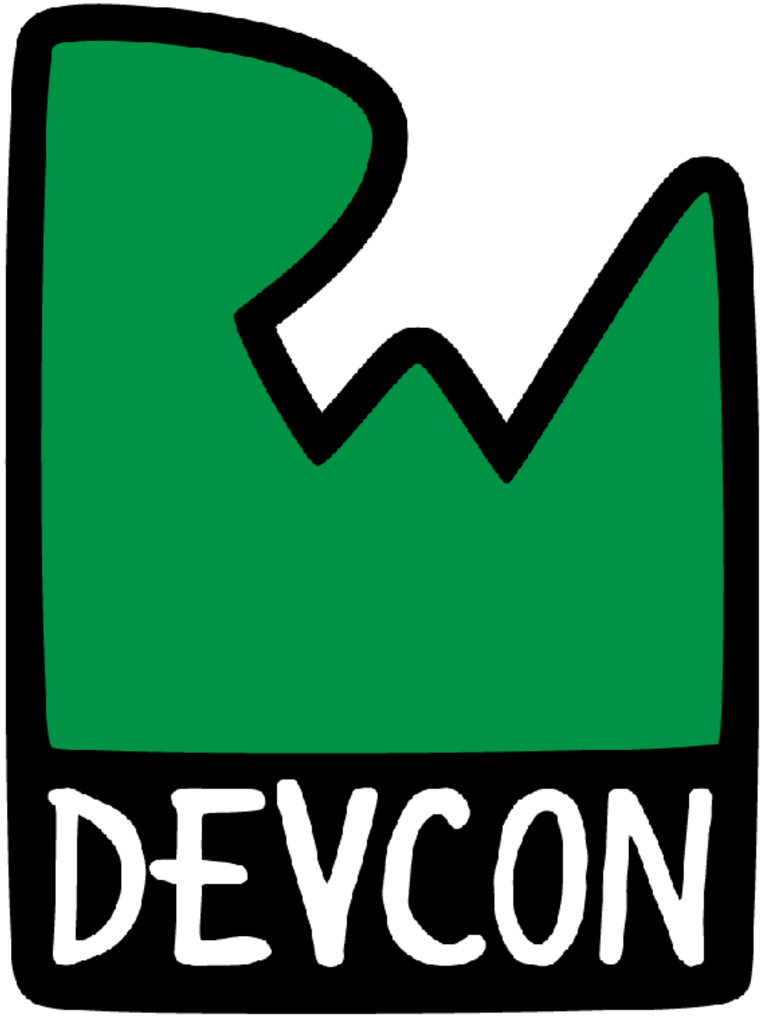
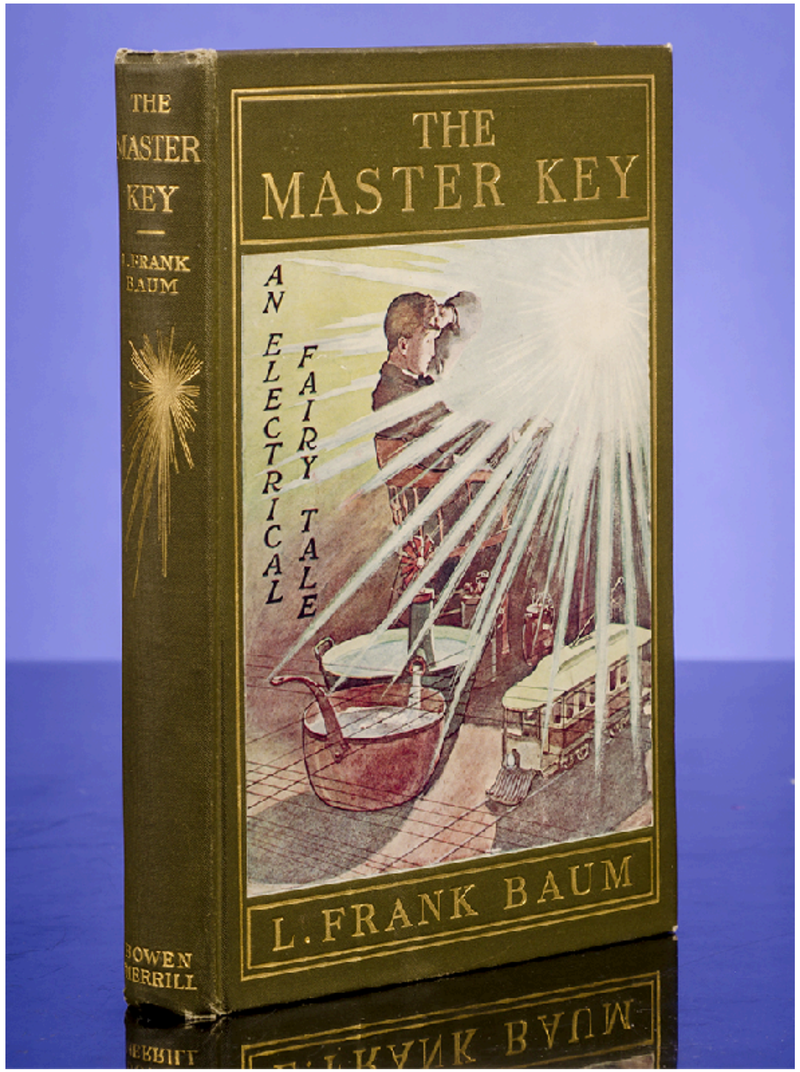
Session 13: Getting Started with ARKit



Overview


AR
VR

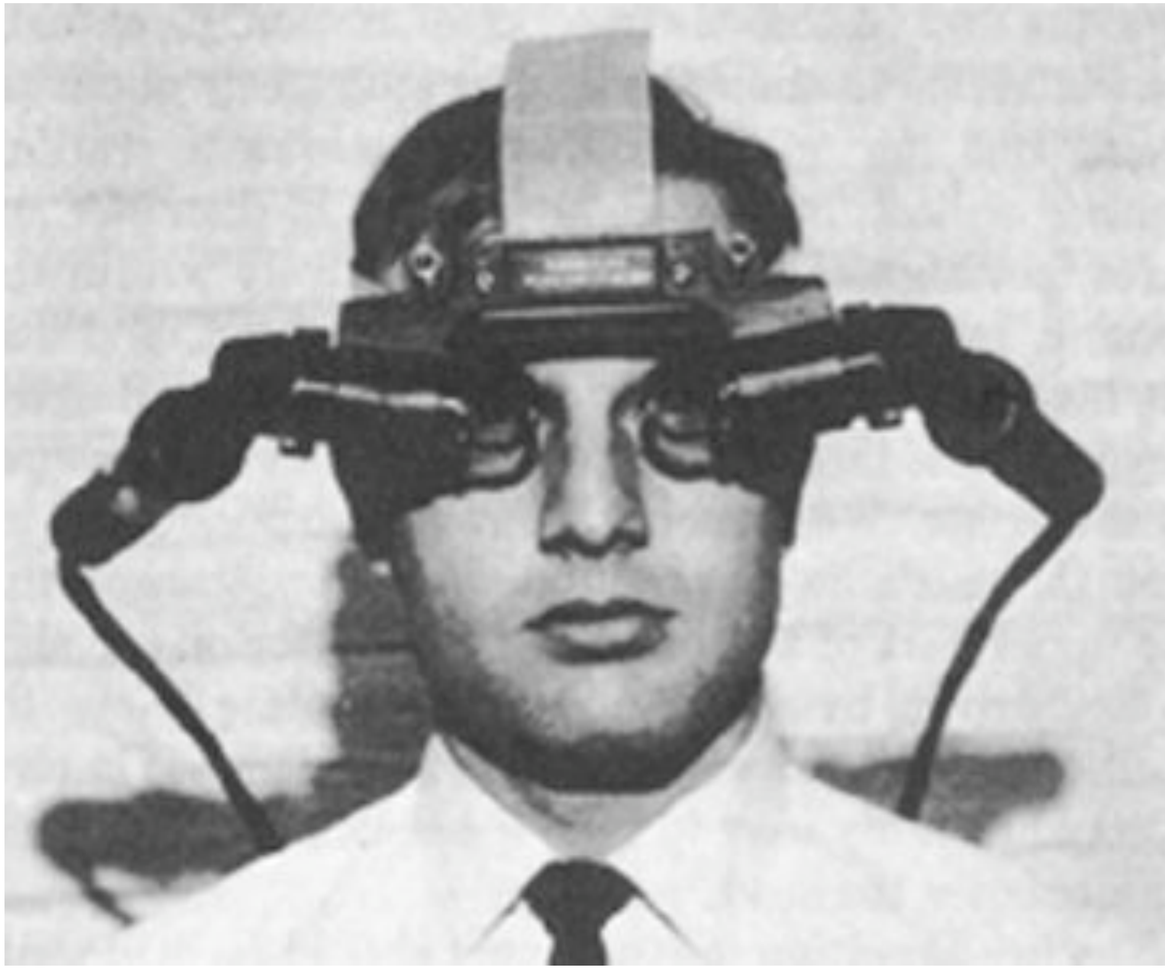
1901: L. Frank Baum



“It consists of this pair of spectacles. While you wear them every one you meet will be marked upon the forehead with a letter indicating his or her character…”

