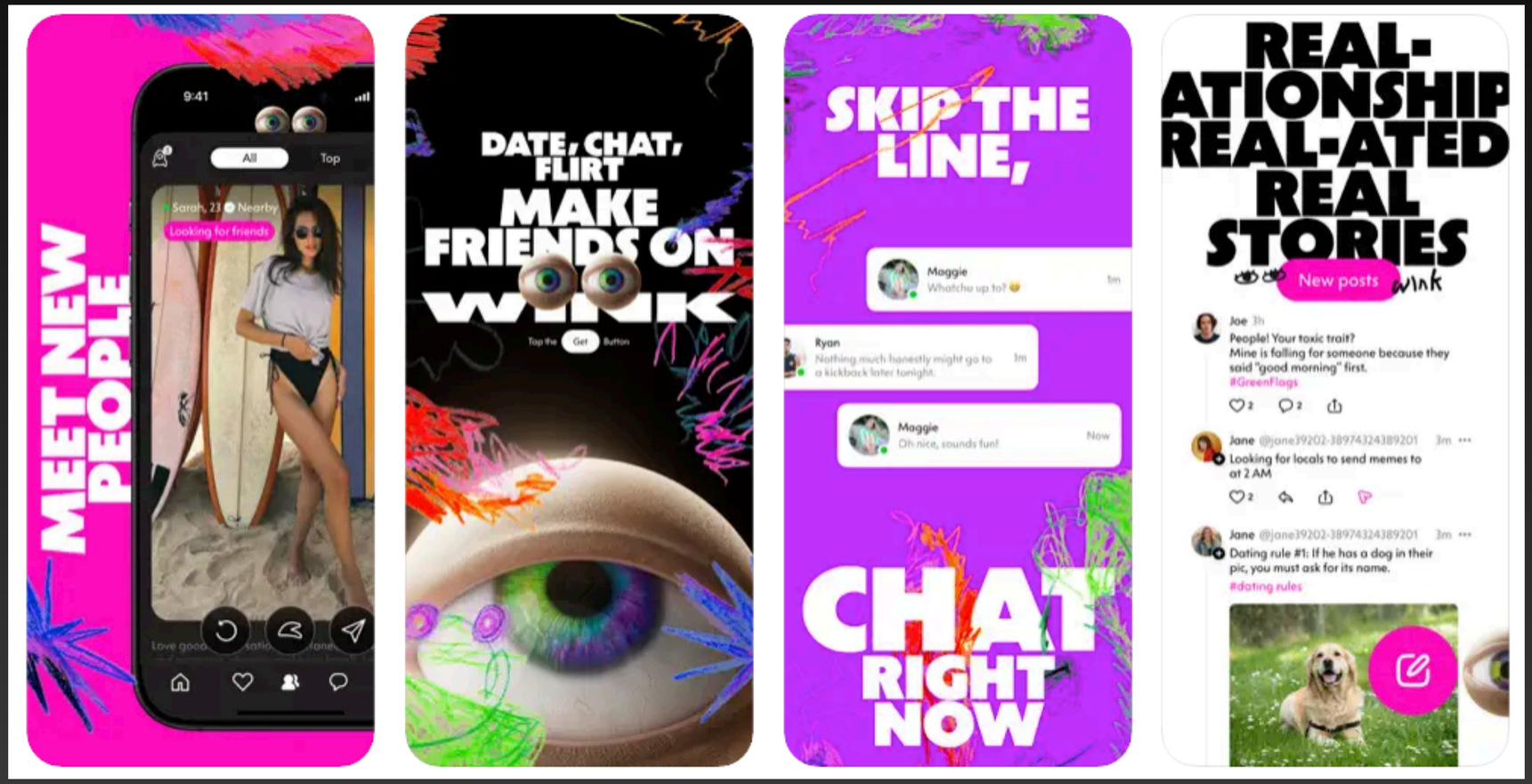
Realtime Face Liveness Detection using TrueDepth Sensor

Ethan Fan & Tate Chen

Gcount


MEET NEW PEOPLE
9:41
All
Top
Looking for friends
DATE, CHAT, FLIRT
MAKE FRIENDS ON WINK
SKIP THE LINE,
Maggie
Whatchu up to?
Ryan
Maggie
Oh nice, sounds fun!
Now
CHAT RIGHT NOW
REAL-ATIONSHIP REAL-ATED REAL STORIES
New posts
wink
Joe 3h
People! Your toxic trait?
Mine is falling for someone because they said "good morning" first.
#GreenFlags
Jane
Looking for locals to send memes to at 2 AM
Jane
Dating rule #1: If he has a dog in their pic, you must ask for its name.
#dating rules

