Building Screenshot OCR with Vision and CoreML

Victor Pavlychko

About this Workshop

During the workshop we will:

- Understand how text recognition is done
- Learn how to to build a text recognizer app using iOS frameworks

And write some code:

- CoreImage kernel to adjust contrast
- Use Vision to find text in the image
- Use CoreML to classify characters

bit.ly/2JXs4Ch

Pokémon GO: A Brief Intro

Pokémon Stats

- What players want to know:
  - Attack, defense, stamina
  - Exact level

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Pokémon Stats

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- What players know:
  - CP = f(level, attack, defense, stamina)
  - HP = g(level, stamina)
  - Approximate level

IV Checker Apps

- Checking Pokémon stats
  - Take a screenshot
  - Switch to an IV Checker app
  - Use OCR to read values from the image
  - Calculate values player needs

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Tesseract OCR: An Easy Win?

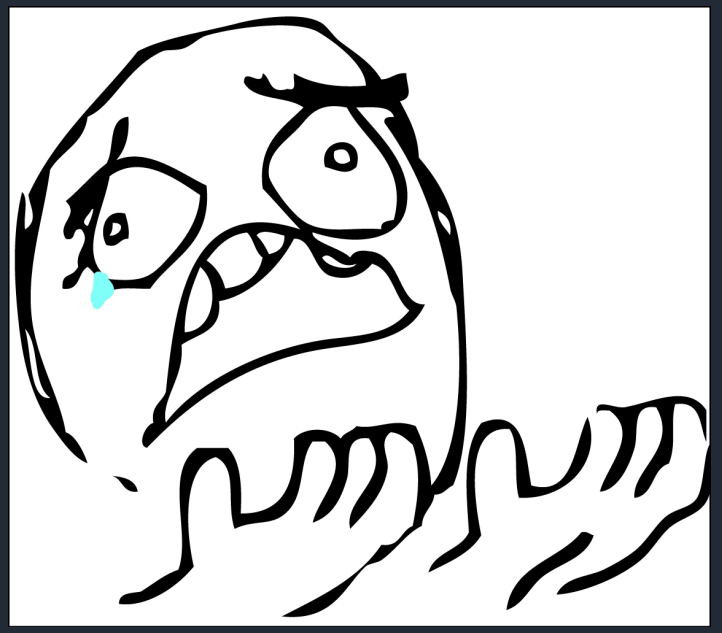
- Ready to use OCR engine maintained by Google
- Supports multiple languages
- Works on many platforms
- Has iOS wrappers available on GitHub
- What could go wrong?

Keyboard Memory Limits

Keyboard Memory Limits


```
Thread 3: EXC_RESOURCE RESOURCE_TYPE_MEMORY (limit=66 MB, unused=0x0)
```

Keyboard extensions is a constrained environment with 66 MB memory limit.




CHALLENGE ACCEPTED

Building Custom OCR

Image Processing Pipeline

Original

Image Processing Pipeline

Original

Remove Color

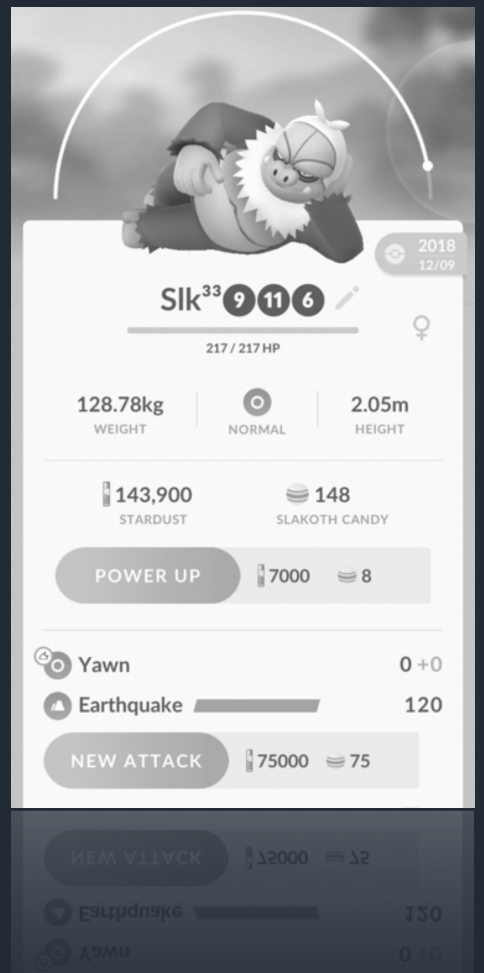


Image Processing Pipeline

Original

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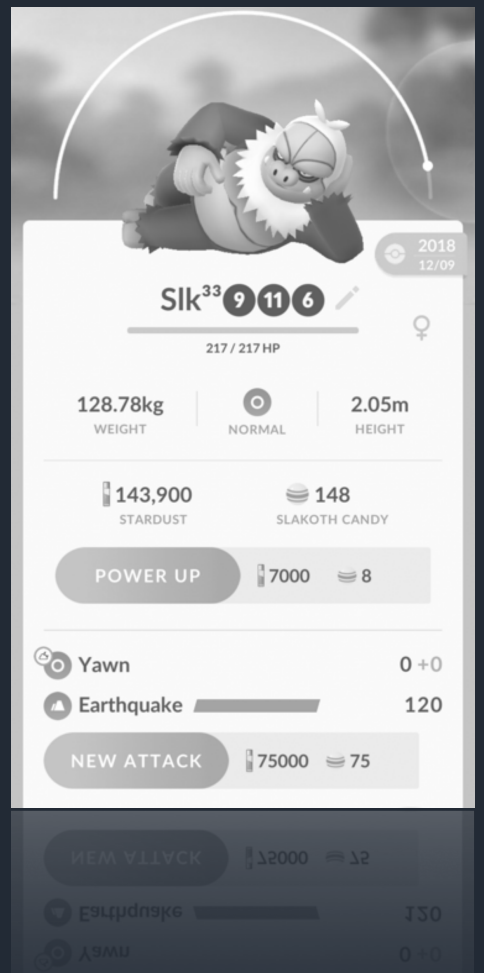
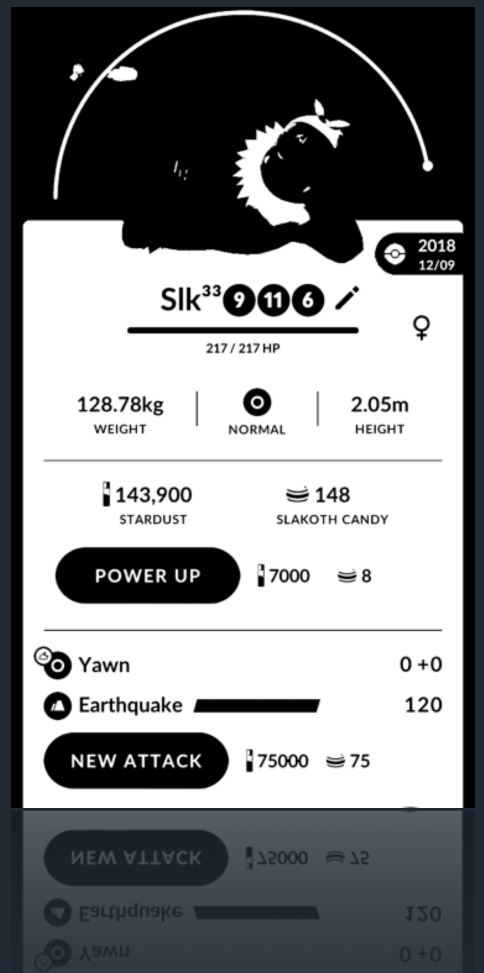


Add Contrast



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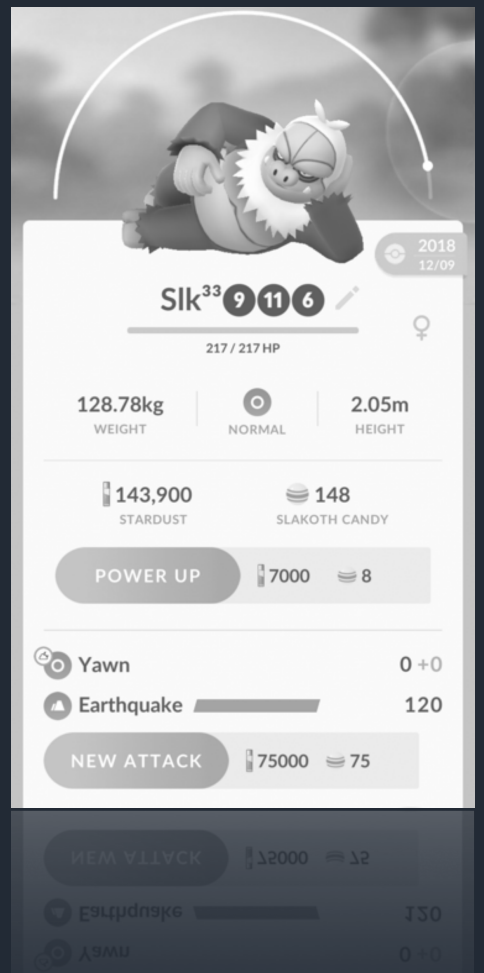