- Good: G
- Evil: E
- Wise: W
- Foolish: F
- Kind: K
- Cruel: C

1968: Ivan Southerland



1990: Tom Caudell

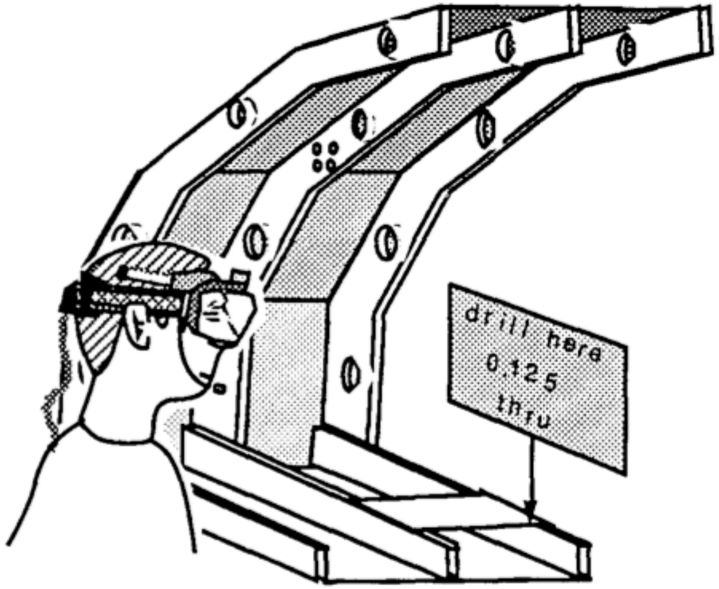
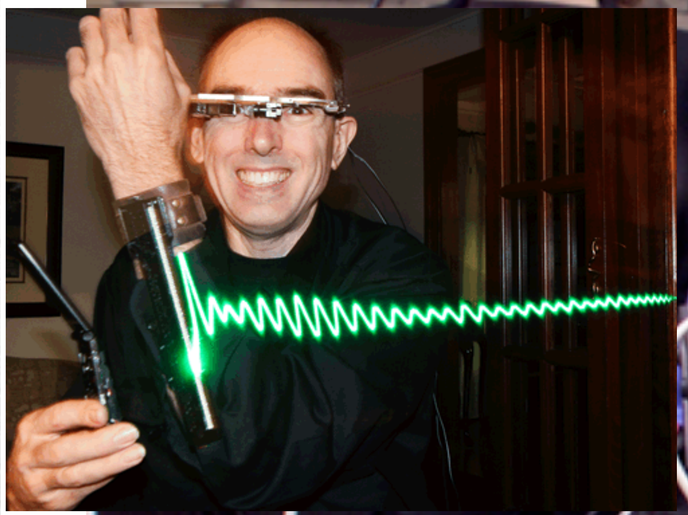
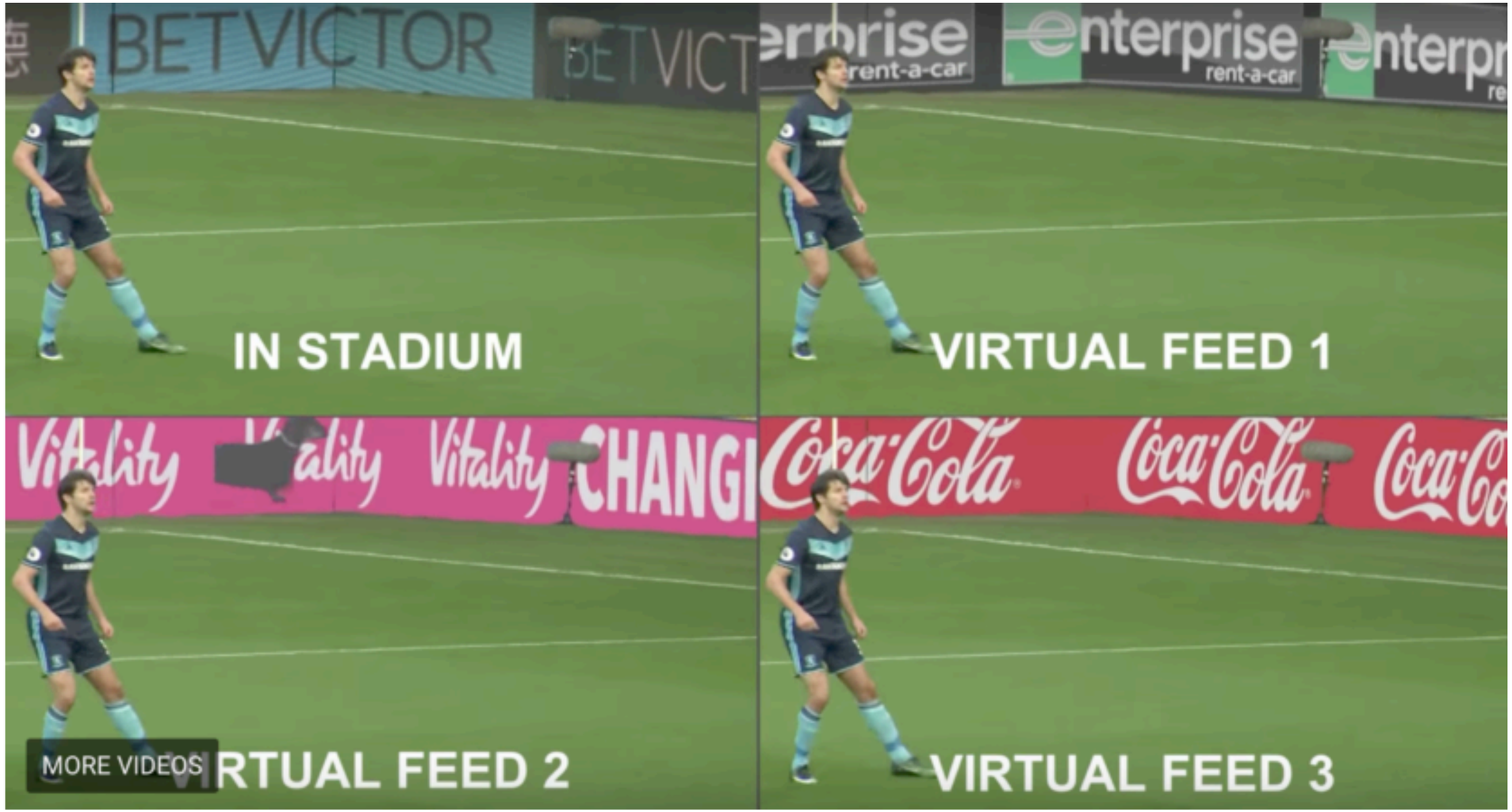


Figure 1. An application where the HUDset is used to dynamically mark the position of a drill/rivet hole inside an aircraft fuselage.

1980s, 1990s and on: Steve Mann

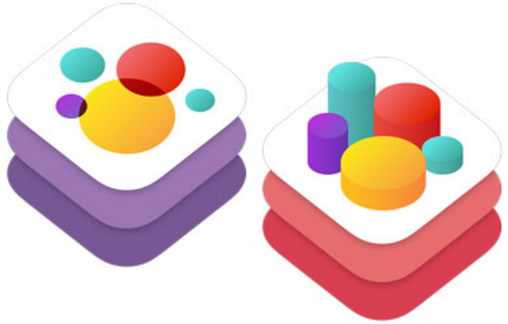


1998: Sports Broadcasting



ARKit in a Nutshell

+



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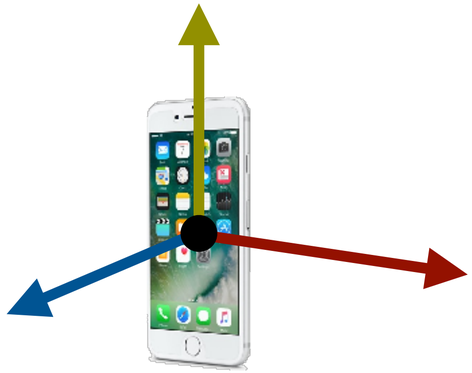


Real-world images

These come from a camera, and can simply be a backdrop for your app (think Pokémon Go), or can provide input for it (think IKEA Place).

Virtual images

These are 2D or 3D images drawn on top of the real-world images from the camera.

Sensor smarts

This is the AR application's ability to detect its position and orientation, as well as objects and conditions in the real world.

=

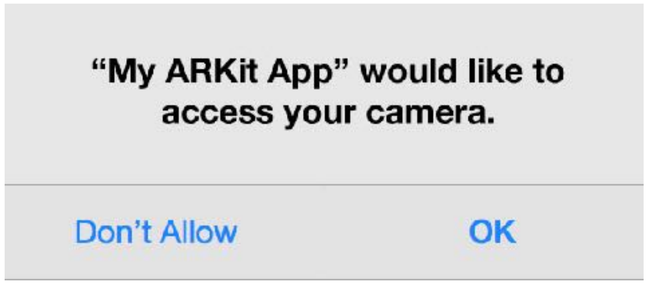
ARKit USER REQUIREMENTS

iDevice with A9 processor or later

- iPhone: 6S / 6S Plus / 7S / 7S Plus / 8 / 8 Plus / X
- iPad Pro: 9.7” / 10.5” / 12.9”
- iPad: 2017 model

iOS 11

The first iOS version that supports ARKit

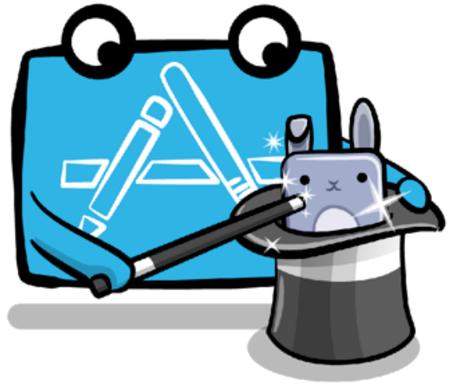


Permission to use the camera

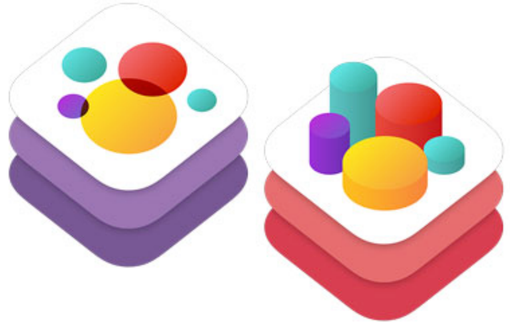
Adequate light

ARKit DEVELOPER REQUIREMENTS

The user requirements



Xcode 9.3 or later



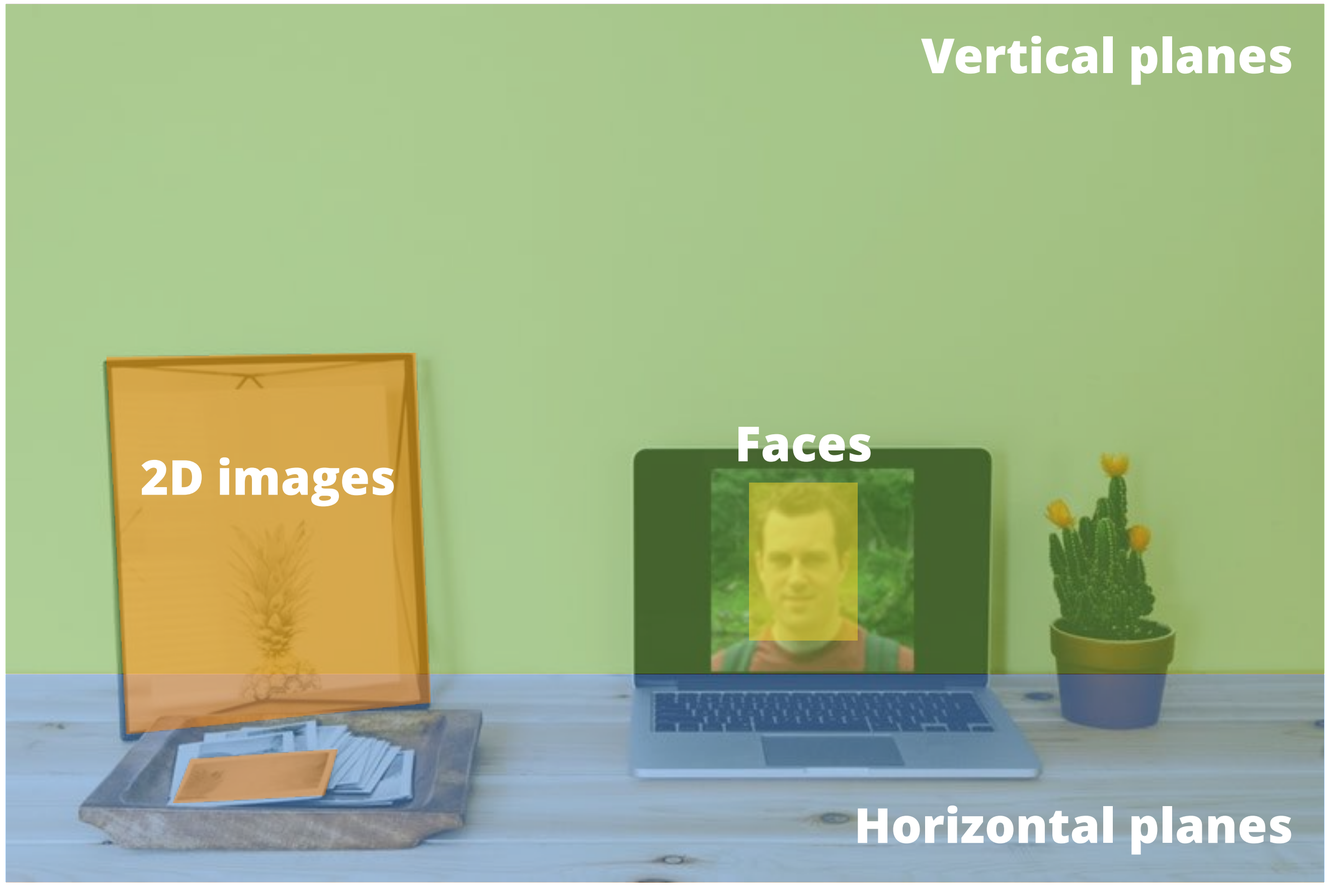
SpriteKit / SceneKit basics

Readiness to walk about and wave your iDevice

Willingness to do at least a little 3D math...

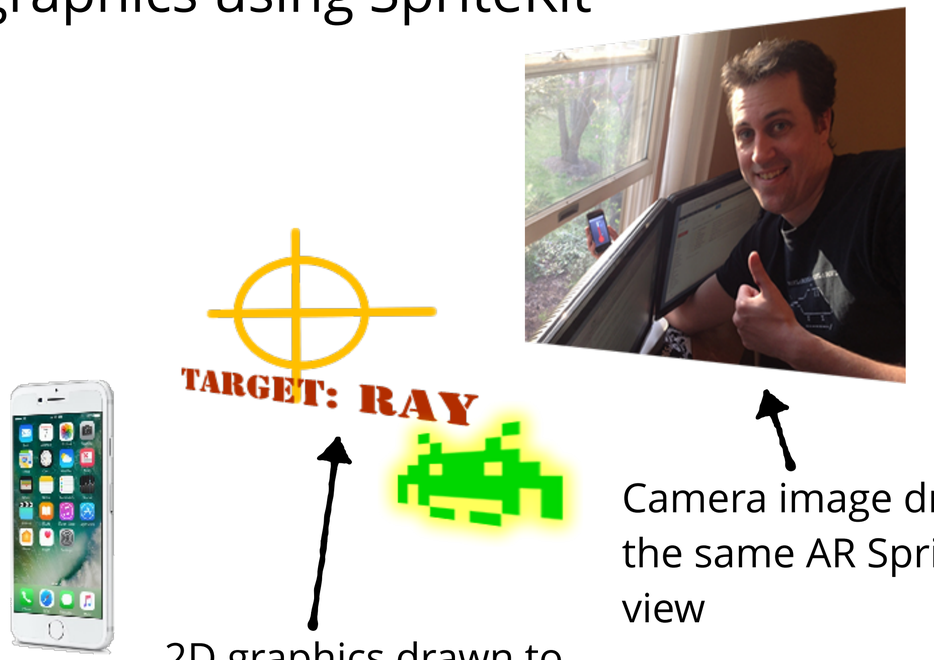
...and deal with changes and upgrades.

