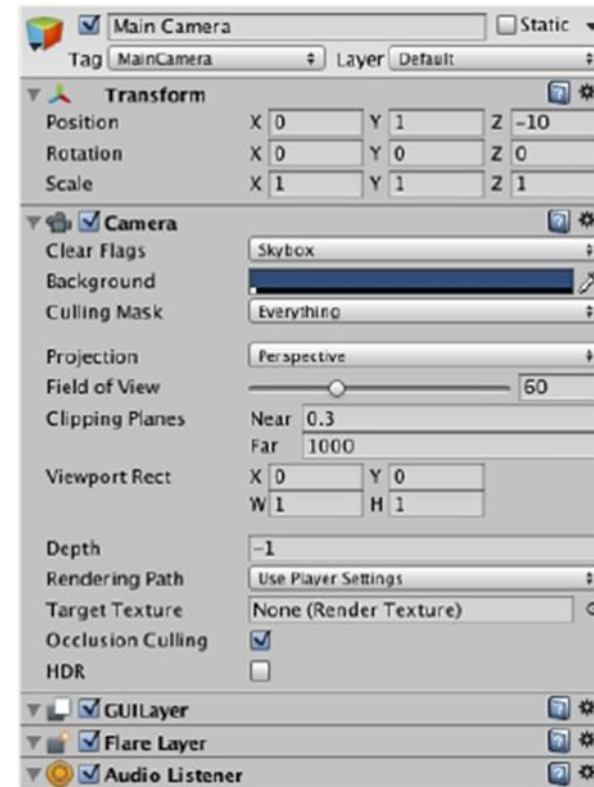
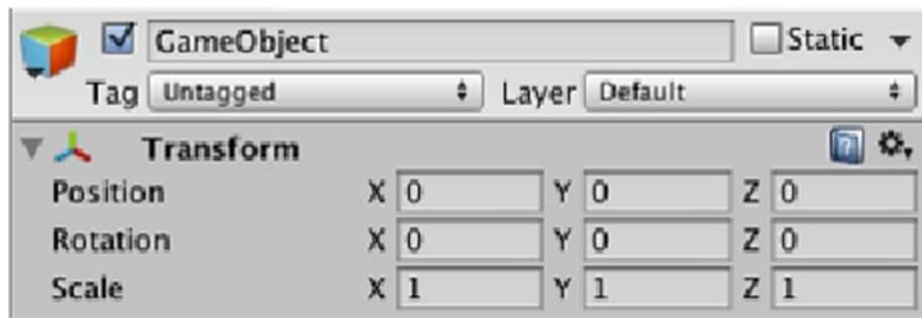


# Building Scenes

- ▶ Use GameObjects:
  - Containers that hold different components
    - Eg 3D model, texture, animation
- ▶ Use Inspector
  - View and edit object properties and other settings
- ▶ Use Scene View
  - Position objects, camera, lights, other GameObjects etc
- ▶ Scripting
  - Adding interaction, user input, events, etc

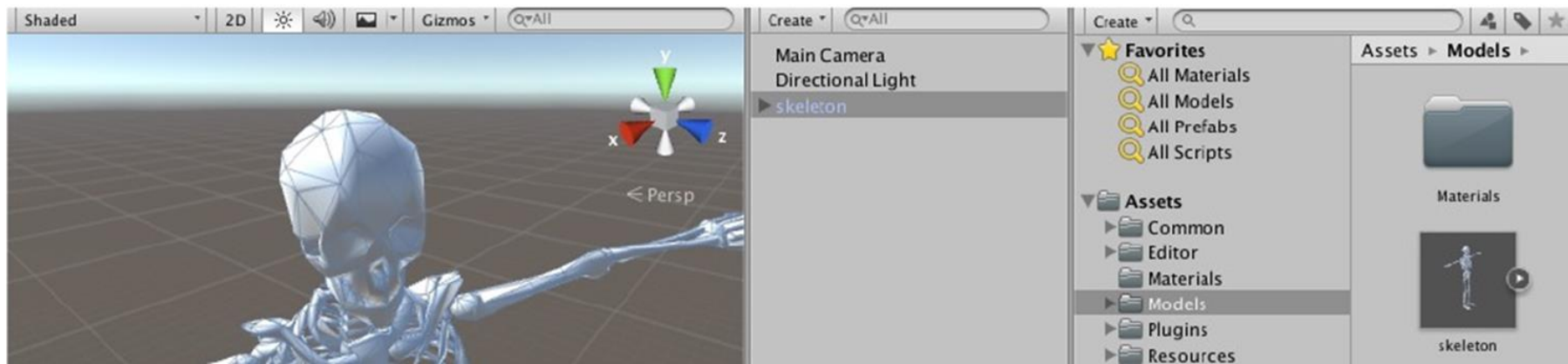
# GameObjects

- ▶ Every object in Scene is a GameObject
- ▶ GameObjects contain Components
  - Eg Transform Component, Camera Component