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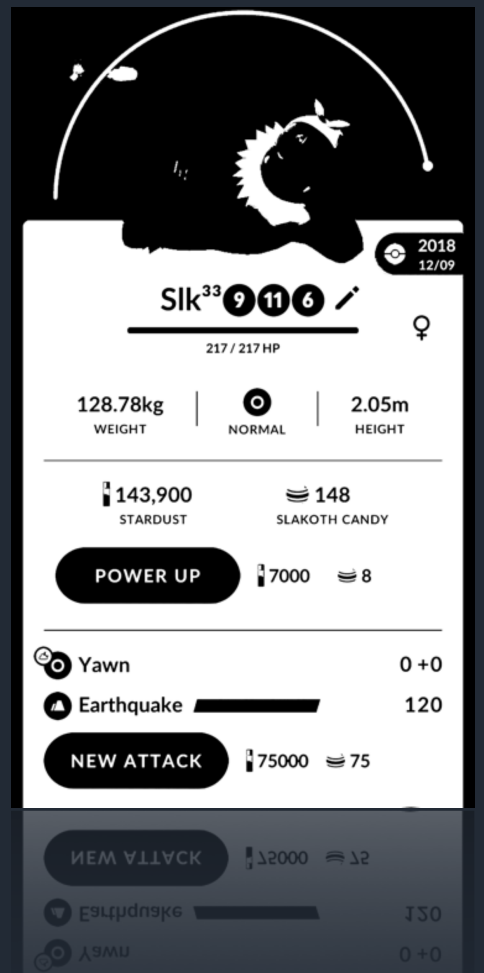
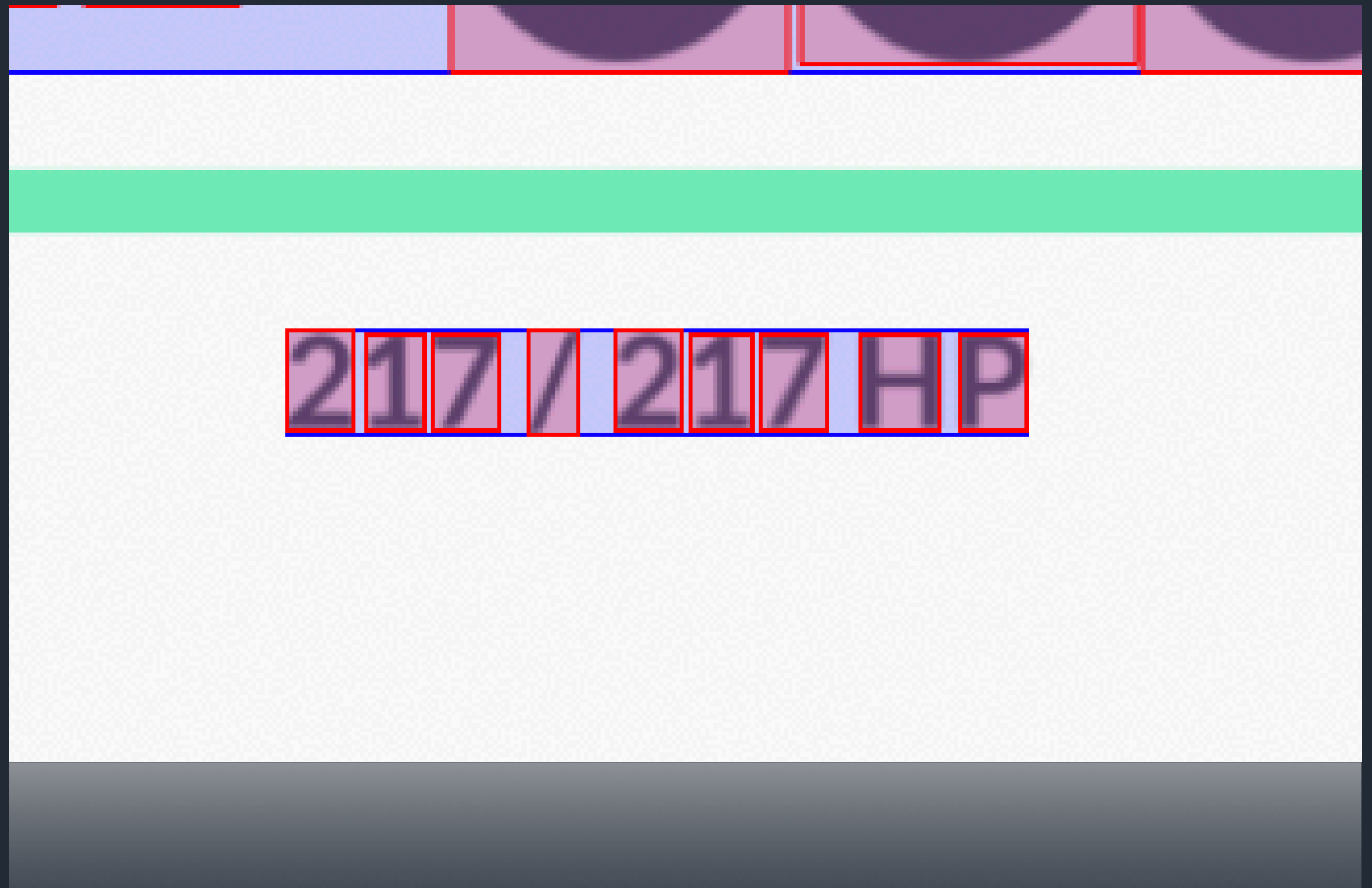


Find Text

Text Boxes



Building a Classifier: CreateML

Let’s Give it a Try!

- Apple: it’s best to use images that are at least 299x299 pixels
- The resulting classifier seems to accept 299x299 images only

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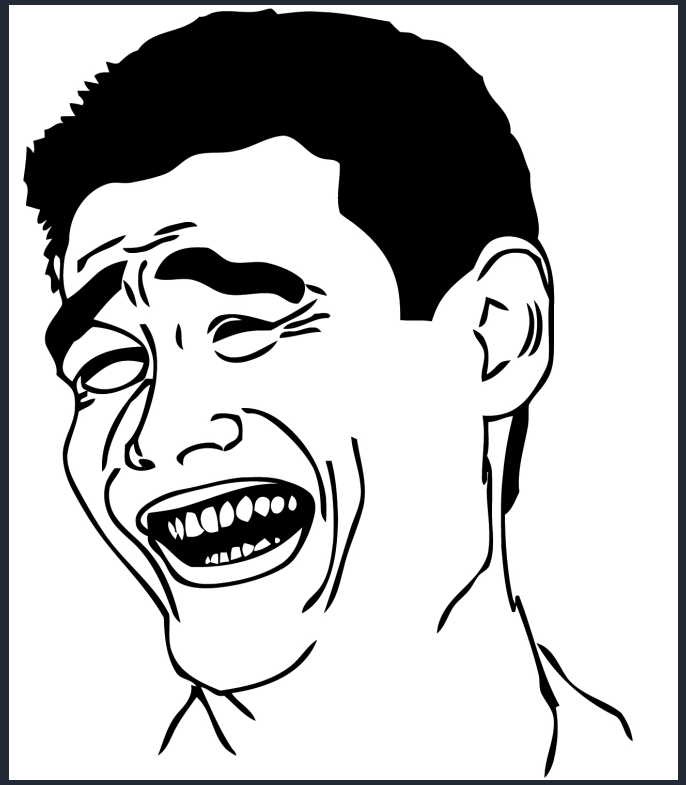
- Apple: it’s best to use images that are at least 299x299 pixels
- The resulting classifier seems to accept 299x299 images only
- Good luck classifying letters with that…