What real-world things can ARKit identify?



SpriteKit AR vs. SceneKit AR

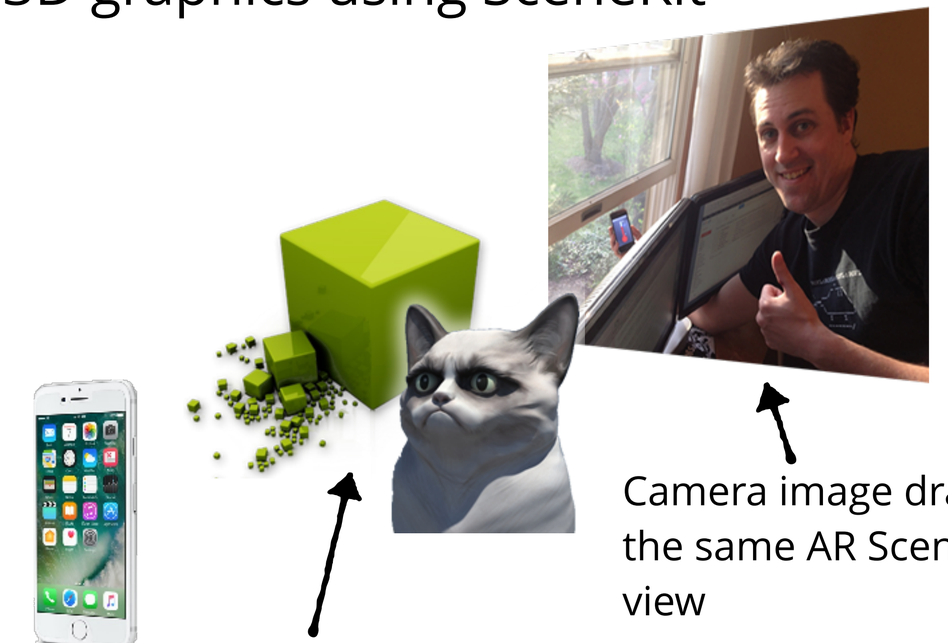
SpriteKit AR:
Overlaying camera images with
2D graphics using SpriteKit



Camera image drawn to the same AR SpriteKit view

2D graphics drawn to an **AR SpriteKit view** (**ARSKView**)

SceneKit AR:
Overlaying camera images with
3D graphics using SceneKit



Camera image drawn to the same AR SceneKit view

3D graphics drawn to an **AR SceneKit view** (**ARSCNView**)

The demos

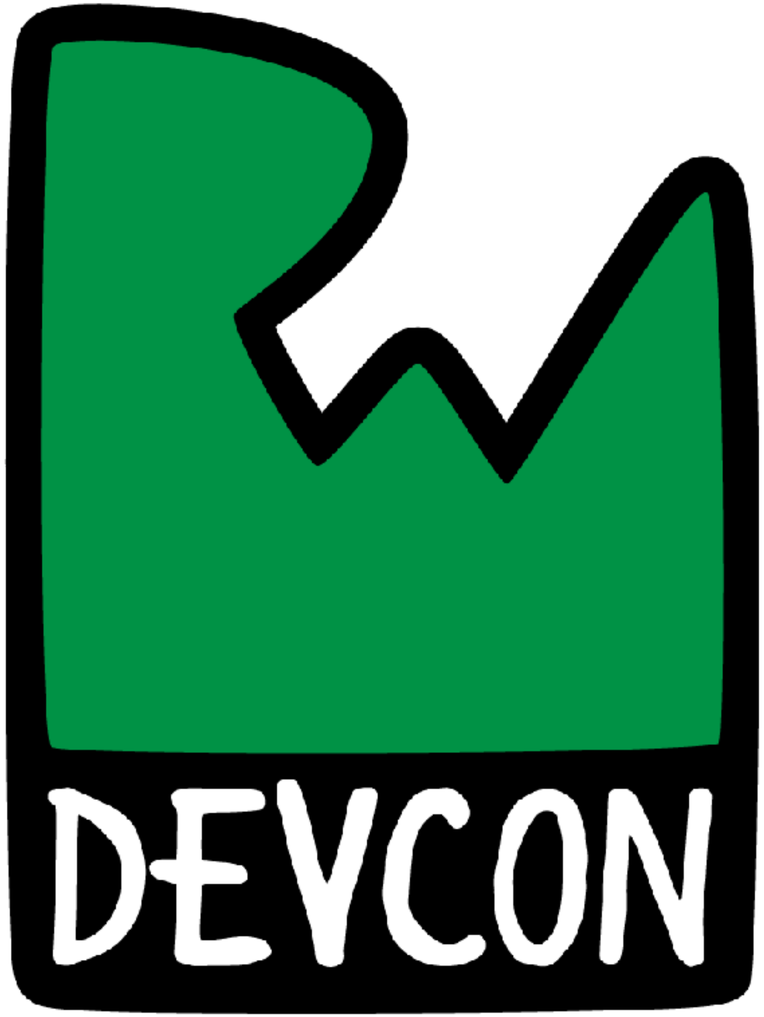
Demo 1: *Happy AR Painter*

In which you begin your ARKit journey by paying homage to the great Bob Ross by building an app that paints in real-world 3D.

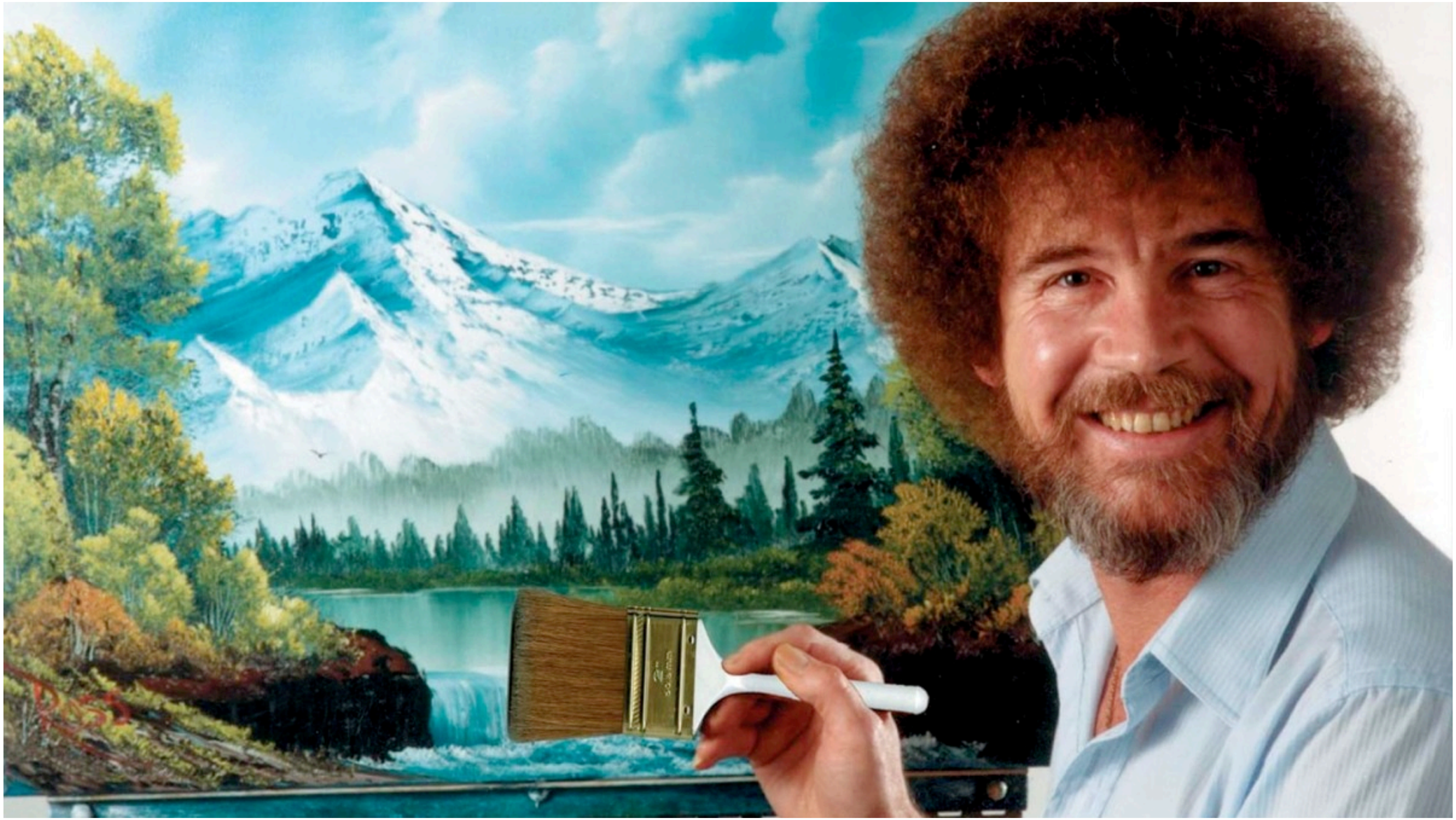
Demo 2: *Raykea*

Let’s make our own version of the most popular ARKit app. Why should makers of semi-disposable furniture have all the fun?