Agenda

- Why use face liveness check

- Why we build face depth verication

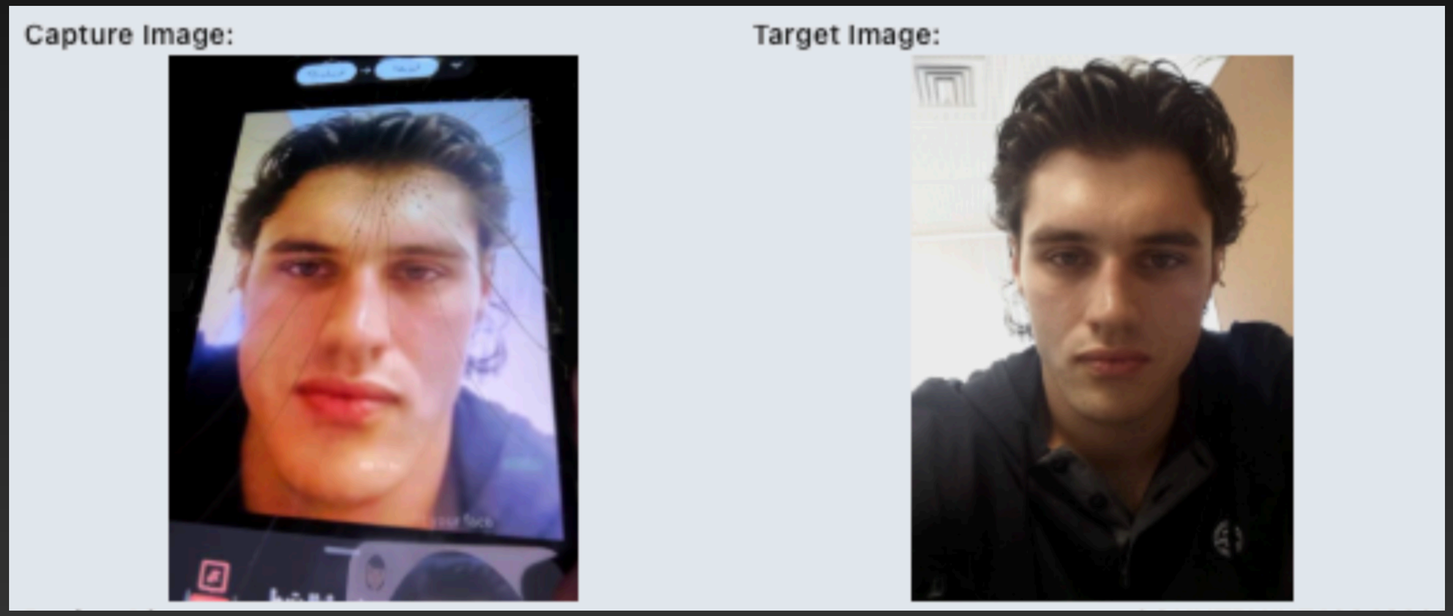
- Use Create ML to train classifer and CoreML model

- Inference pipeline and classification

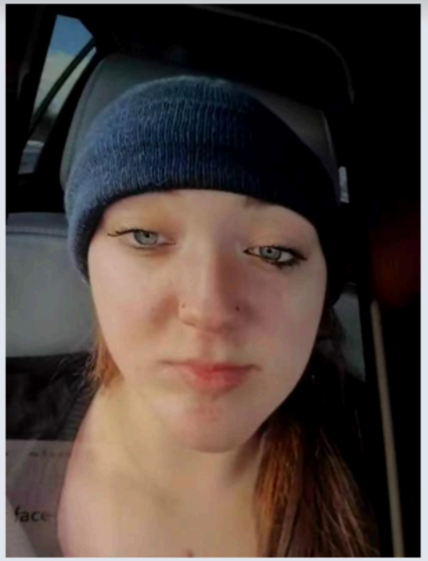
- Optimization

Why we need face liveness?

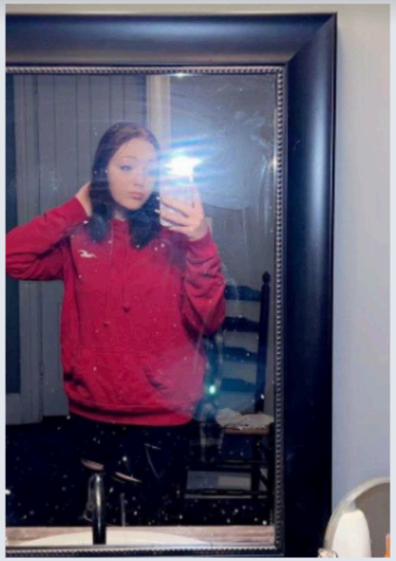
Prevent Spoofing Attacks



Capture Image:

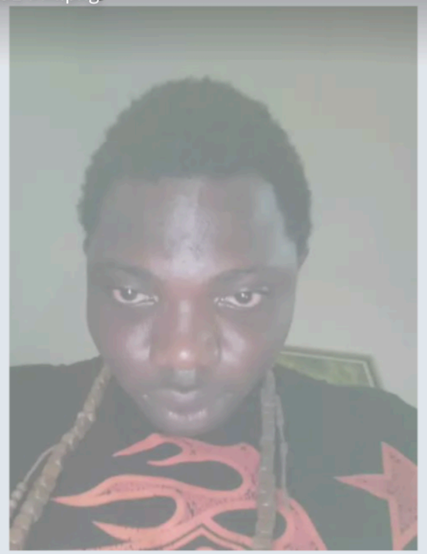


Target Image:

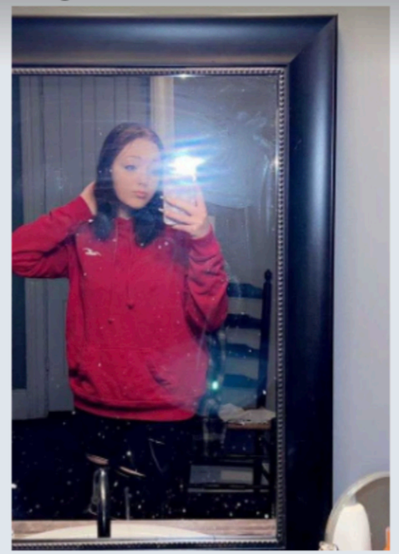


Capture Image:

22 at 7.19.01 PM.png



Target Image:



Why we build depth verification?