Preprocessing

Grayscale Filter

$$L = R \times 0.299 + G \times 0.587 + B \times 0.114$$

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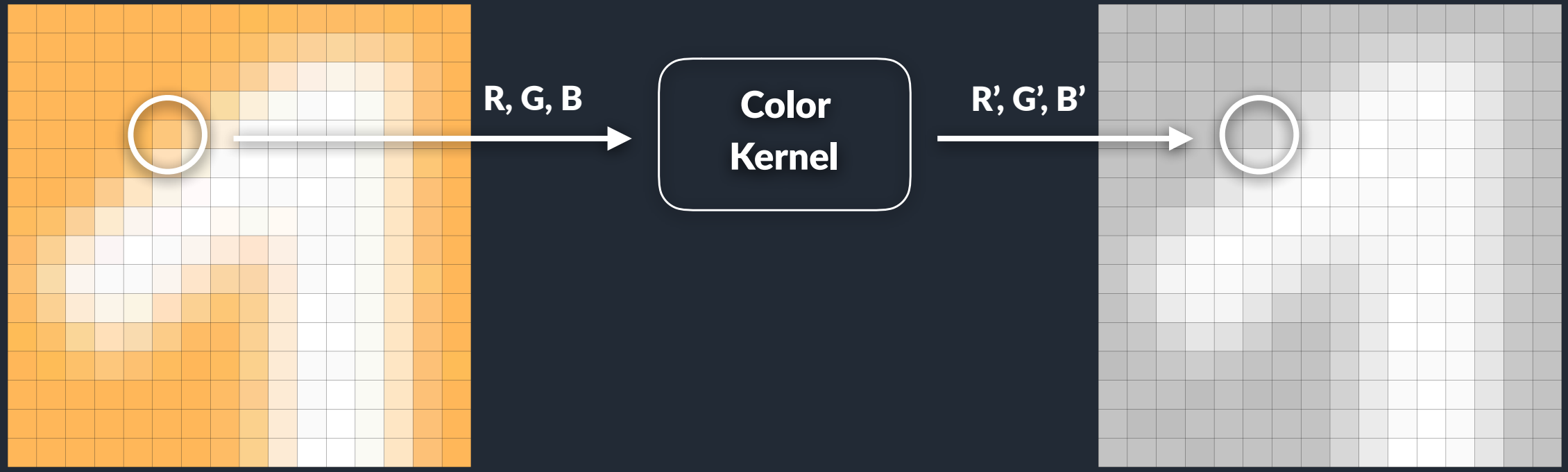

Grayscale Kernel


```
kernel vec4 grayscale_kernel(__sample s) {
    float v = dot(s.rgb, vec3(0.299, 0.587, 0.114));
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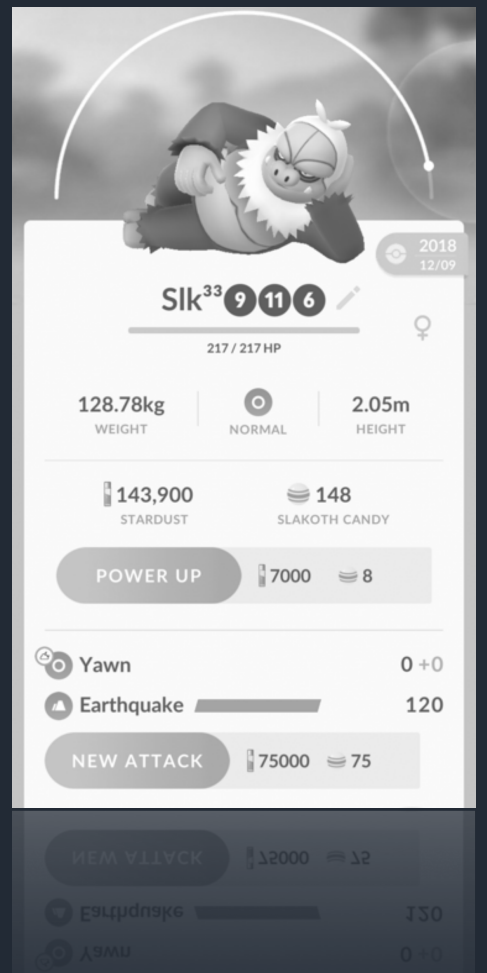
What is Contrast?

Grayscale



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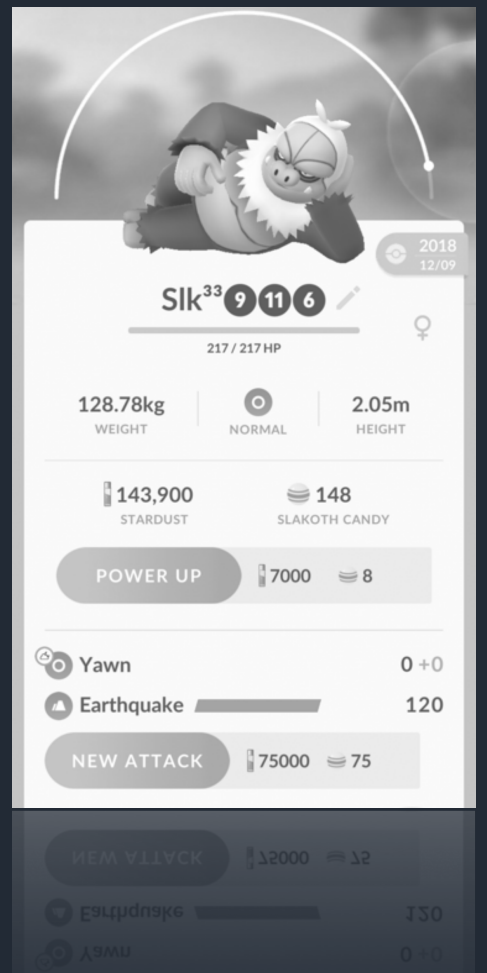

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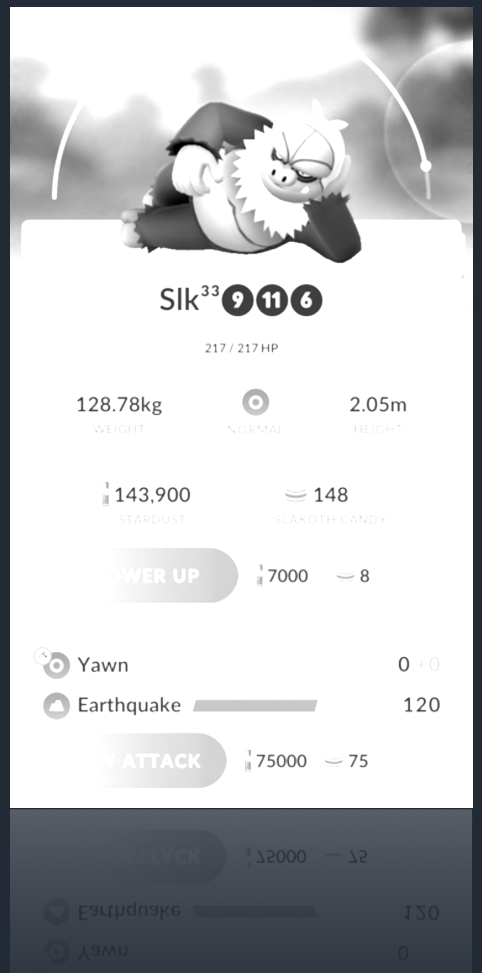

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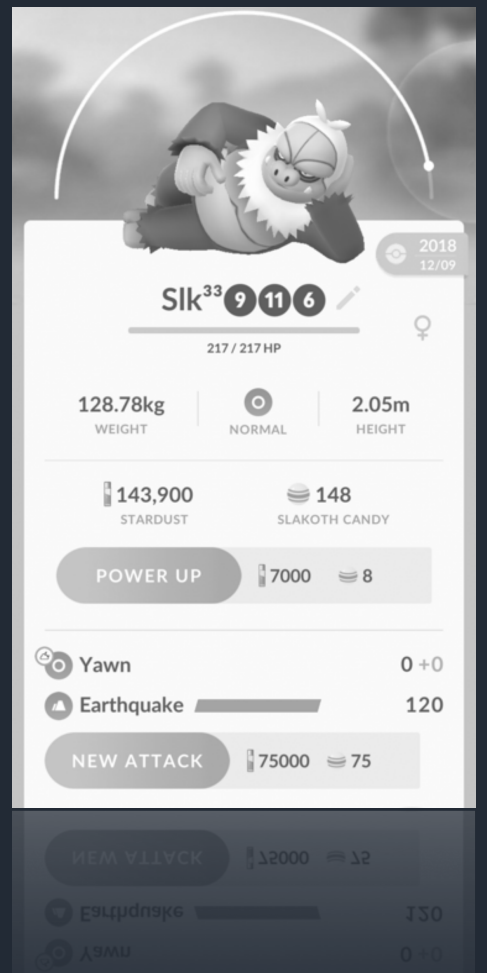

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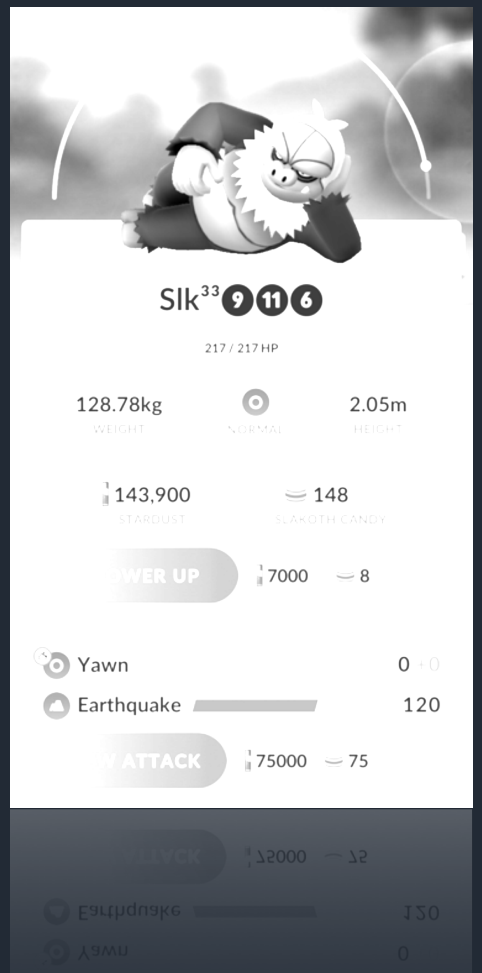
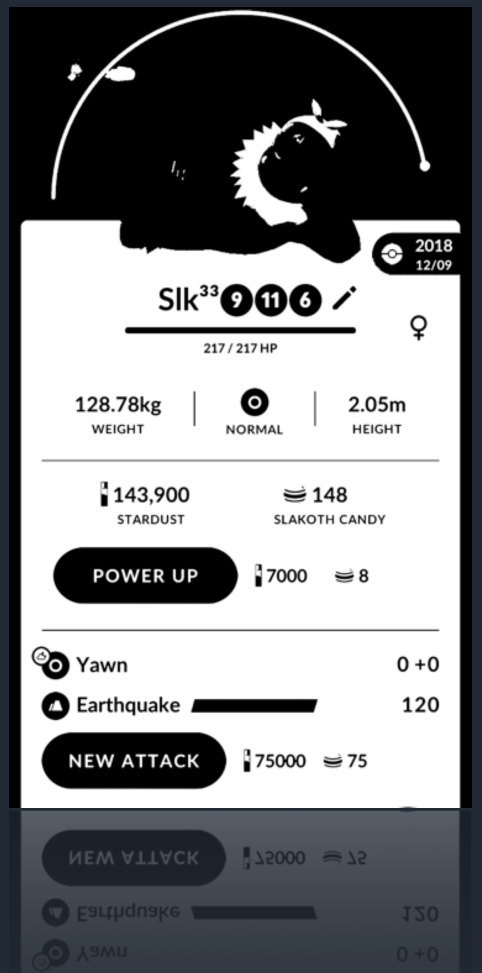


Local Contrast



Local Contrast Filter

$$L' = L' = (L - L_{min}) / (L_{max} - L_{min})$$

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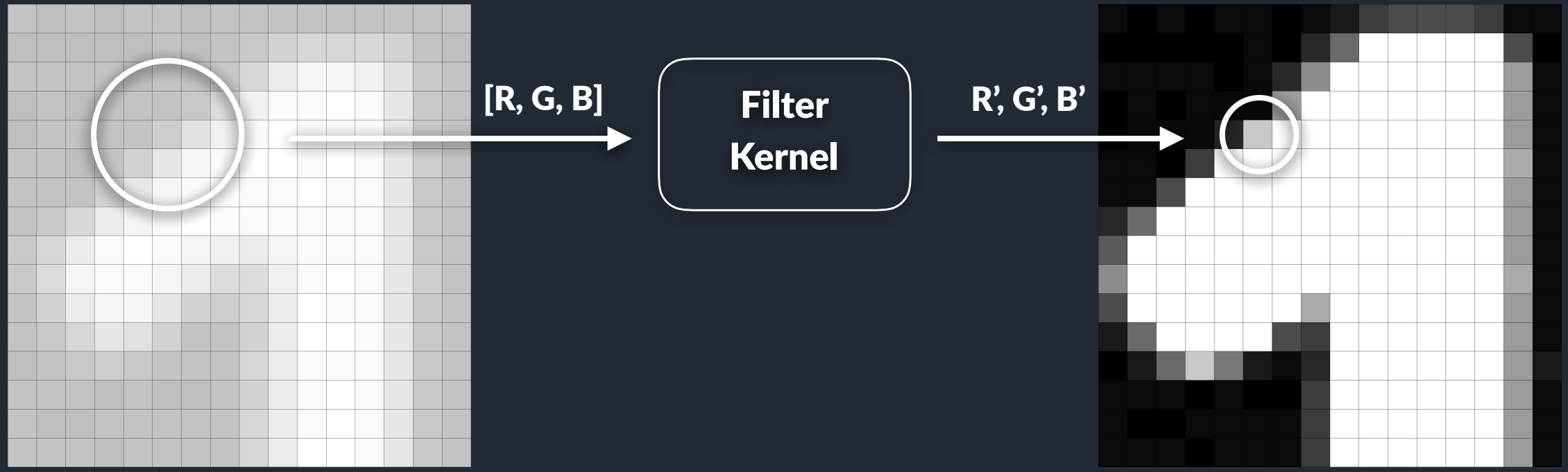

Why Use CoreImage Kernels?

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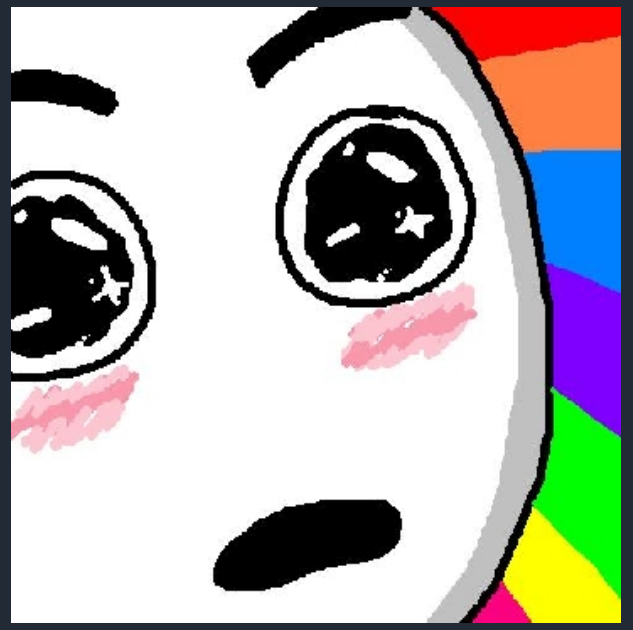
iPhone XS resolution is **1125 x 2436** giving us **2.7 million pixels**

Contrast filter with 10 pixel radius reads **400 pixels** per each pixel

Which total to **1 billion iteration** loop



Code Time!

Detecting Text with Vision

Working with Text Detection API

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```
let request = VNDetectTextRectanglesRequest { request, error in
    if let result = request.results?.first as? VNTextObservation {
        print(result.boundingBox)
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}
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Working with Text Detection API


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request.revision = VNDetectTextRectanglesRequestRevision1
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let handler = VNImageRequestHandler(cvPixelBuffer: pixelBuffer, options: [:])
try handler.perform([request])
```