Session 13: Getting Started with ARKit

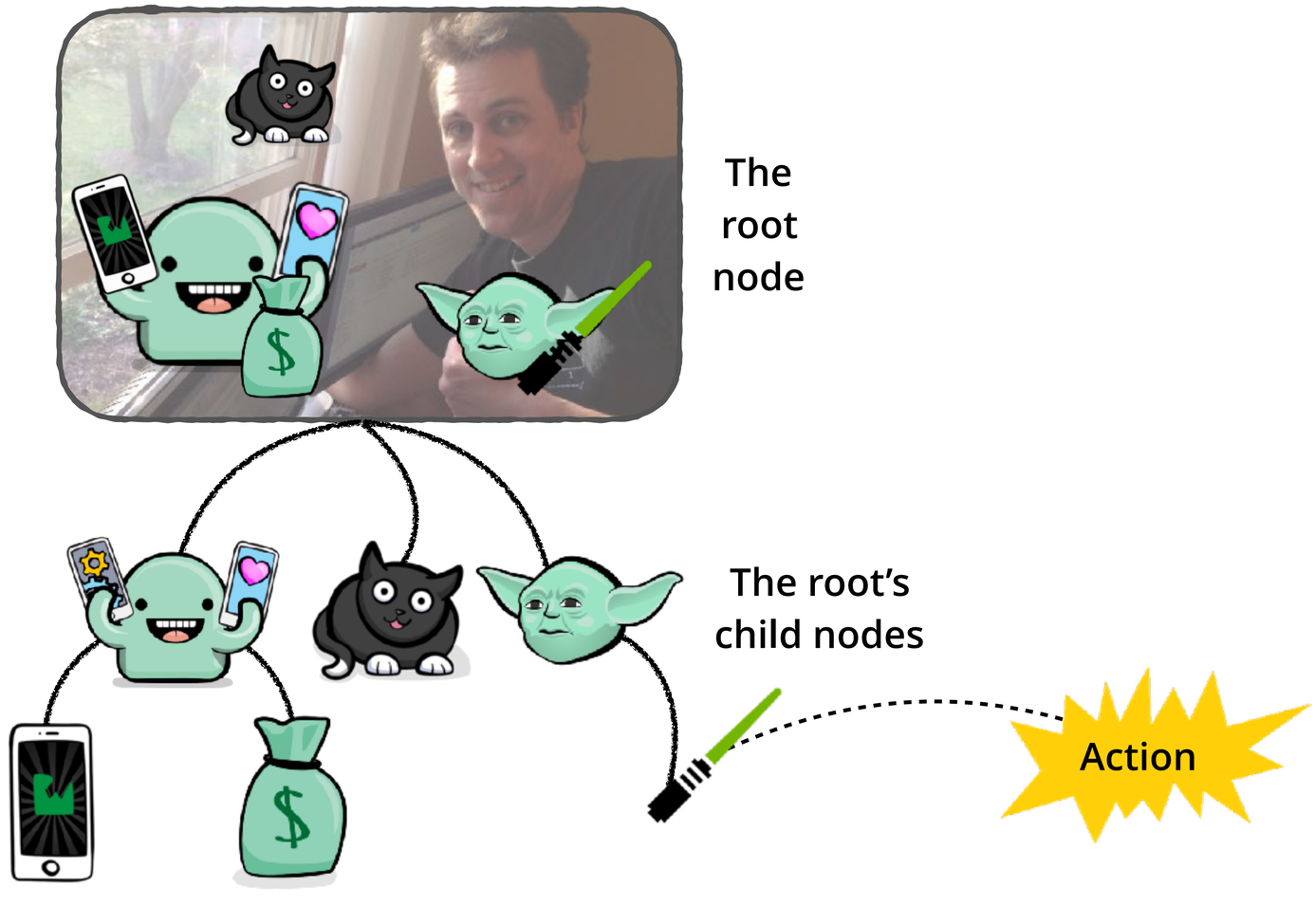


Happy AR Painter



Quick SceneKit Overview

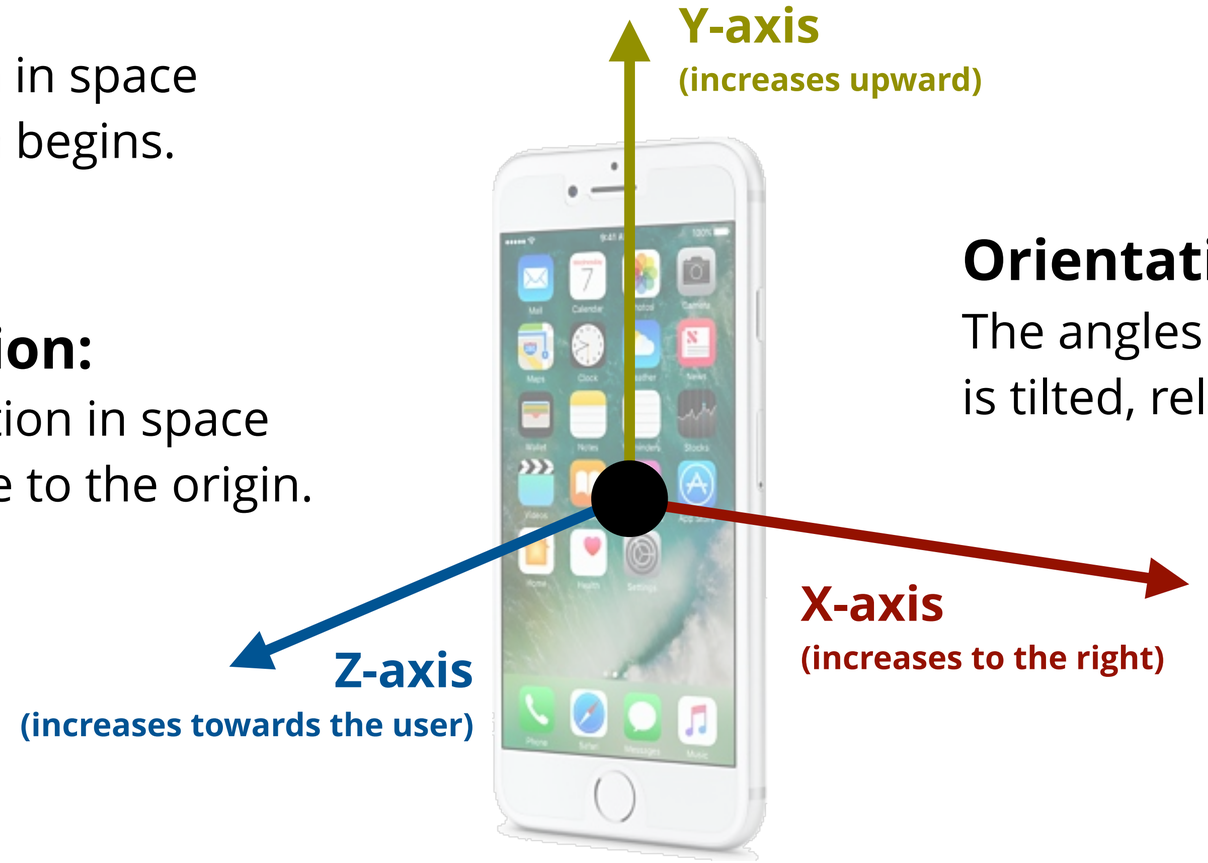
Scene graph



SceneKit's 3D Coordinate System

Origin:
The device's position in space when the AR session begins.

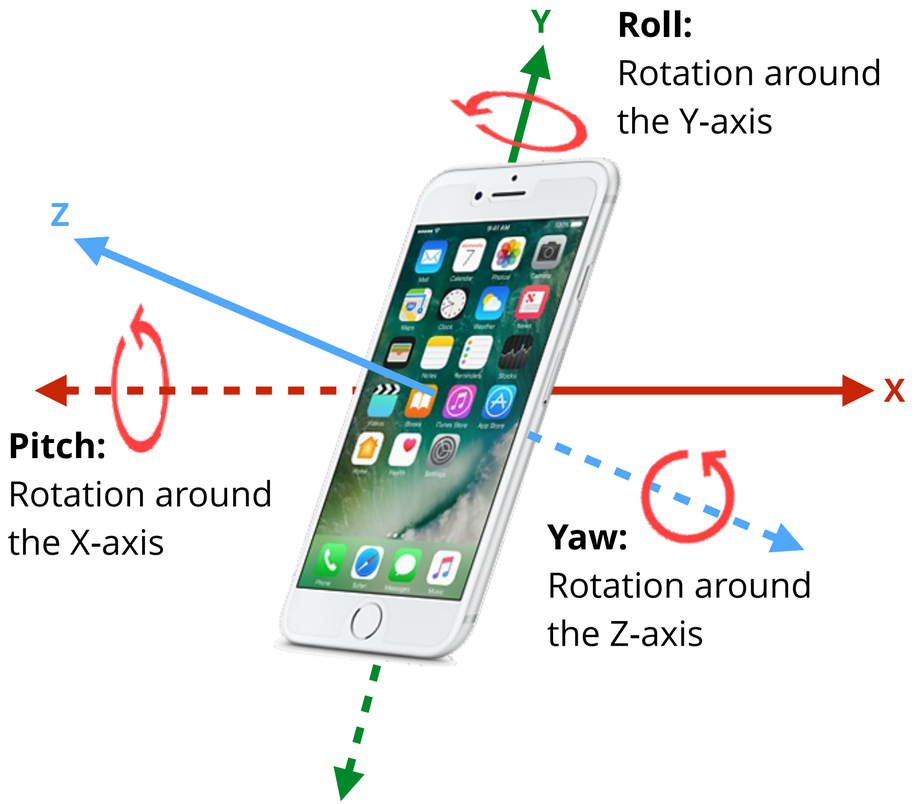
Position:
A position in space relative to the origin.



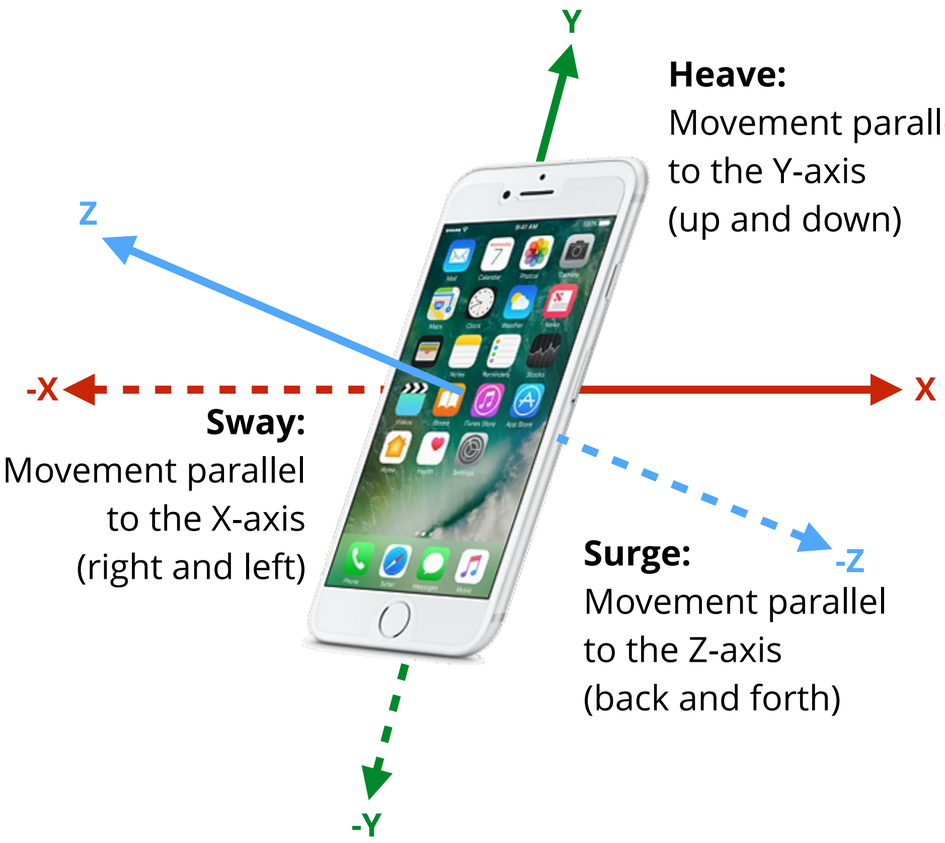
Orientation:
The angles at which something is tilted, relative to x-, y-, and z-axes.

Configuration: 3 or 6 degrees of freedom?