Issues we are facing …

- Apple didn’t provide any API for face liveliness

- Low light environment or under the sun

- Unable to distinguish 2D facial images

- It will be a significant expense when scaling up

AWS Liveness Pricing

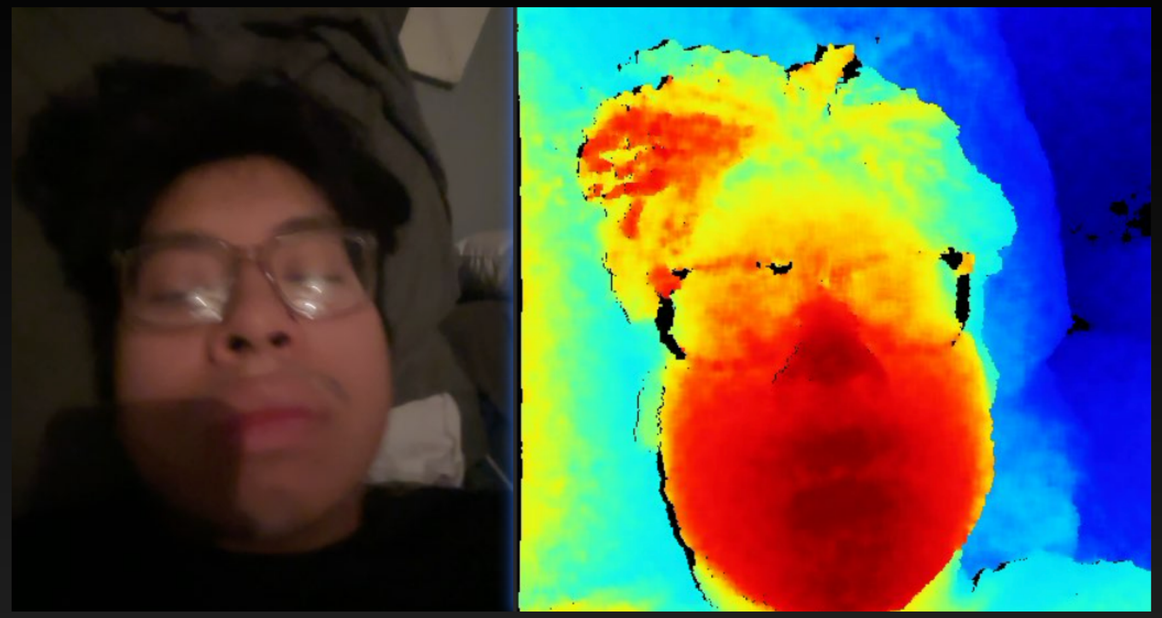
Pricing example 1 – Face Liveness check cost for 400,000 checks a month

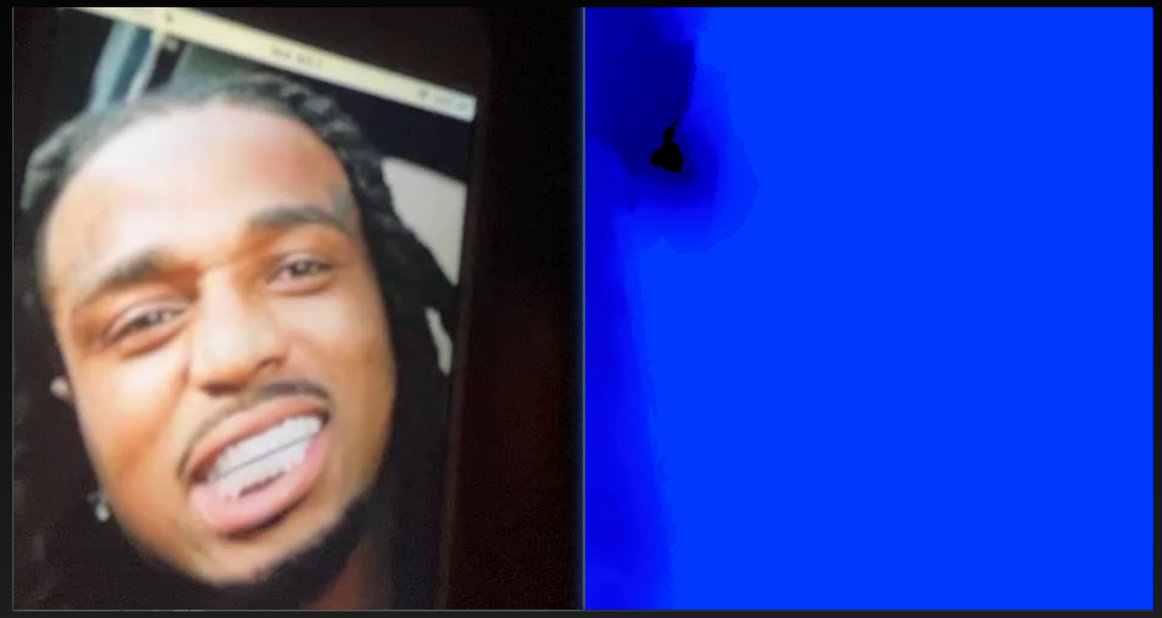
Let's assume your application performs 400,000 liveness checks in a month and you use th