OK, Show me the Text!

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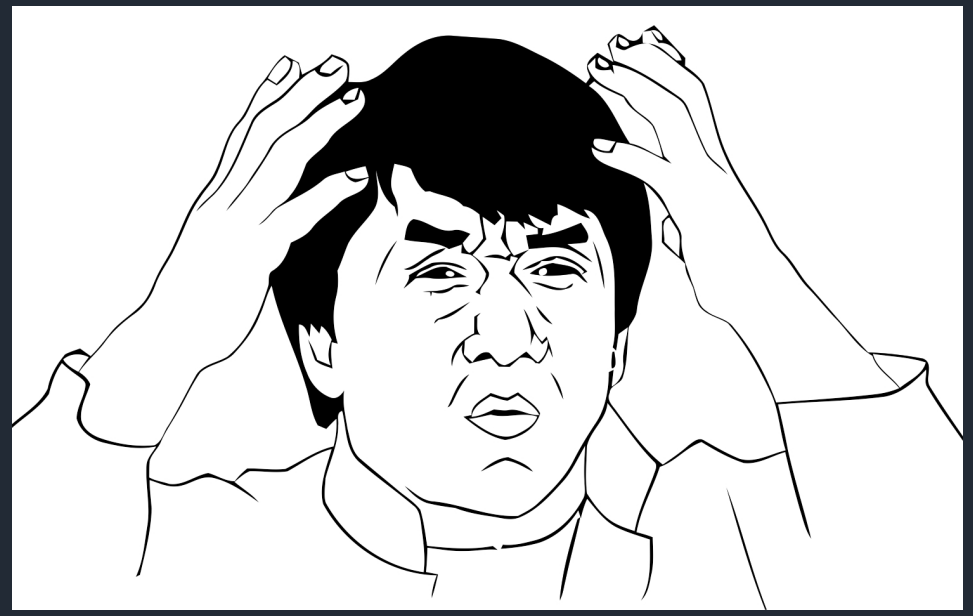