`AROrientationTrackingConfiguration`
`ARWorldTrackingConfiguration`

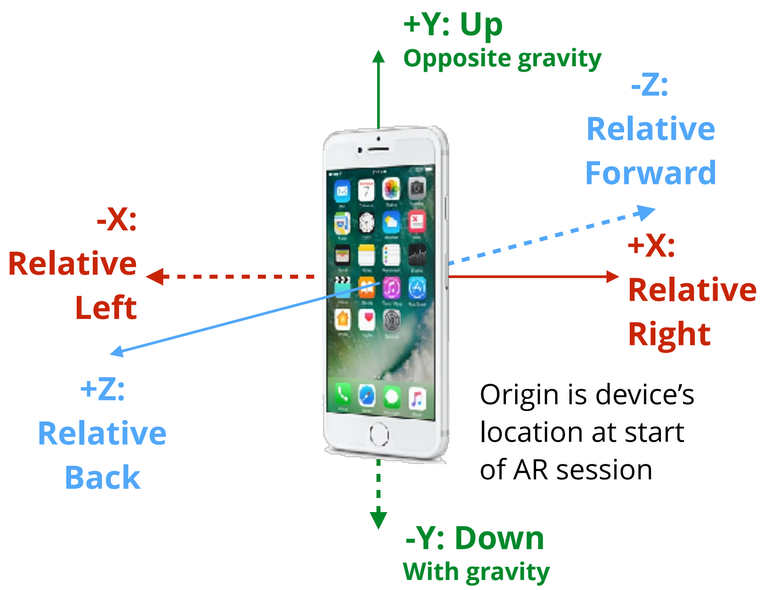


`ARWorldTrackingConfiguration`

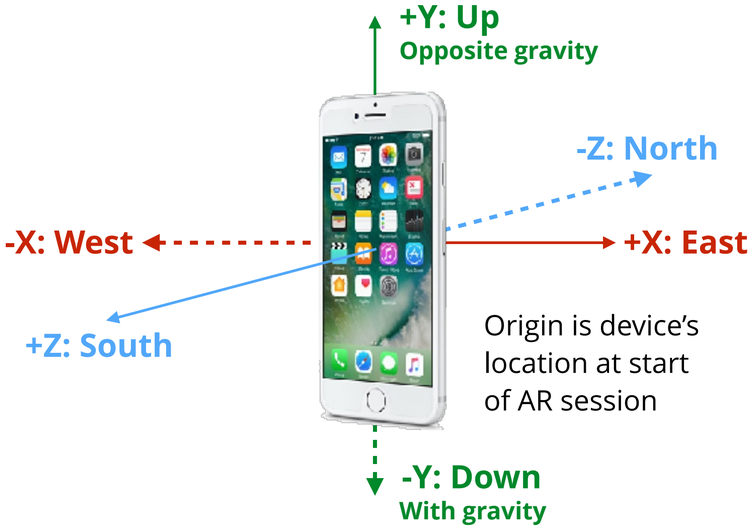


Alignment: Relating to the real world

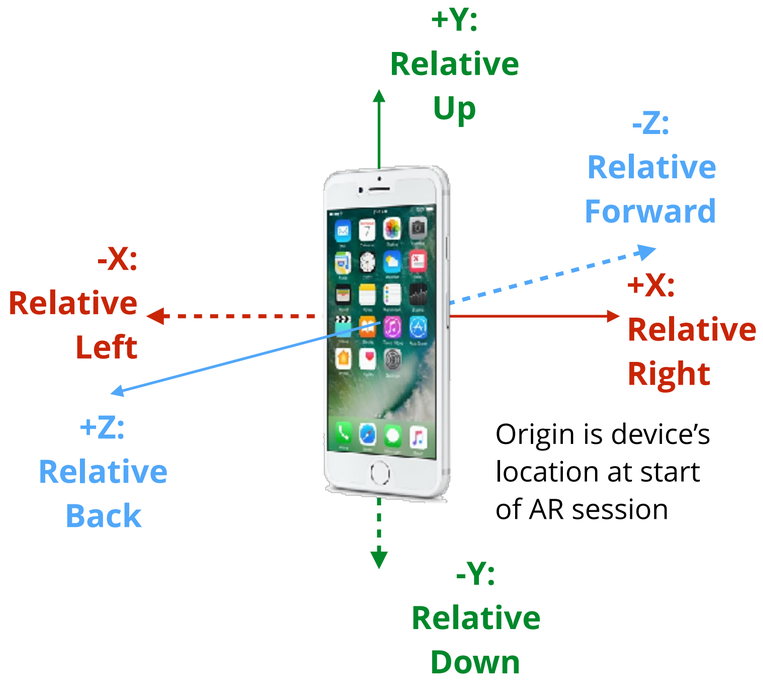
`gravity`



`gravityAndHeading`

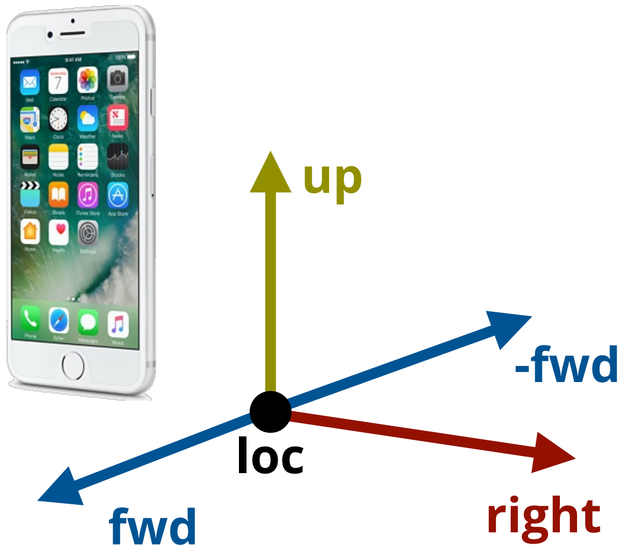


`Camera`



The SceneView's Transformation Matrix

A 4-by-4 matrix representing the scene's ***location*** and ***orientation***:



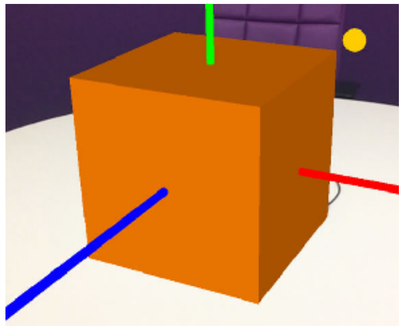
Orientation: Which way the camera's facing

Location: Where the camera is

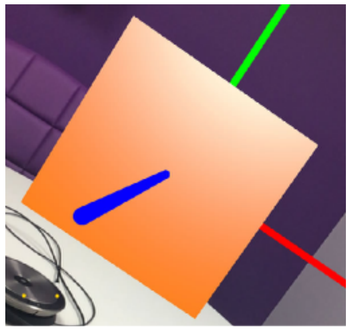
$$\begin{bmatrix} \text{right}_x & \text{up}_x & -\text{fwd}_x & \text{loc}_x \\ \text{right}_y & \text{up}_y & -\text{fwd}_y & \text{loc}_y \\ \text{right}_z & \text{up}_z & -\text{fwd}_z & \text{loc}_z \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Diffuse vs. Specular Reflection

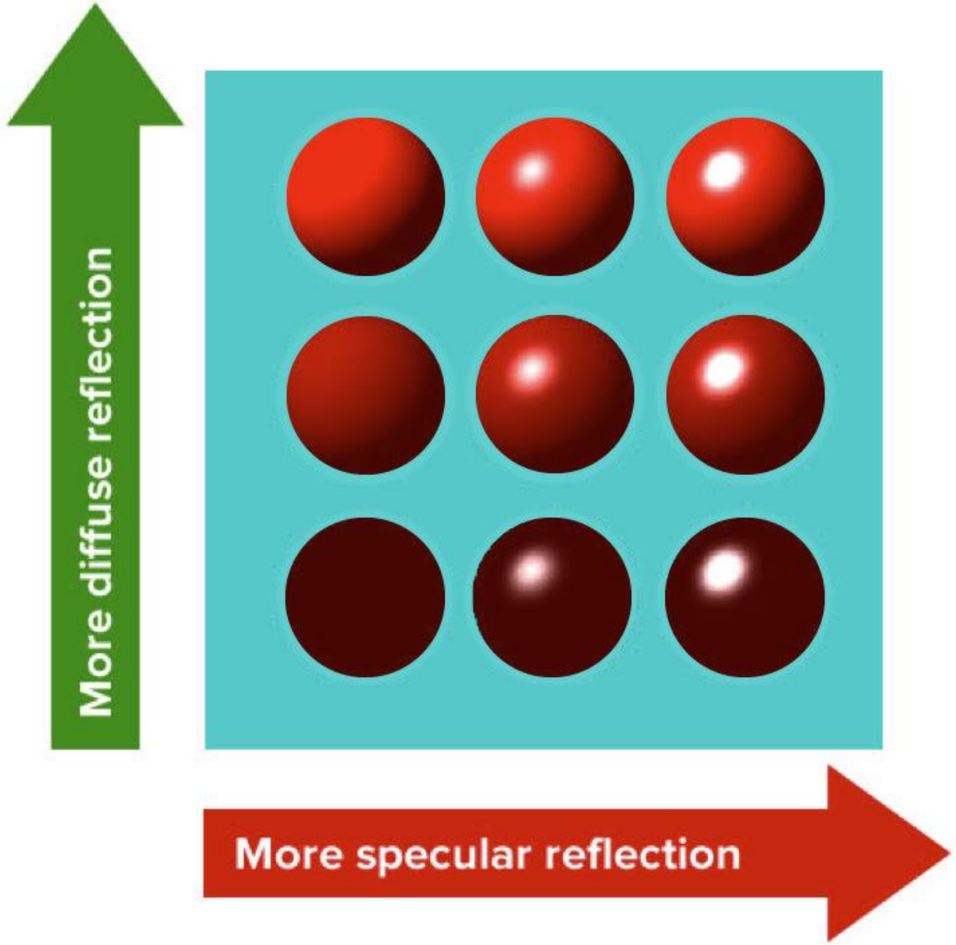
It might be easier to *show* you what these are than to *tell* you about them.



Diffuse reflection



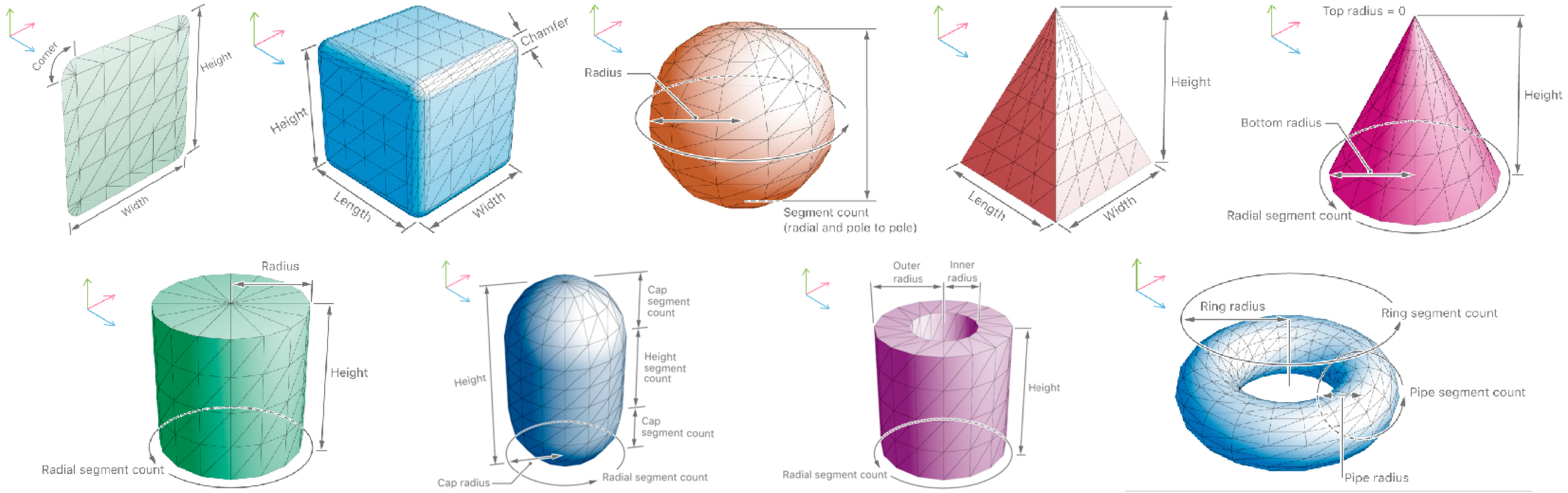
Specular reflection



Demo 1:
Happy AR Painter

How Happy AR Painter works, part 1

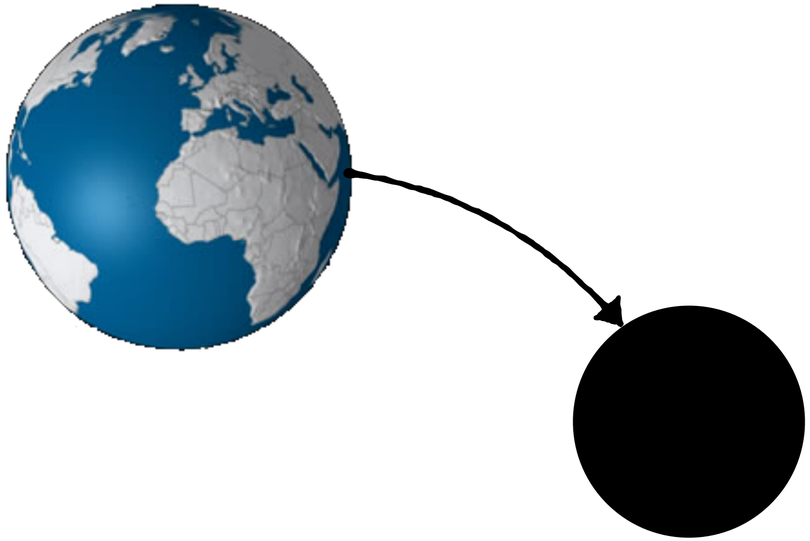
1. Define a SceneKit geometry:



How Happy AR Painter works, part 2

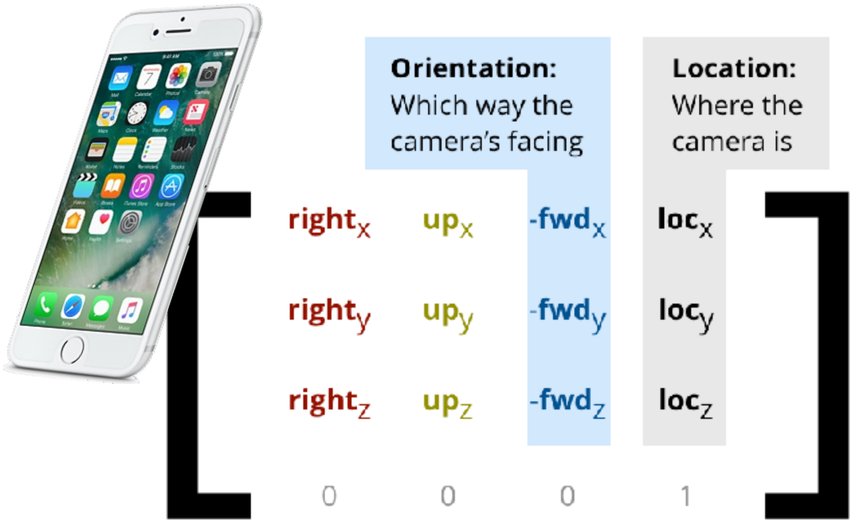
2. Apply reflective properties to the geometry.