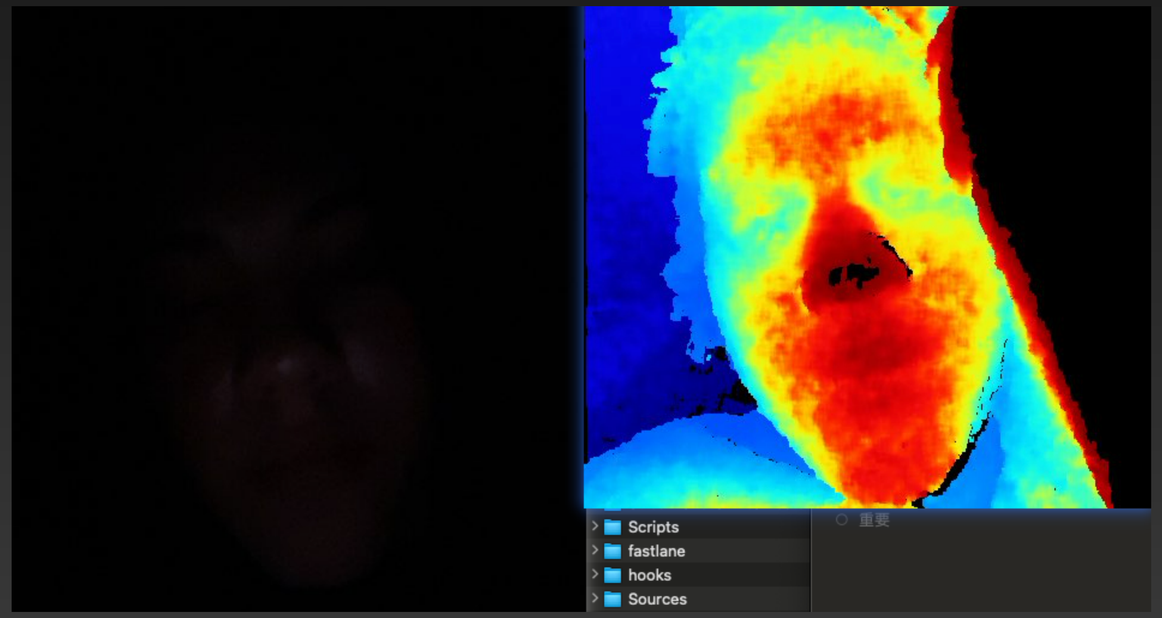
Cost of processing first 500,000 checks in US East (N. Virginia) is $0.015 per check
Total checks processed = 400,000
Total cost per month = $0.015 * 400,000 = $6,000