Image Coordinate Systems

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Top-left Coordinates

0, 0

1125, 2436

Image Coordinate Systems

Top-left Coordinates

0, 0

1125, 2436

Vision Coordinates

1, 1

0, 0

Dealing with Vision Coordinates

Dealing with Vision Coordinates


```
extension VNRectangleObservation {
    var flippedBoundingBox: CGRect {
        return CGRect(
            x: boundingBox.minX, y: 1 - boundingBox.minY - boundingBox.height,
            width: boundingBox.width, height: boundingBox.height
        )
    }
}
```

Dealing with Vision Coordinates


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extension VNRectangleObservation {
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        return CGRect(
            x: boundingBox.minX, y: 1 - boundingBox.minY - boundingBox.height,
            width: boundingBox.width, height: boundingBox.height
        )
    }
}

extension CGRect {
    func denormalized(for size: CGSize) -> CGRect {
        return VNImageRectForNormalizedRect(self, Int(size.width), Int(size.height))
    }
}
```
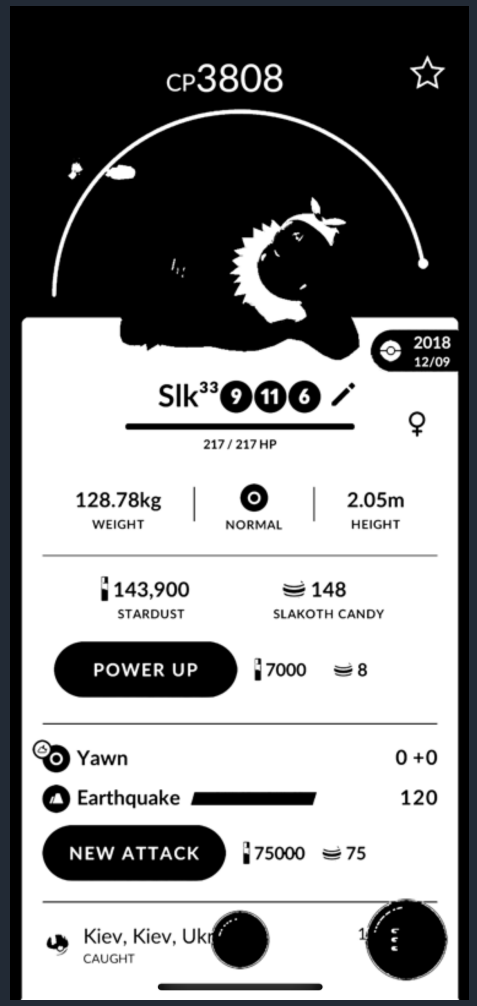
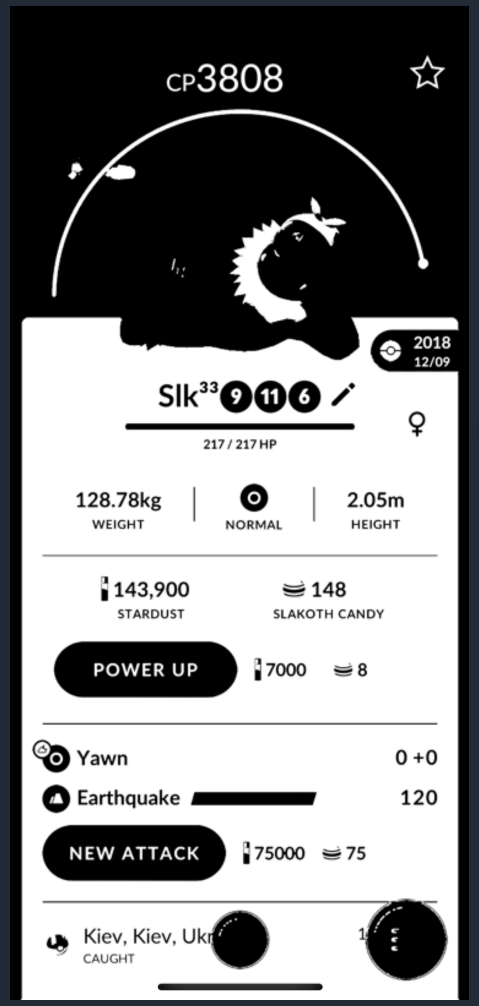

Code Time!

Finding Interesting Text

Analyzing Screenshot Layout

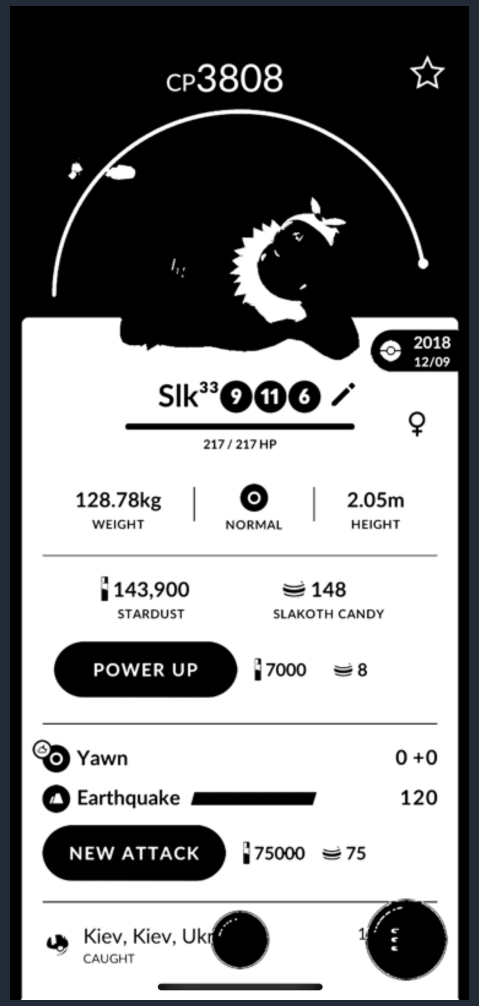


Analyzing Screenshot Layout



Health: blackWidth > w / 3 && blackWidth < w * 2 / 3

Analyzing Screenshot Layout



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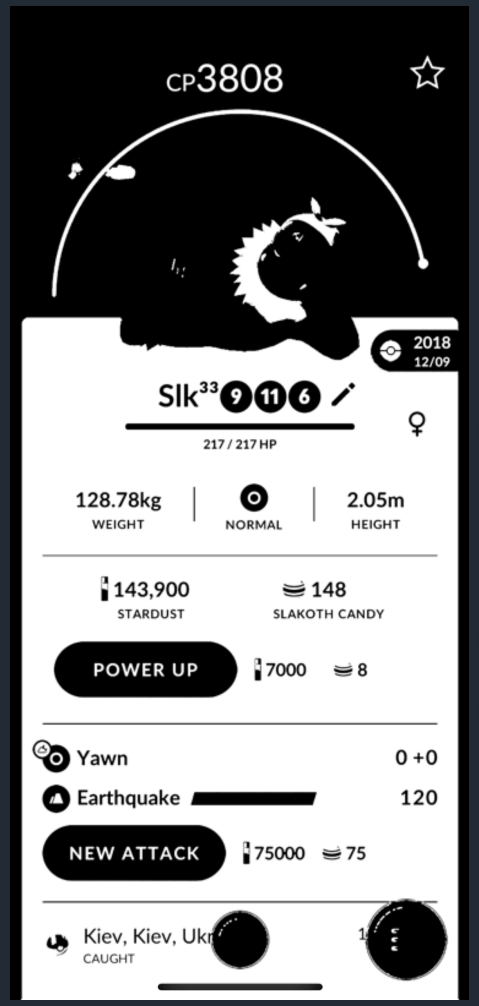