3. Assign the geometry to a node.

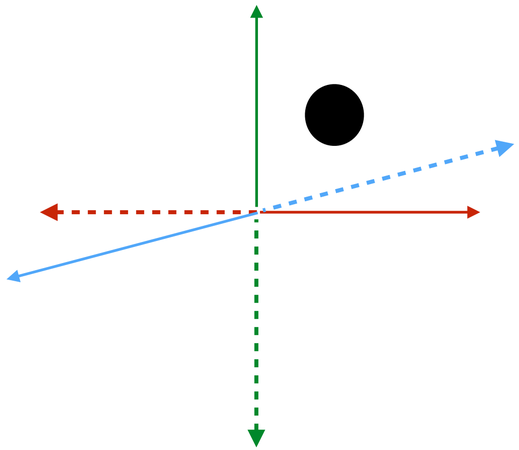


How Happy AR Painter works, part 3

4. Get the device's orientation and position from the SceneView's transform matrix.

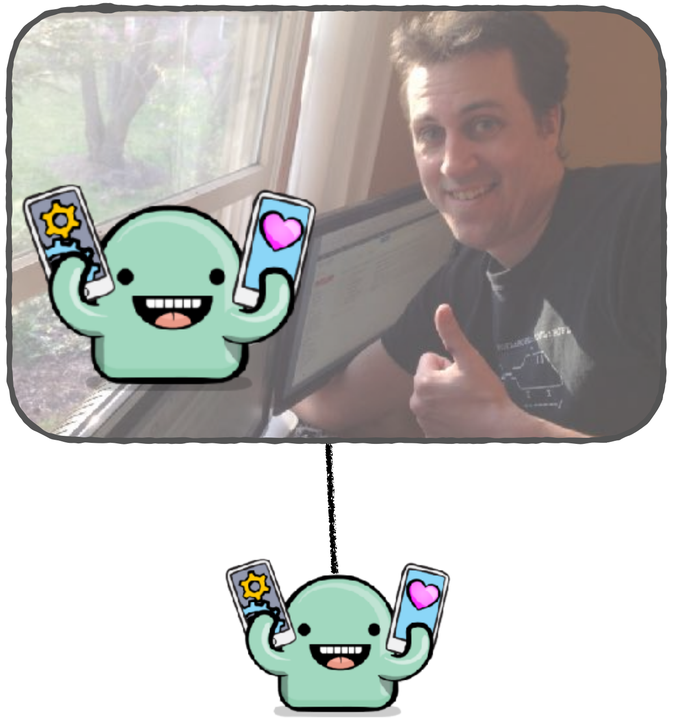


5. Set the node's orientation and position to that of the device's orientation and position.



How Happy AR Painter works, part 4

6. Add the node to the scene.



The root node

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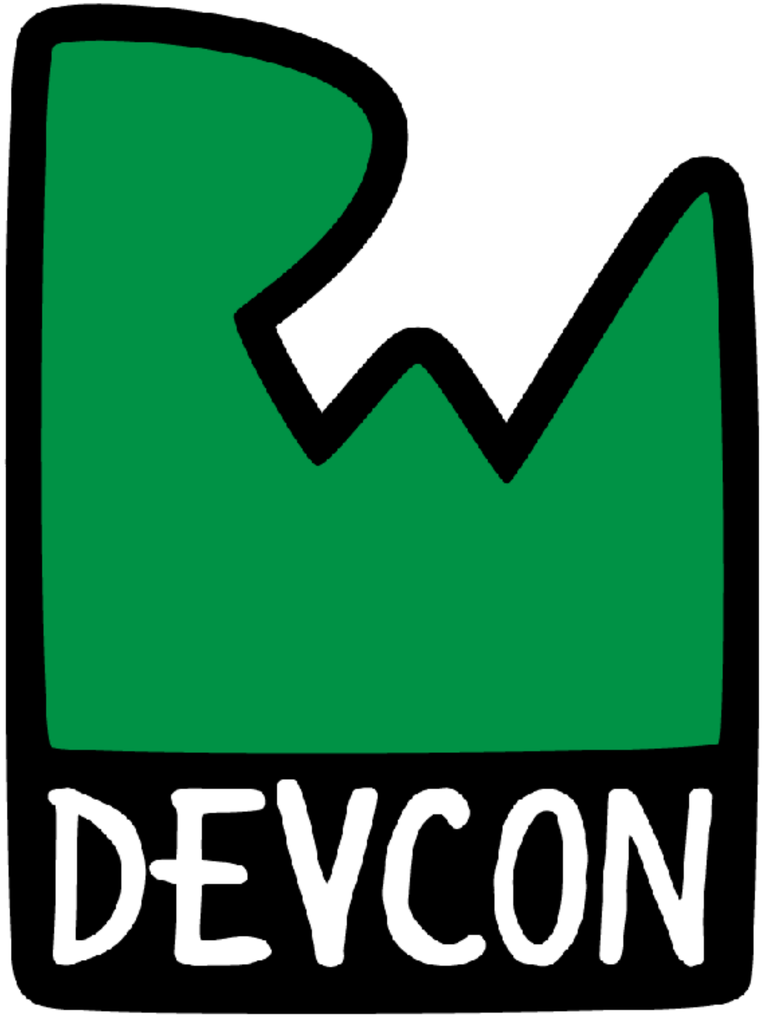
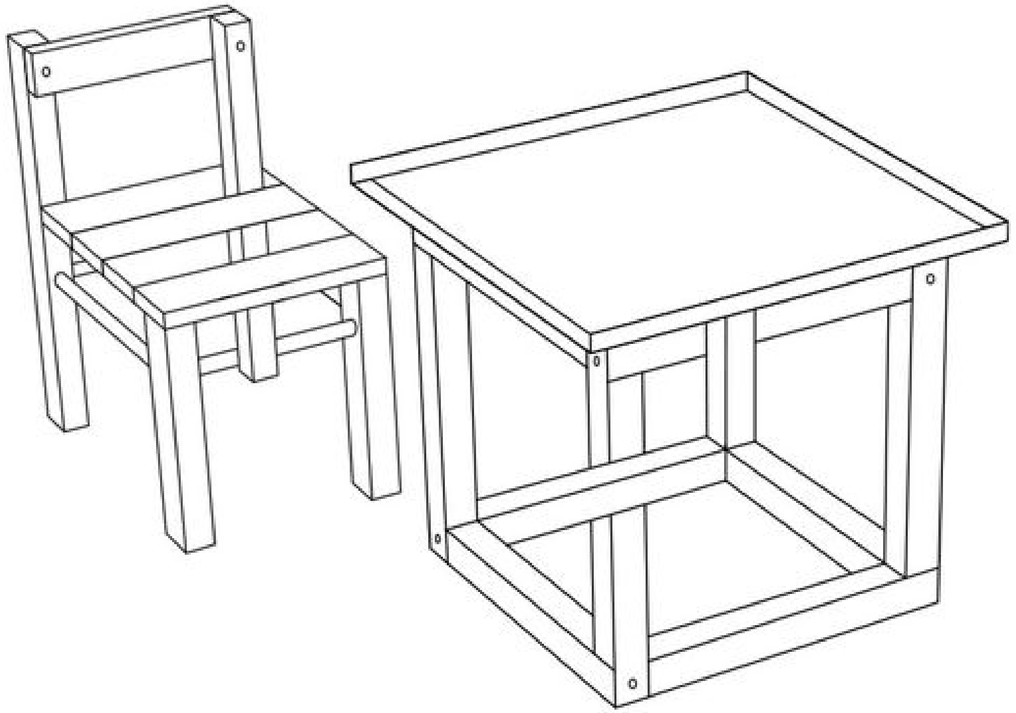
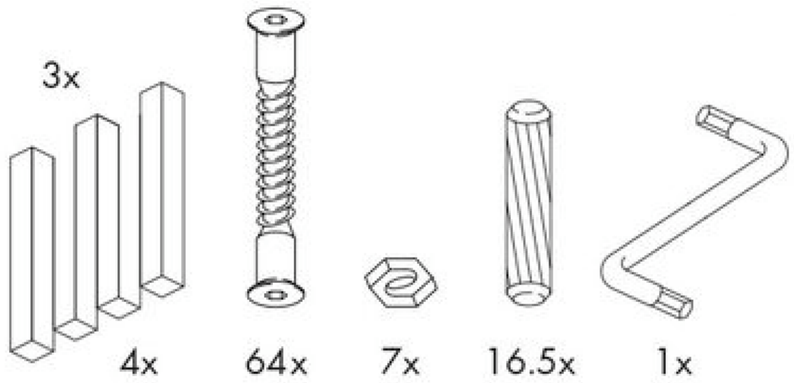


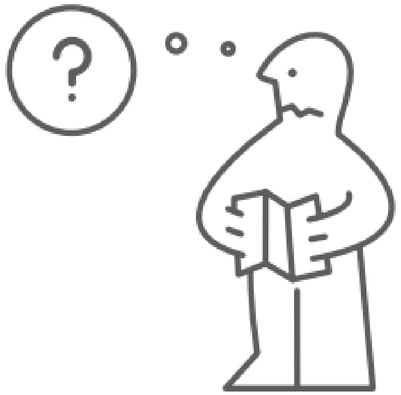
RAYKEA!

PARADÖX

play table and chair







Plane detection

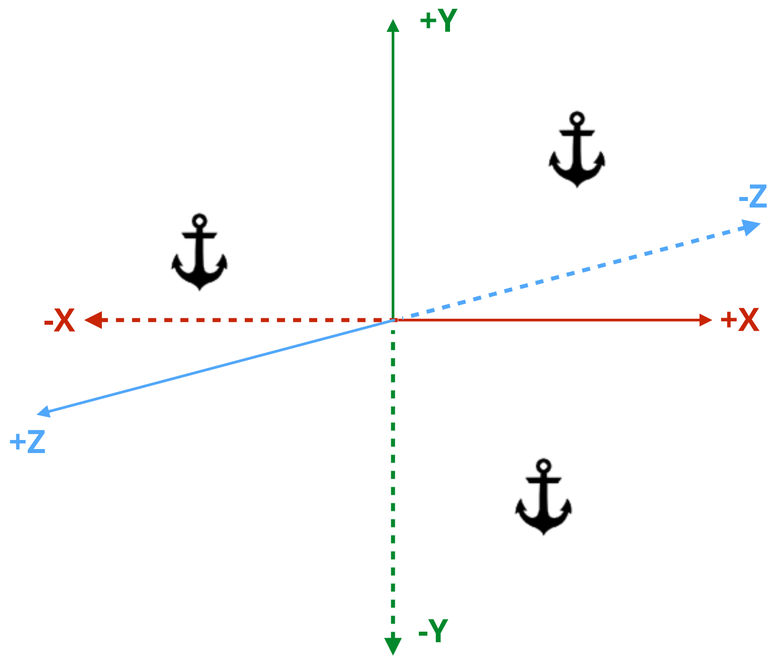
Activating plane detection

These two **`ARWorldTrackingConfiguration`** settings will enable horizontal plane detection:

```
config.worldAlignment = .gravity
// or
config.worldAlignment = .gravityAndHeading

config.planeDetection = .horizontal
// or
config.planeDetection = .vertical
// or
config.planeDetection = [.horizontal,
                         .vertical]
```

AR Anchors



An **`ARAnchor`** is a reference point
in 3D space, marking *position* and *orientation*
in an AR scene.