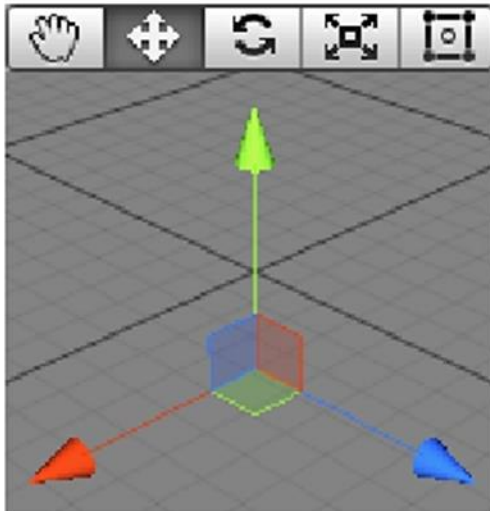
# Adding 3D Content

- ▶ Create 3D asset using modeling package, or download
  - Fbx, Obj file format for 3D models
- ▶ Add file to Assets folder in Project
- ▶ When project opened 3D model added to Project View
- ▶ Drag mesh from Project View into Hierarchy or Scene View
  - Creates a game object

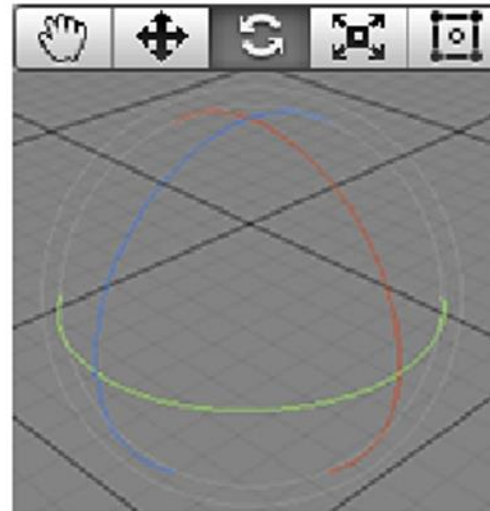


# Positioning/Scaling Objects

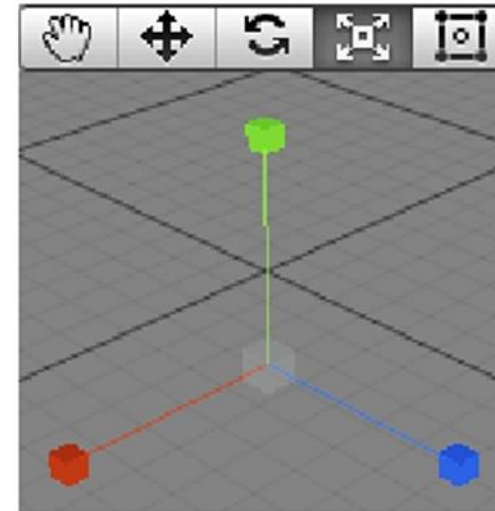
- Click on object and choose transform



Translate (W)



Rotate (E)



Scale (R)

# AR Foundation Overview

# AR Foundation



- ▶ Preview Version 1.5 – Unity 2018.4
- ▶ Verified Version 2.1 – Unity 2019.3
- ▶ Verified Version 5.0 – Unity 2021.2
- ▶ Preview Version 5.1.0 – Unity 2021.2

# Preview vs Verified packages

## ► **Verified Package**

The package has undergone rigorous testing and has been verified to work safely with this specific version of Unity, and all other packages verified for the same version.

## ► **Preview Package**

Preview packages have not yet been verified to be safe to use with the current version of Unity, so you should only use them for testing and to provide feedback.

Some packages are neither verified nor preview packages. In AR Foundation's case, this is because a package was verified in a newer version of Unity but is compatible with earlier versions of Unity.

# “Build once, deploy anywhere”

## ► Required Packages

AR Platform	Provider plug-in	Version
Android	<a href="#">Google ARCore XR Plug-in</a>	5.1
iOS	<a href="#">Apple ARKit XR Plug-in</a>	5.1
HoloLens 2	<a href="#">OpenXR Plug-in</a>	1.5



# Feature Support Per Platform

Feature	ARCore	ARKit	OpenXR
Session	✓	✓	✓
Device tracking	✓	✓	✓
Camera	✓	✓	
Plane detection	✓	✓	
Image tracking	✓	✓	
Object tracking		✓	
Face tracking	✓	✓	
Body tracking		✓	
Point clouds	✓	✓	
Raycasts	✓	✓	
Anchors	✓	✓	✓
Meshing		✓	✓
Environment probes	✓	✓	
Occlusion	✓	✓	
Participants		✓	

# Supported Platform Packages

Package Name	Version
ARCore XR Plug-in	4.2
ARKit XR Plug-in	4.2
ARKit Face Tracking	4.2
Magic Leap XR Plug-in	6.0
Windows XR Plug-in	5.0

# Getting started

- ▶ Downloaded the packages
- ▶ Configure the platform settings
- ▶ Configure XR management
- ▶ Modifying a scene to use AR
- ▶ Adding AR features

# Useful links

- ▶ AR Foundation Samples  
<https://github.com/Unity-Technologies/arfoundation-samples>
- ▶ AR Foundation Demos  
<https://github.com/Unity-Technologies/arfoundation-demos>