*https://aws.amazon.com/rekognition/pricing/

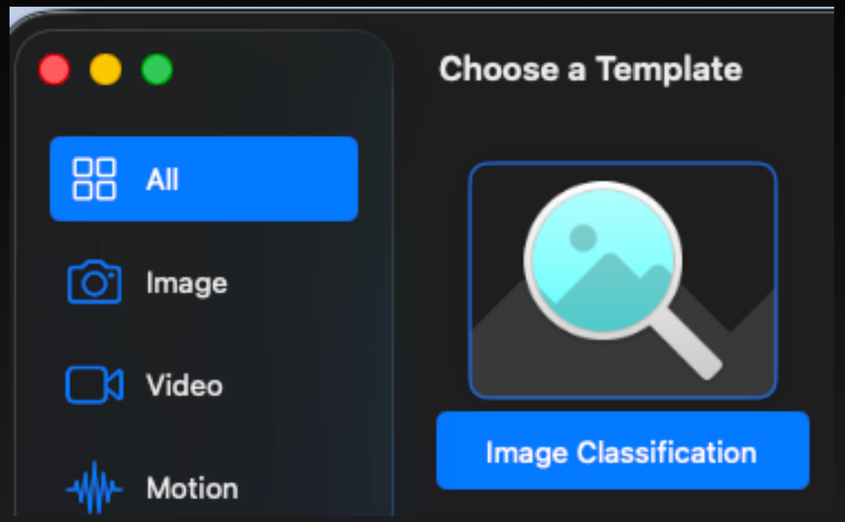
Train 2D Depth Images with CreateML

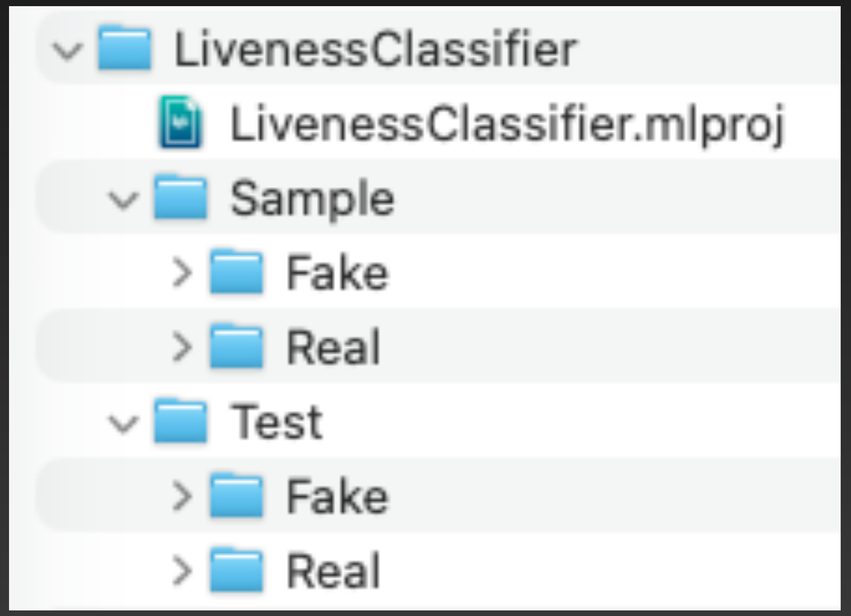


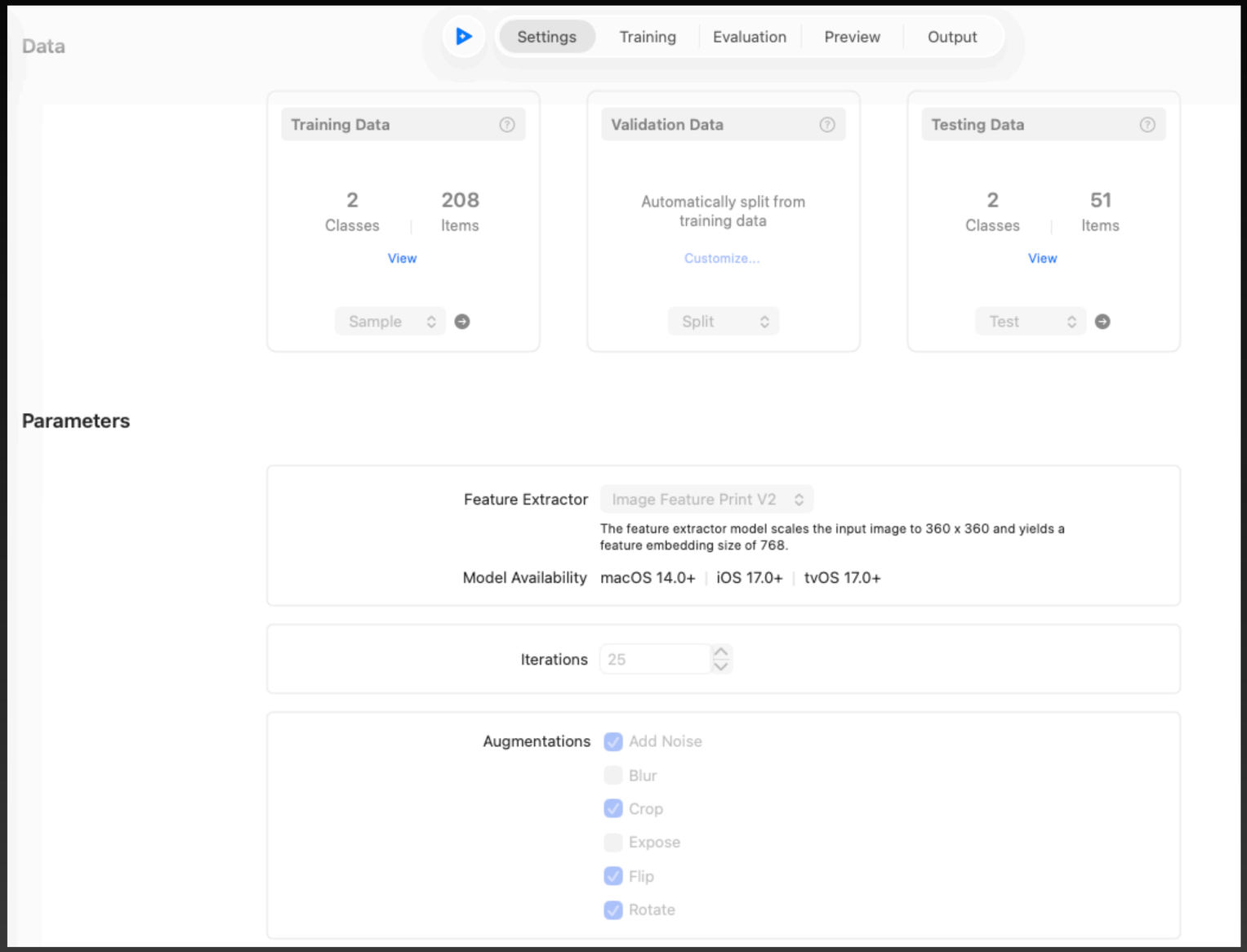


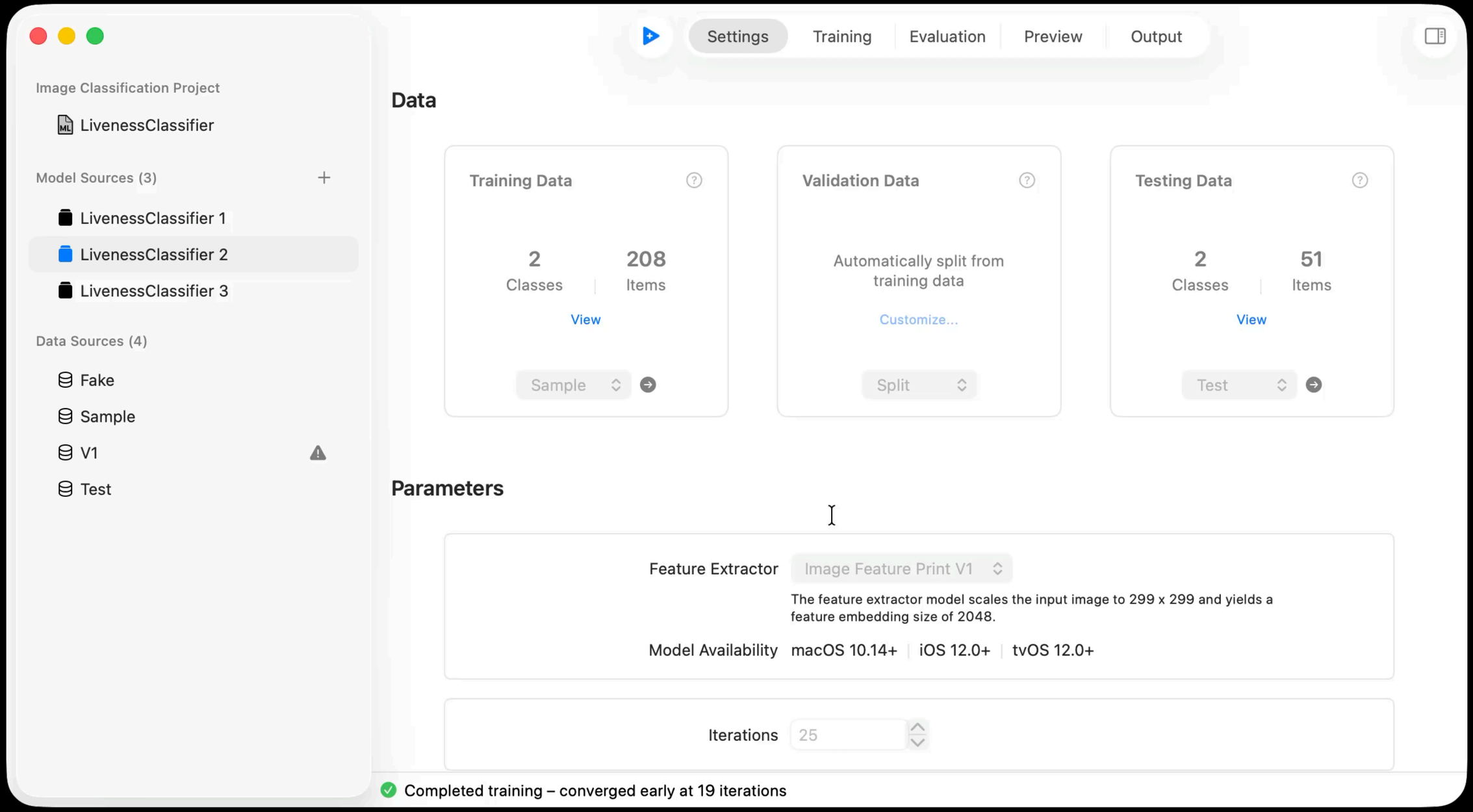

Scripts
fastlane
hooks
Sources

Create ML


Choose a Template
All
Image
Video
Motion
Image Classification


LivenessClassifier
LivenessClassifier.mlproj
Sample
Fake
Real
Test
Fake
Real


Data
Settings
Training
Evaluation
Preview
Output
Training Data
2
Classes
208
Items
View
Sample
Validation Data
Automatically split from training data
Customize...
Split
Testing Data
2
Classes
51
Items
View
Test
Parameters
Feature Extractor
Image Feature Print V2
The feature extractor model scales the input image to 360 x 360 and yields a feature embedding size of 768.
Model Availability
macOS 14.0+
iOS 17.0+
tvOS 17.0+
Iterations
25
Augmentations
Add Noise
Blur
Crop
Expose
Flip
Rotate


Settings
Training
Evaluation
Preview
Output
Image Classification Project
LivenessClassifier
Model Sources (3)
LivenessClassifier 1
LivenessClassifier 2
LivenessClassifier 3
Data Sources (4)
Fake
Sample
V1
Test
Data
Training Data
2
Classes
208
Items
View
Sample
Validation Data
Automatically split from training data
Customize...
Split
Testing Data
2
Classes
51
Items
View
Test
Parameters
Feature Extractor
Image Feature Print V1
The feature extractor model scales the input image to 299 x 299 and yields a feature embedding size of 2048.
Model Availability
macOS 10.14+
iOS 12.0+
tvOS 12.0+
Iterations
25
Completed training – converged early at 19 iterations