They can be added to a scene in 2 ways:

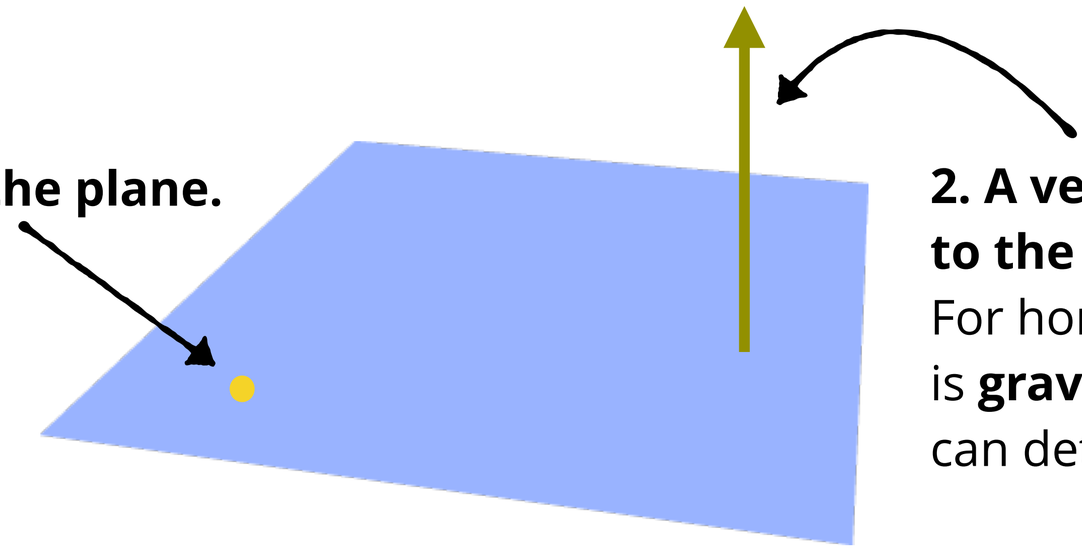
1. ***Programmatically,* by your code.**
   Do this to keep track of specific objects or locations.

2. ***Automatically,* by ARKit.**
   With plane detection turned on, ARKit adds **`ARPlaneAnchors`** (a subclass of **`ARAnchor`**) to the scene.

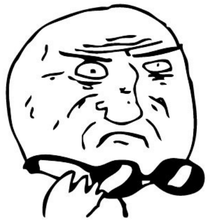
How ARKit detects horizontal planes

The equation for a plane is defined by 2 things...

1. A point on the plane.

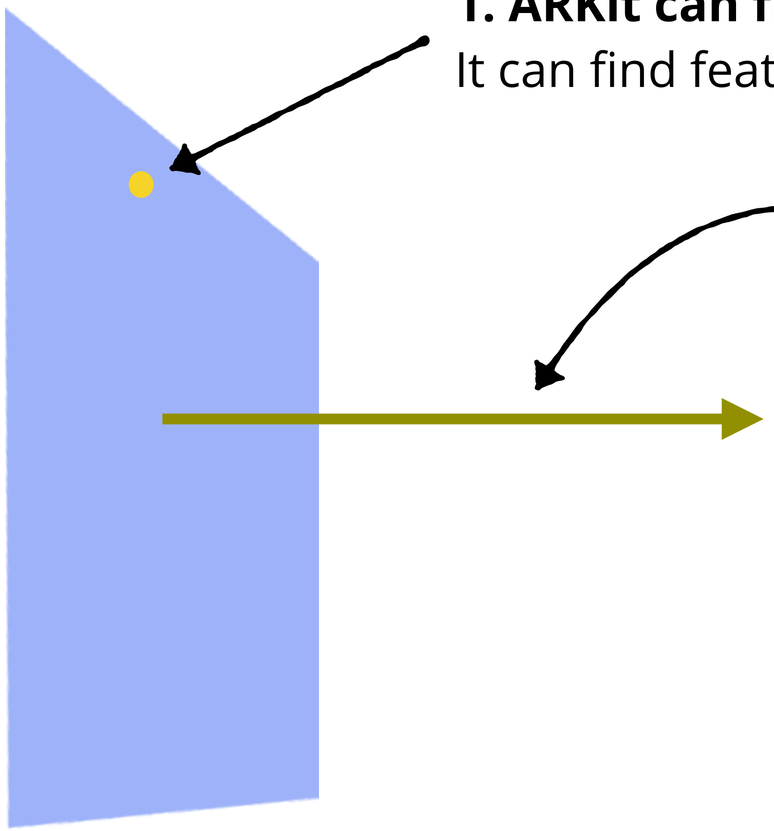


2. A vector *normal* (perpendicular) to the plane.
For horizontal planes, this vector is **gravity,** which the accelerometer can detect.



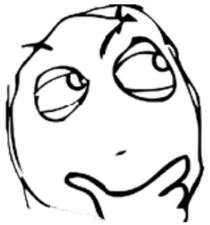
(Don't believe this? Try plane detection with the AR configuration's **`worldAlignment`** property to **`camera`**,
the one setting that doesn't align the Y-axis with gravity.)

Detecting vertical planes is trickier



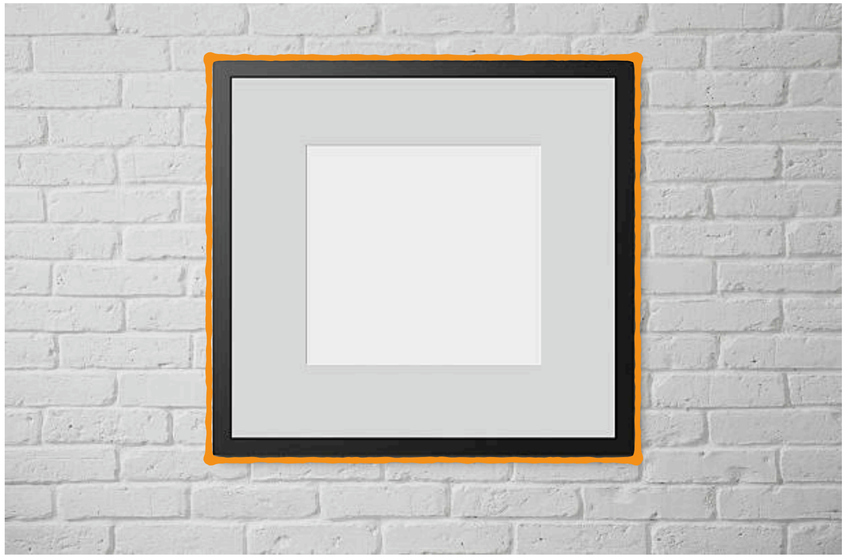
1. ARKit can find points on a vertical plane.
It can find feature points on vertical surfaces easily.

2. The hard part is *finding the plane's normal.*
With vertical planes, we don't have a handy force like gravity to rely on to find the normal.

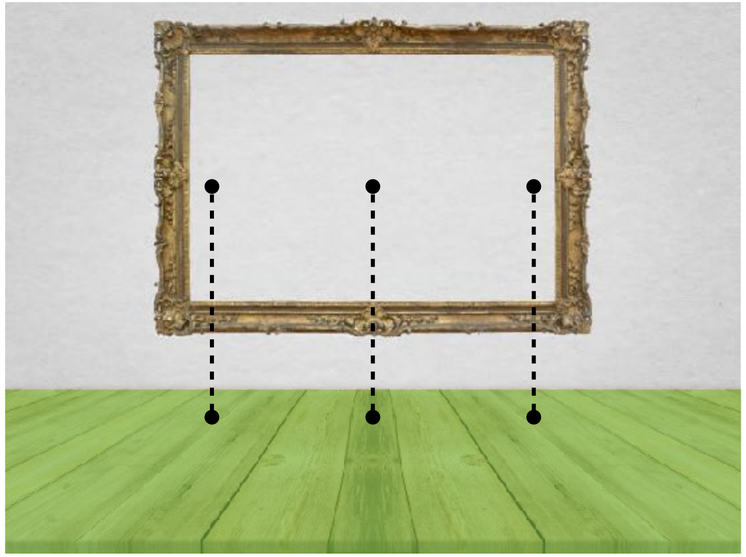


(Special bragging rights to the first person who can answer this question: "Why can't we simply use a vector that's *perpendicular* to gravity as the normal for vertical surfaces?")

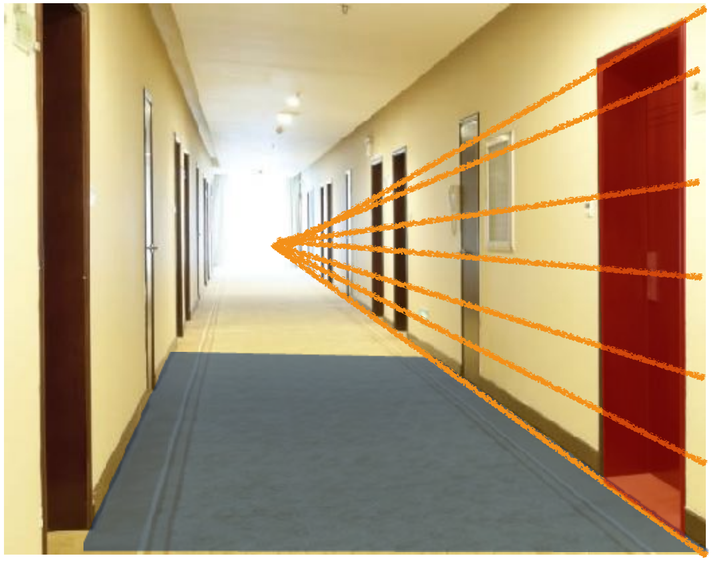
So how does ARKit detect vertical planes?



High-contrast borders



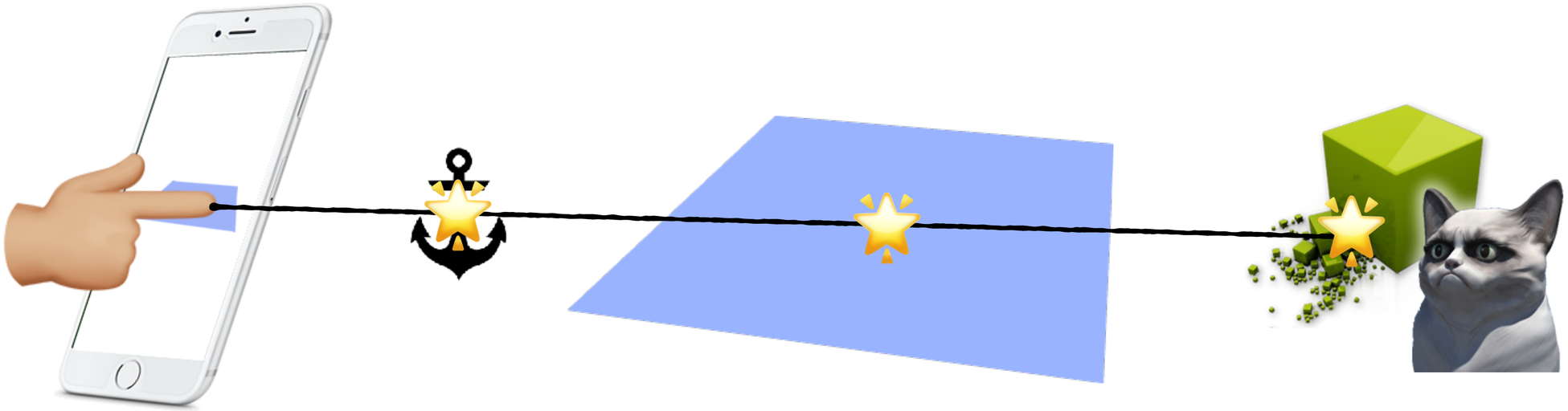
Points and
a known horizontal plane

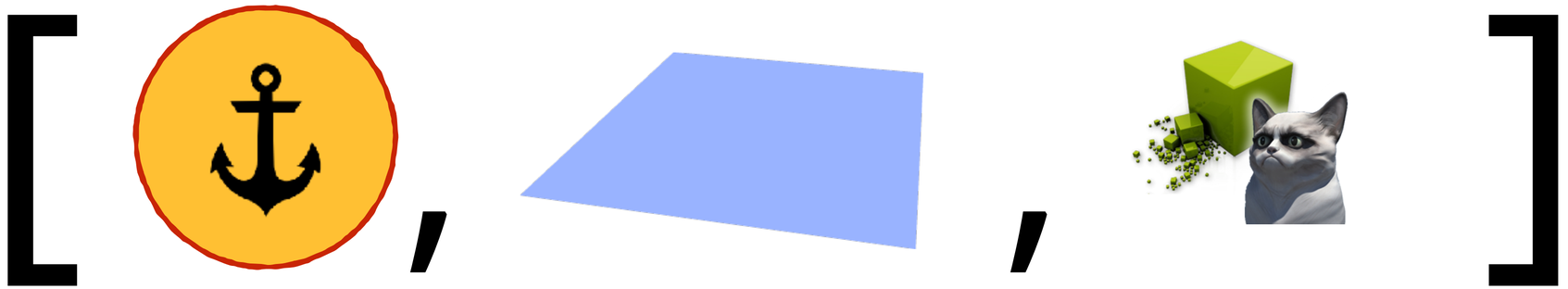


Raycasting

Hit testing

Hit testing answers the question “Does this 2D screen coordinate correspond to the 3D coordinates on an AR anchor, real-world feature, or virtual object?