White panel: whiteWidth > w / 2

Analyzing Screenshot Layout

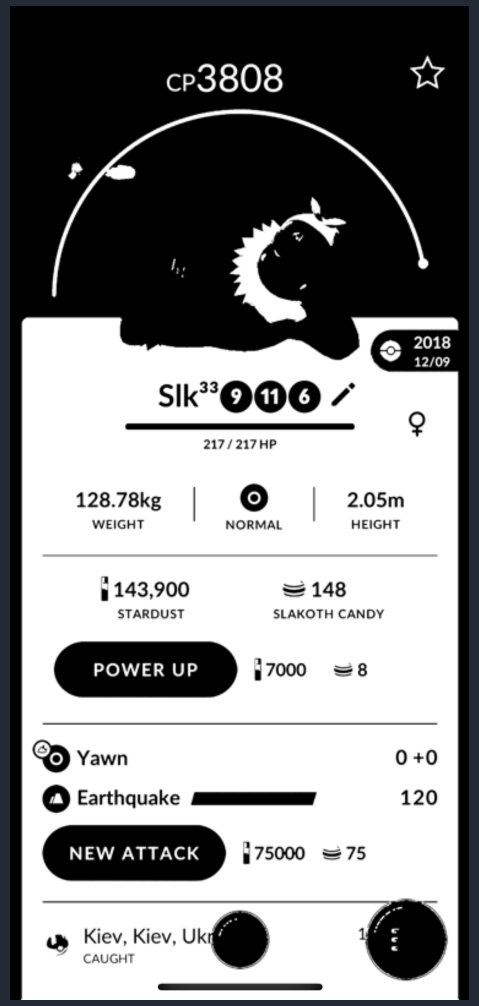


Health: blackWidth > w / 3 && blackWidth < w * 2 / 3

White panel: whiteWidth > w / 2

Separator: blackWidth > w * 2 / 3

Analyzing Screenshot Layout



Health: blackWidth > w / 3 && blackWidth < w * 2 / 3

White panel: whiteWidth > w / 2

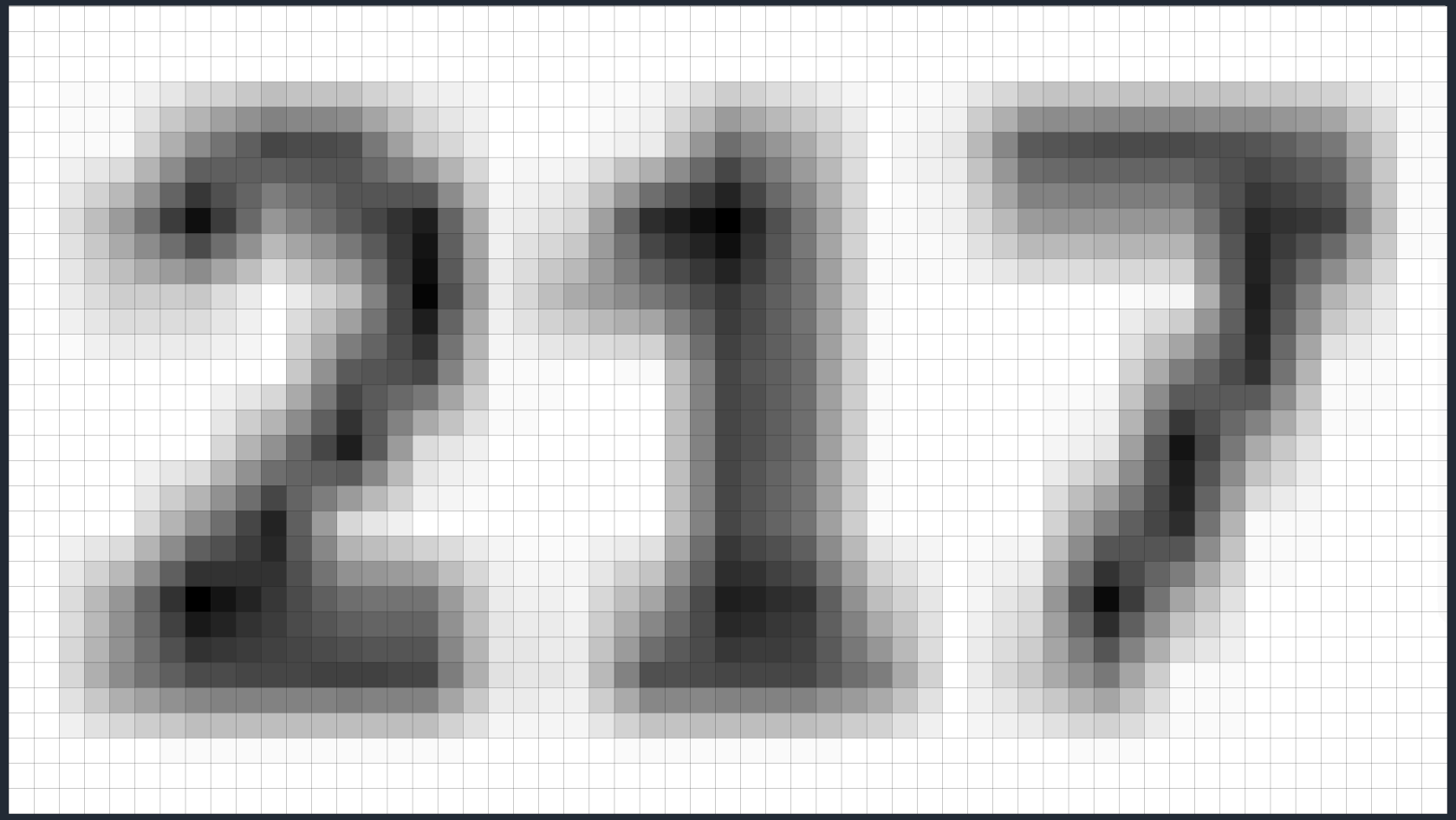
Separator: blackWidth > w * 2 / 3

Unknown: everything else

Code Time!

Classifying Images with CoreML

Preparing an Image for Classification



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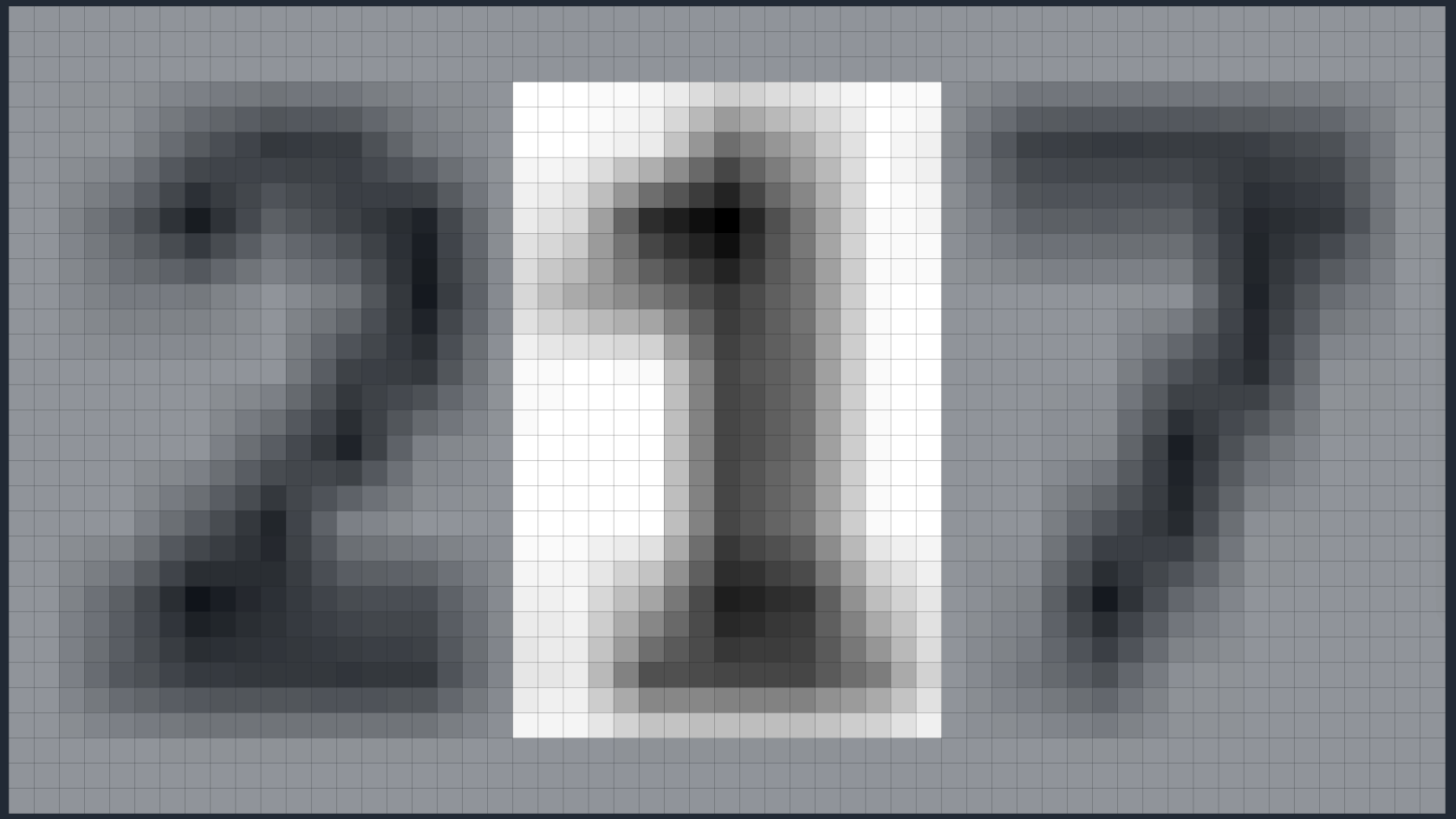

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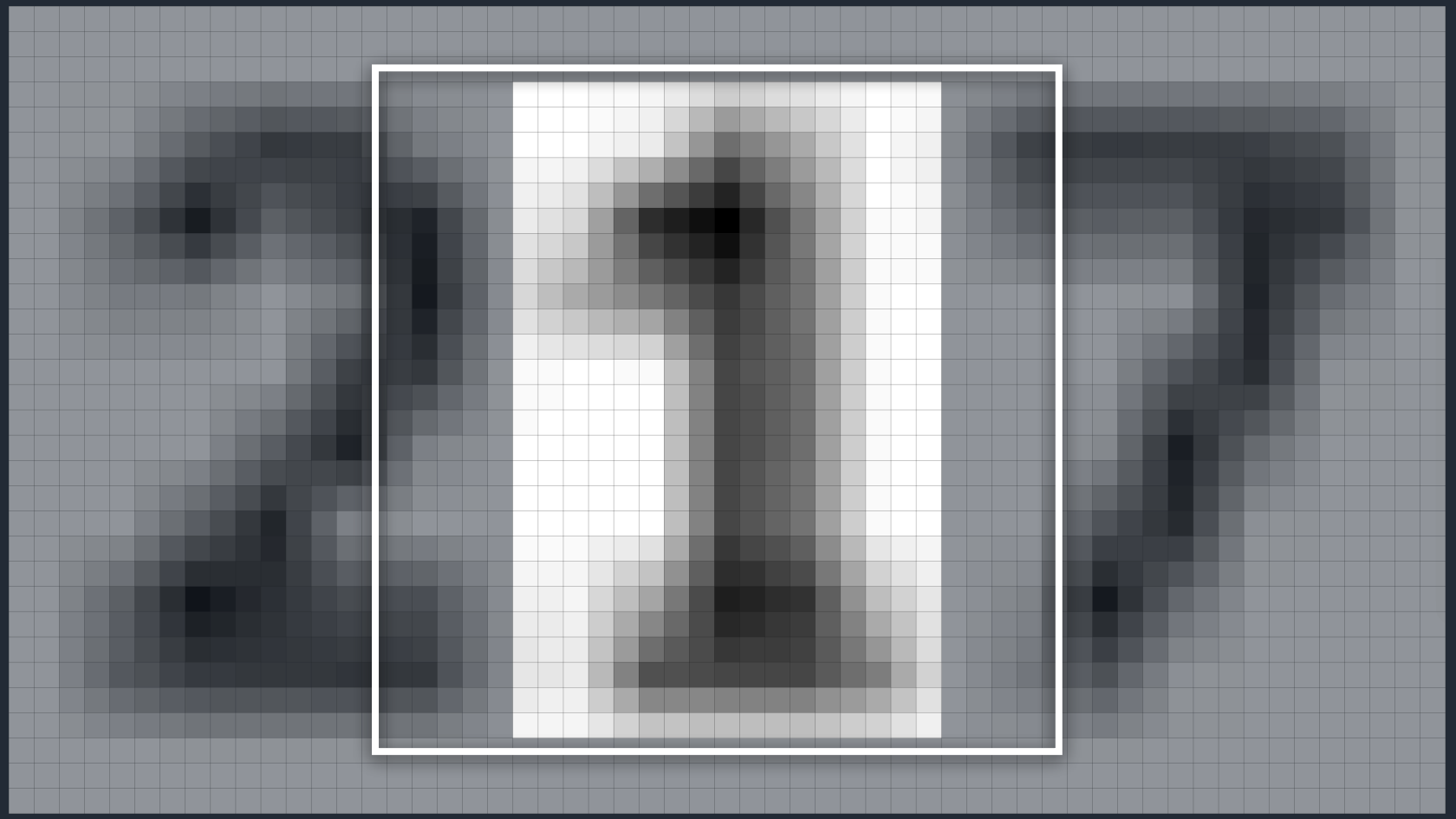