Inference Pipeline and Classification

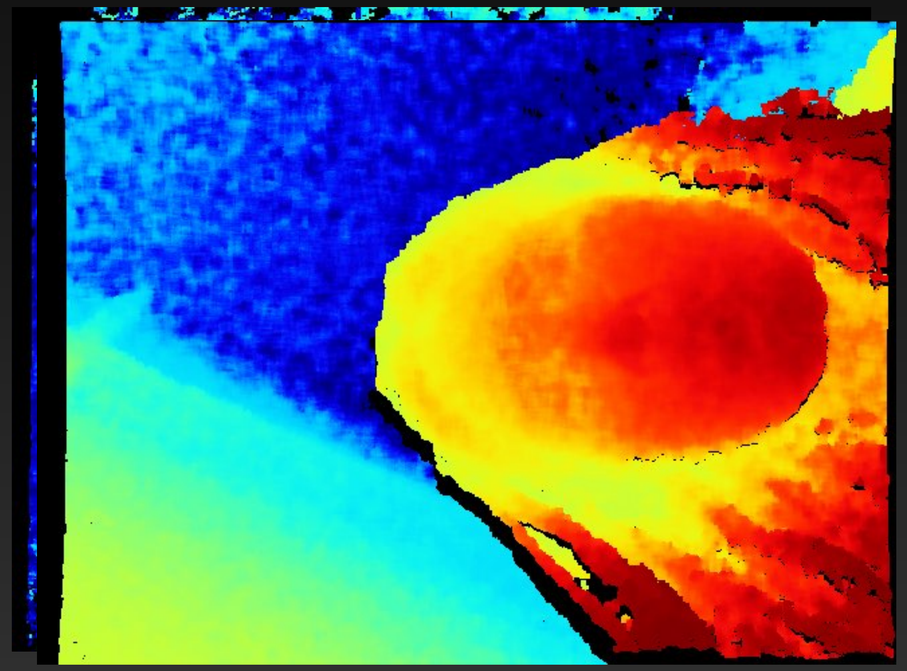
AVFoundation Depth Data from Capture Sessions

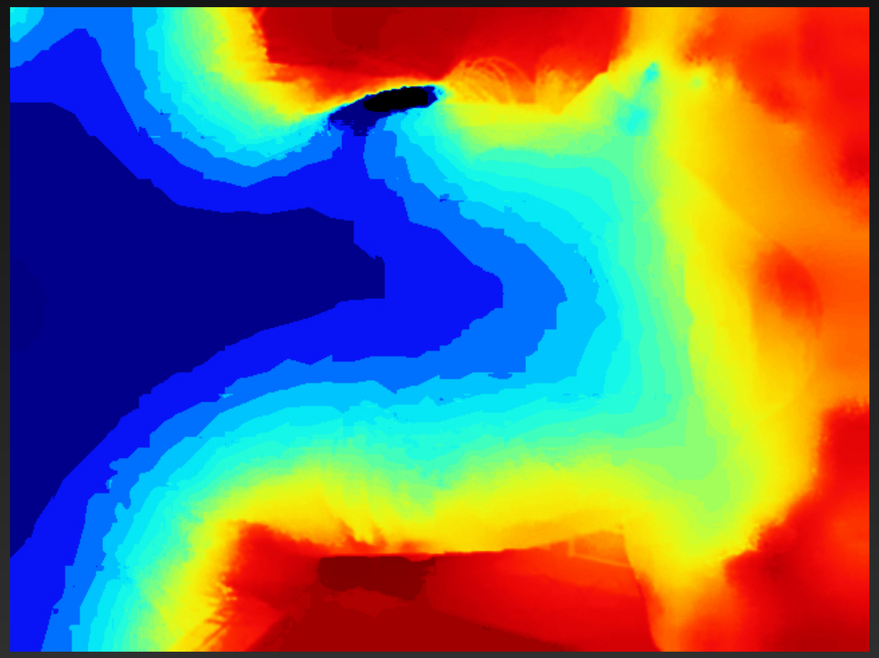
```
// Add a video data output
if session.canAddOutput(videoDataOutput) {
    session.addOutput(videoDataOutput)
    videoDataOutput.videoSettings = [kCVPixelBufferPixelFormatTypeKey as String:
        Int(kCVPixelFormatType_32BGRA)]
} else {
    print("Could not add video data output to the session")
    setupResult = .configurationFailed
    session.commitConfiguration()
    return
}

// Add a depth data output
if session.canAddOutput(depthDataOutput) {
    session.addOutput(depthDataOutput)
    depthDataOutput.isFilteringEnabled = false
    if let connection = depthDataOutput.connection(with: .depthData) {
        connection.isEnabled = true
    } else {
        print("No AVCaptureConnection")
    }
} else {
    print("Could not add depth data output to the session")
    setupResult = .configurationFailed
    session.commitConfiguration()
    return
}
```

```
// Use an AVCaptureDataOutputSynchronizer to synchronize the video data and depth data outputs.
// The first output in the dataOutputs array, in this case the AVCaptureVideoDataOutput, is the
    "master" output.
outputSynchronizer = AVCaptureDataOutputSynchronizer(dataOutputs: [videoDataOutput,
    depthDataOutput])
outputSynchronizer!.setDelegate(self, queue: dataOutputQueue)
session.commitConfiguration()
```

```swift
// MARK: - Video + Depth Frame Processing

func dataOutputSynchronizer(_ synchronizer: AVCaptureDataOutputSynchronizer,
                            didOutput synchronizedDataCollection: AVCaptureSynchronizedDataCollection)
                                {

    if !renderingEnabled {
        return
    }

    // Read all outputs
    guard renderingEnabled,
        let syncedDepthData: AVCaptureSynchronizedDepthData =
        synchronizedDataCollection.synchronizedData(for: depthDataOutput) as?
            AVCaptureSynchronizedDepthData,
        let syncedVideoData: AVCaptureSynchronizedSampleBufferData =
        synchronizedDataCollection.synchronizedData(for: videoDataOutput) as?
            AVCaptureSynchronizedSampleBufferData else {
            // only work on synced pairs
            return
    }

    if syncedDepthData.depthDataWasDropped || syncedVideoData.sampleBufferWasDropped {
        return
    }

    let depthData = syncedDepthData.depthData
    let depthPixelBuffer = depthData.depthDataMap
    let sampleBuffer = syncedVideoData.sampleBuffer
```