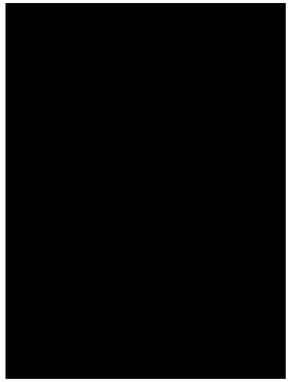




What causes tracking to fail?

Too few features

Too much motion



Too little light

Relocating

How well is the camera tracking?

This ARKit delegate method gets called whenever the camera's tracking state changes...

```
session(_:cameraDidChangeTrackingState:)
```

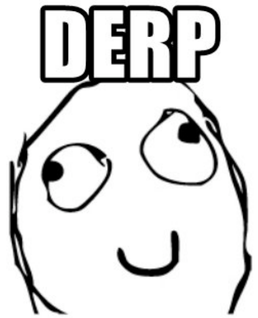
...and it gives us this very handy property...

```
ARCamera.trackingState
```

...which will contain one of three possible values:

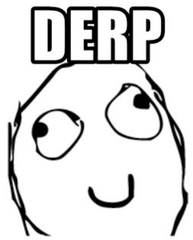
```
.notAvailable
```

```
.normal
```




```
.limited
```

Reasons why tracking is limited



If tracking is limited, you can check the **`reason`** property to see why.

`.initializing`

`.excessiveMotion`

`.insufficientFeatures`

`.relocalizing`

Demo 2:
Raykea

How Raykea works, part 1

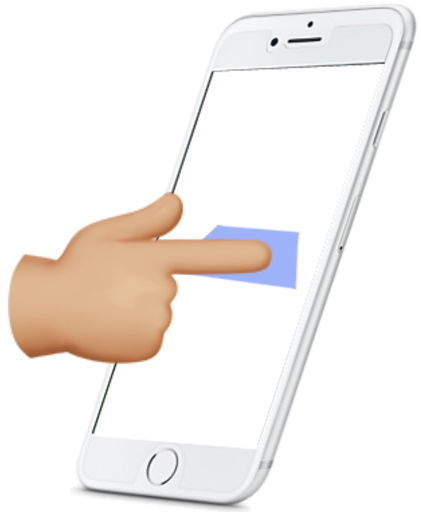
1. Continuously seek horizontal and vertical planes.

2. Cover any detected vertical planes with a poster.

How Raykea works, part 2

3. Cover any detected horizontal planes with a “place furniture here” grid.

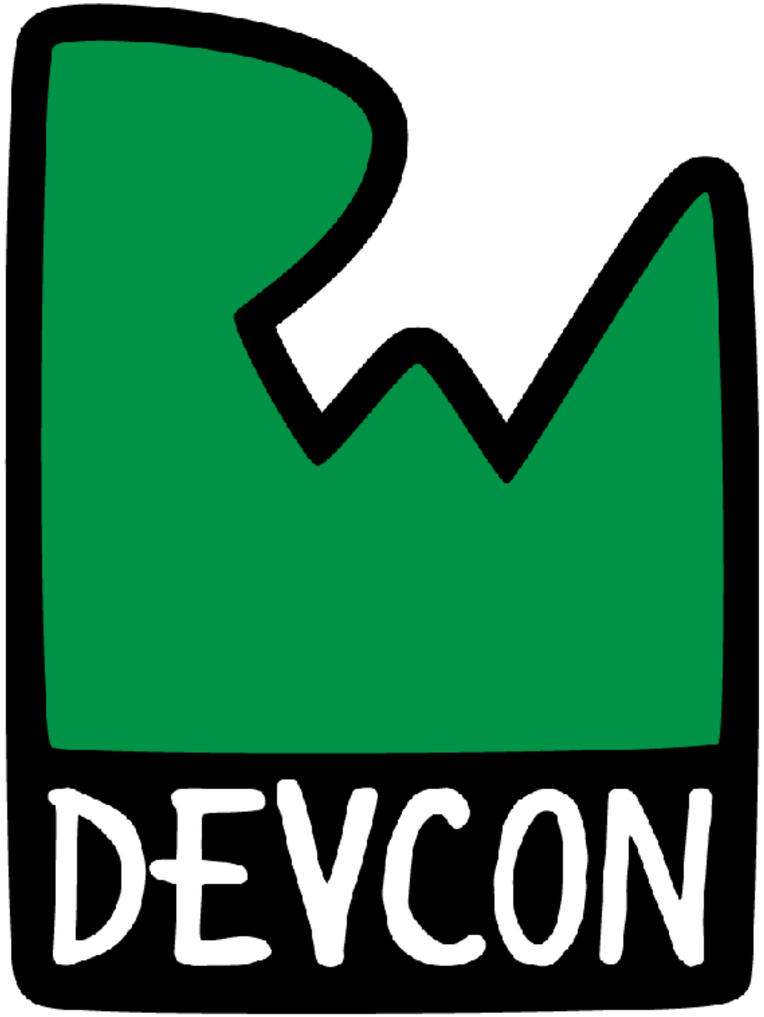
4. When the user taps the screen, perform a hit test to see if that tap corresponds to a detected horizontal plane.



How Raykea works, part 3

5. If the tap corresponds to a detected horizontal plane,
find the real-world coordinates that correspond to that tap,
and draw furniture at those coordinates.

Session 13: Getting Started with ARKit



Conclusion

What You Learned

Demo 1: *Happy AR Painter*

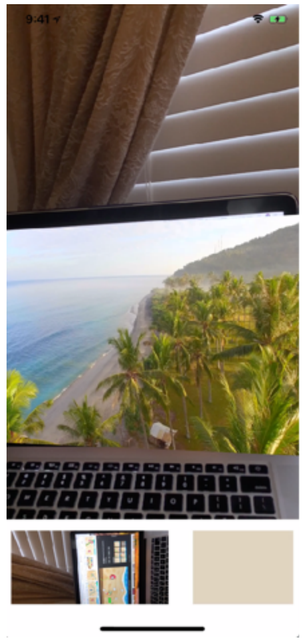
Your first AR scene, where you added simple SceneKit geometric shapes to the scene and used the device's position and orientation.

Demo 2: *Raykea*

You took Demo 1's lessons, added 3D models, hit tests, and plane detection, and started interacting with the real world.

What You DIDN't Learn

Even at less than a year old, ARKit already offers so much ground to cover that a single workshop can't cover it all...



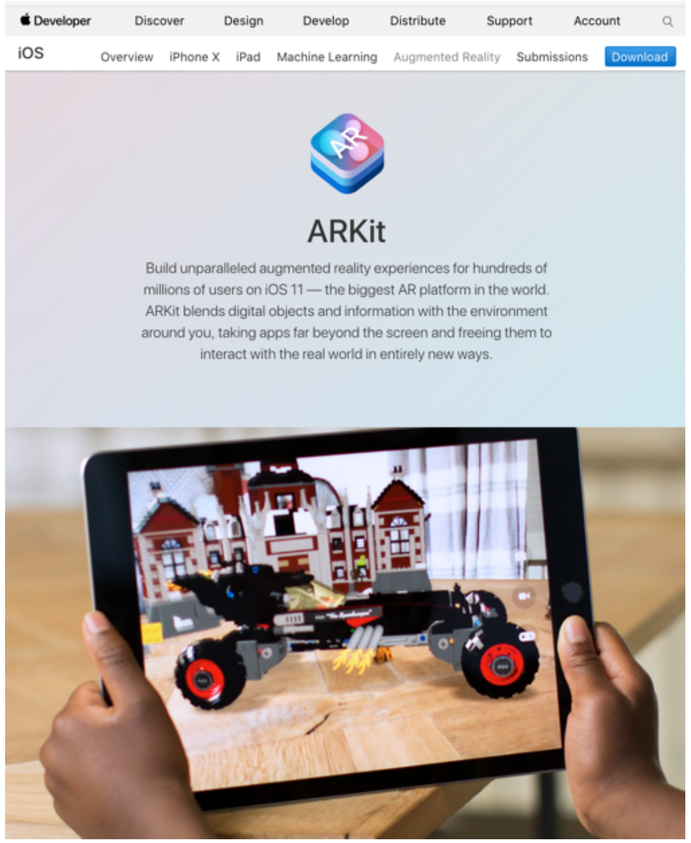
Embedding video in AR scenes and 2D image recognition

SceneKit physics

SpriteKit and ARKit

ARKit and Core Location

Where To Go From Here?



Apple's ARKit documentation

- Apple developer (developer.apple.com.arkit)
- Apple's human interface guidelines (developer.apple.com/ios/human-interface-guidelines)

"Awesome ARKit" repo on GitHub

github.com/olucurious/Awesome-ARKit

RayWenderlich.com and ARKit

ARKit by Tutorials

Coming soon!

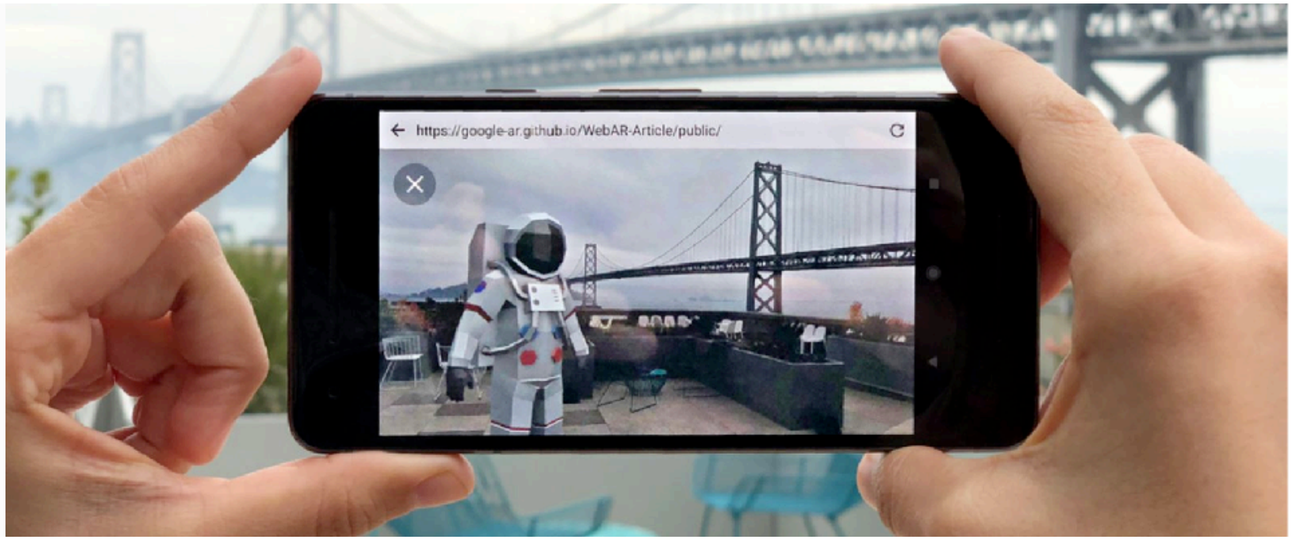
Articles

Coming soon!

Videos

Coming soon!

These are the early days of mobile AR



You have a responsibility

Competitor! I'm going to cover them up.

Totally sketch neighborhood

You don't want to know what this guy's into

Pronounces the word as "nu-cue-ler"

Who made this pile of dirt? *Aliens*.

Tap here to get demographic info on this guy based on his shoes

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