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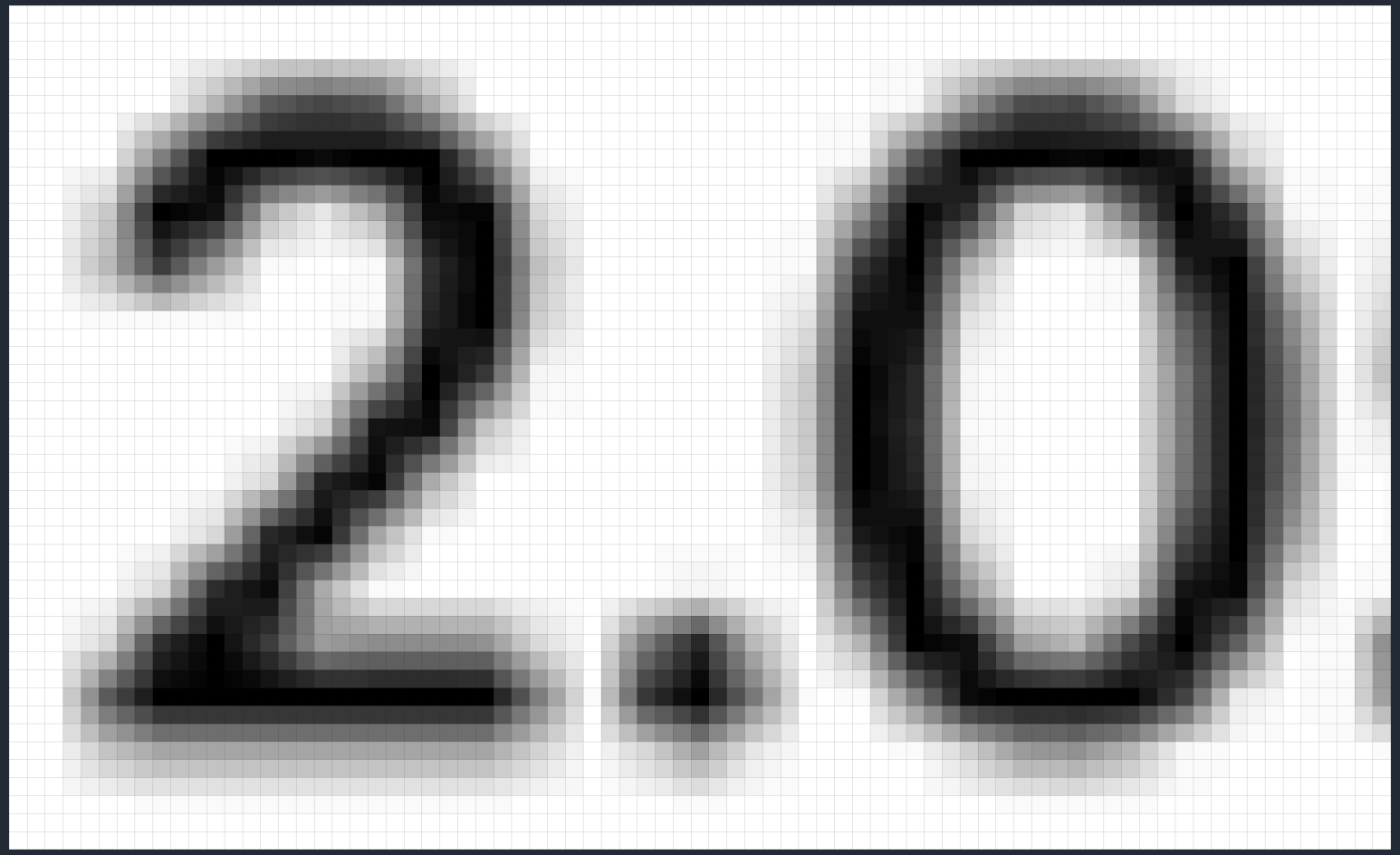

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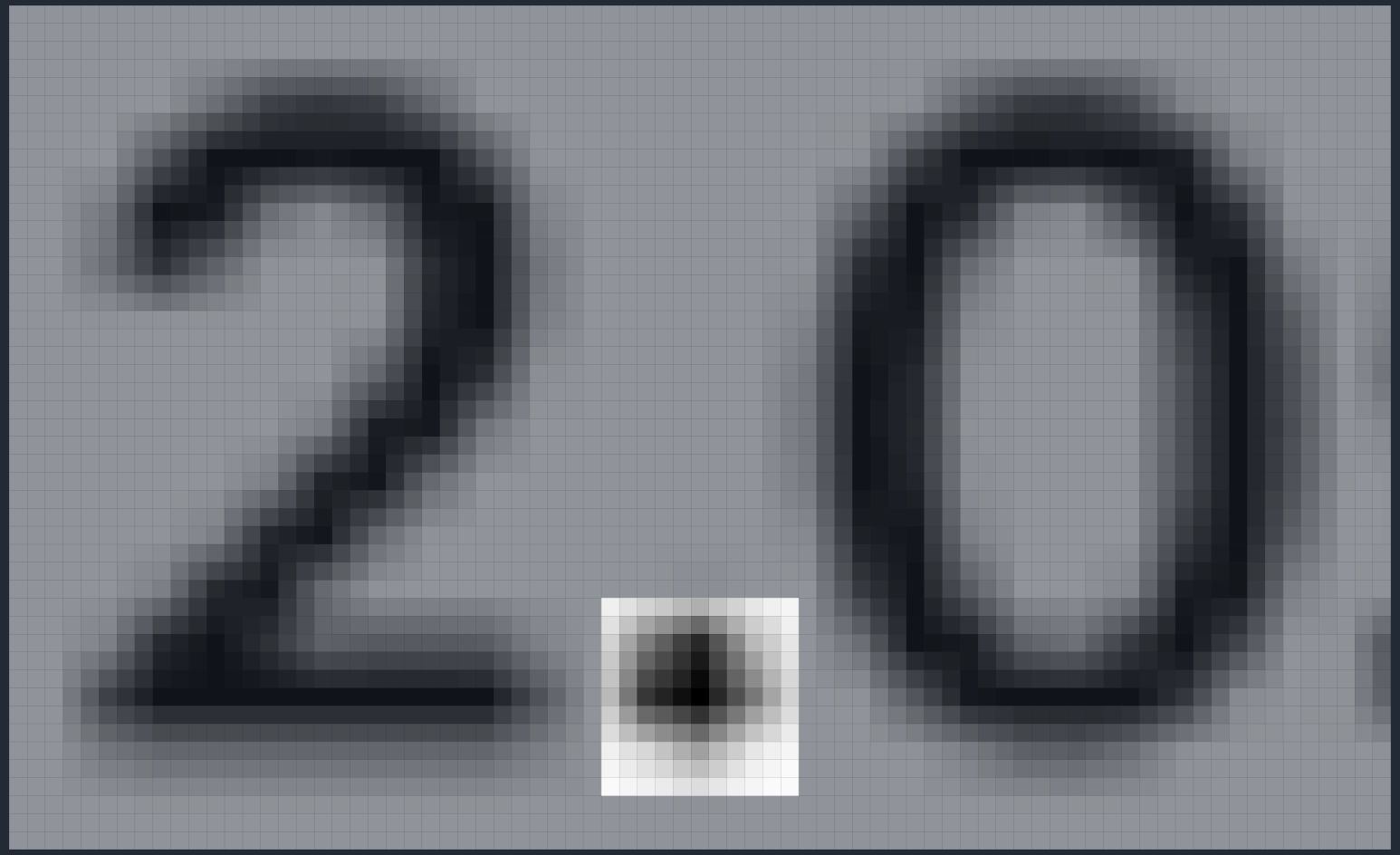

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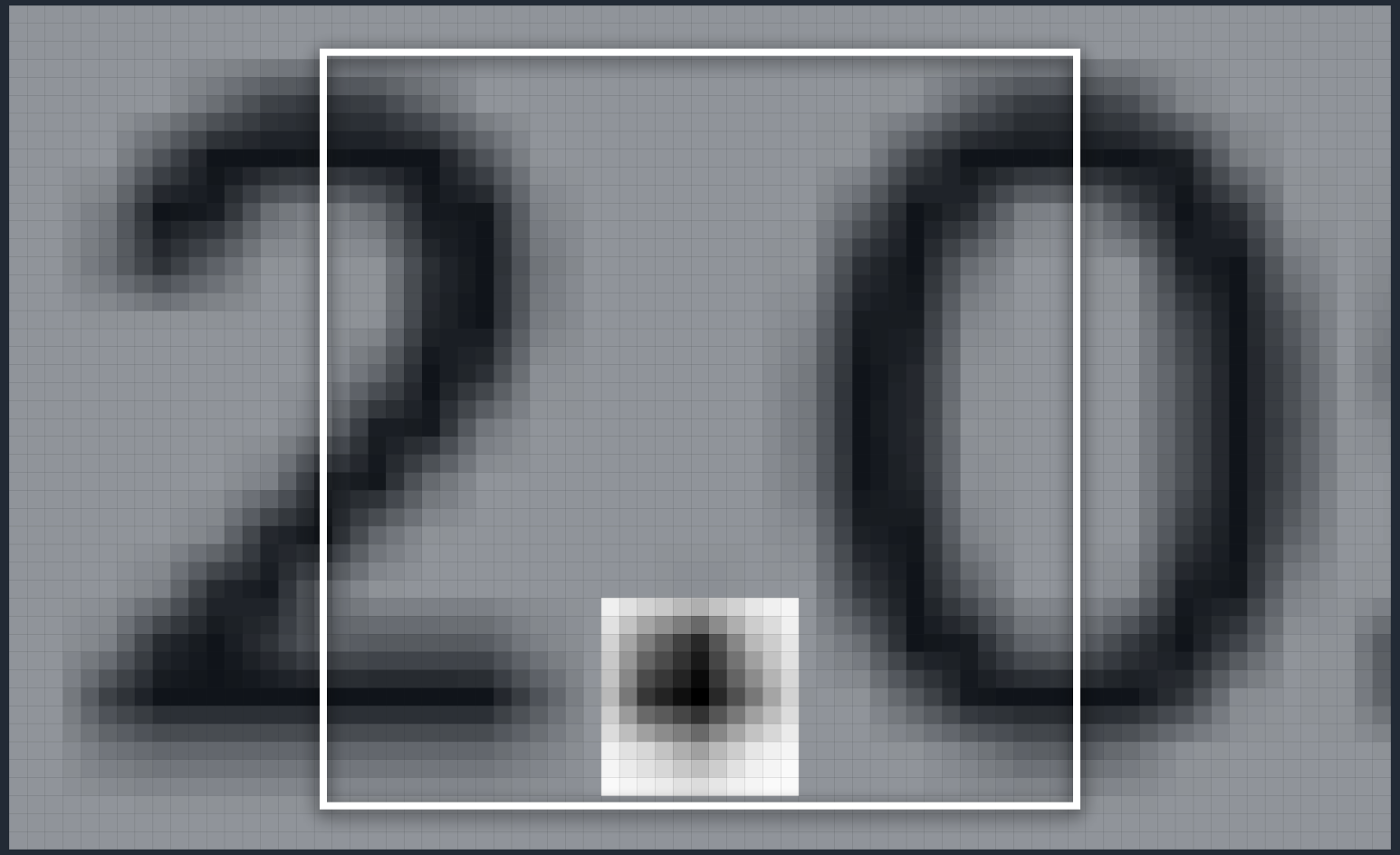

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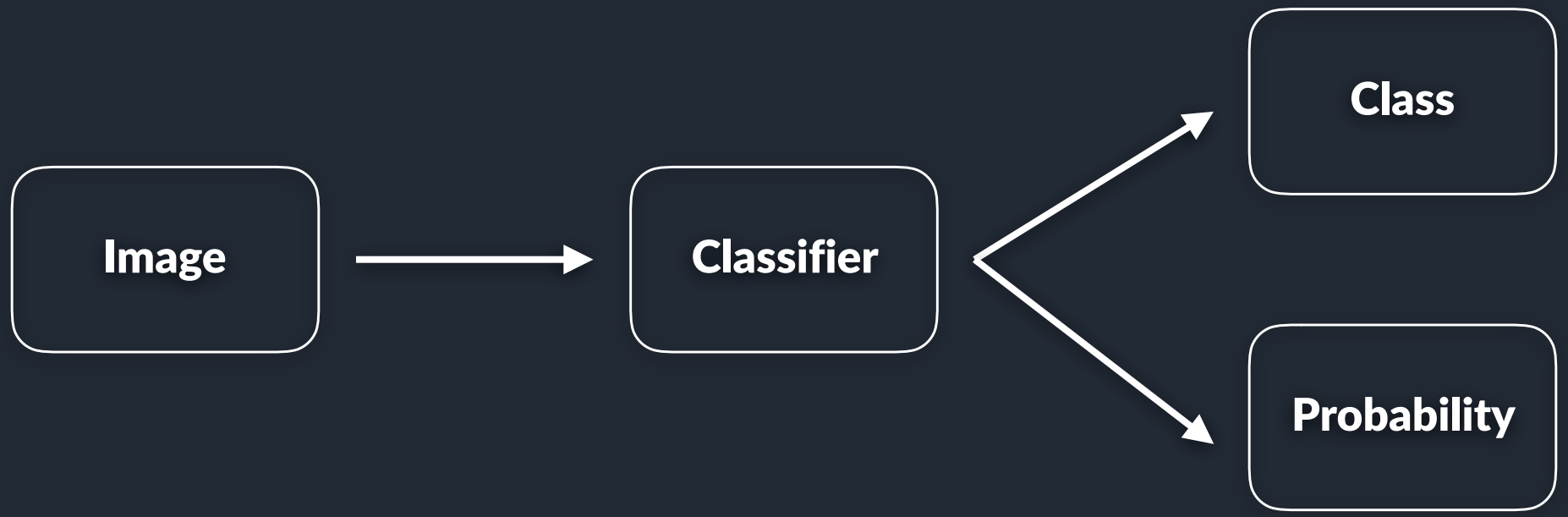

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    let probability = prediction.output[classLabel] ?? 0
    guard probability > threshold else {
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Questions?

Thank You!

Victor Pavlychko

Facebook: victor_pavlychko
Twitter: @victorpavlychko
GitHub: victor-pavlychko

bit.ly/2JXs4Ch