Convert Depth Data to 2D using Metal Shader



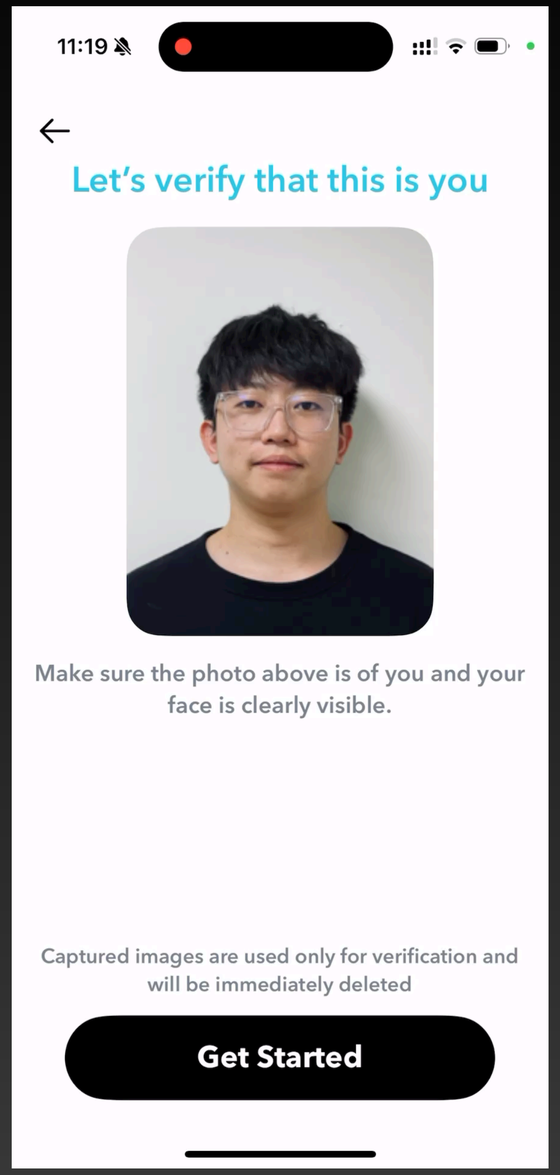


JET color coding to distinguish depth values, ranging from red (close) to blue (far)

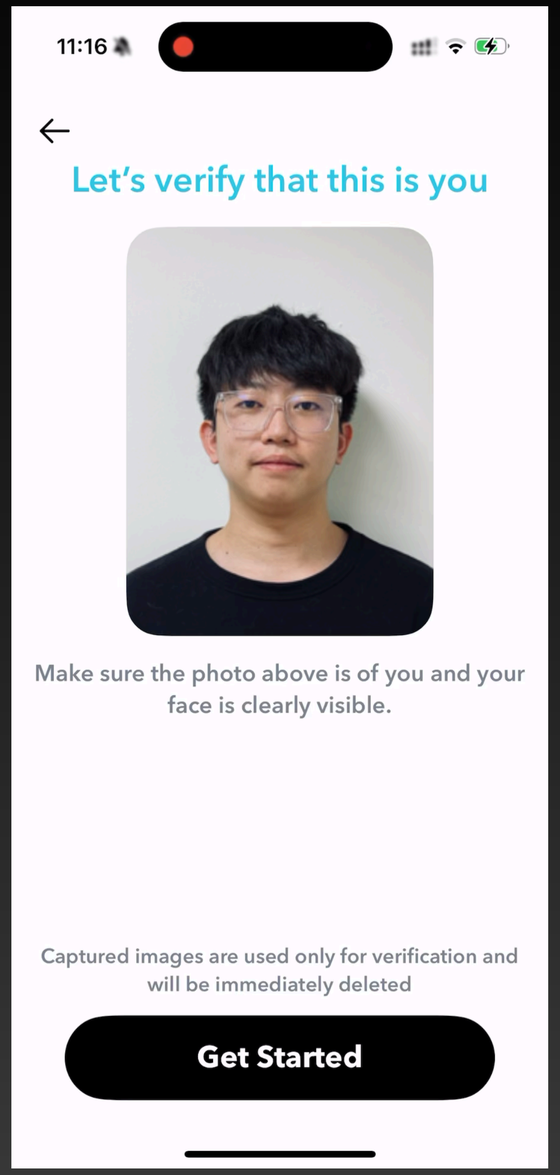
Classifying Images with Vision and Core ML

https://developer.apple.com/documentation/coreml/classifying-images-with-vision-and-core-ml

AWS Rekognition



TrueDepth Sensor



Optimization

- Only run inferences when detecting face

- When the face is within a certain distance

- Skip frames

We save around 75% cost after implementing depth verification

Twitter/X: coolioxlr