# Capstone Project

# Computer Vision

- Capstone Project
  - We will be creating a program that can detect a hand, segment the hand, and count the number of fingers being held up!
  - Let’s take a peek at what the finished project will look like!

# Capstone Project

## Part One - Variables and Background

# Computer Vision

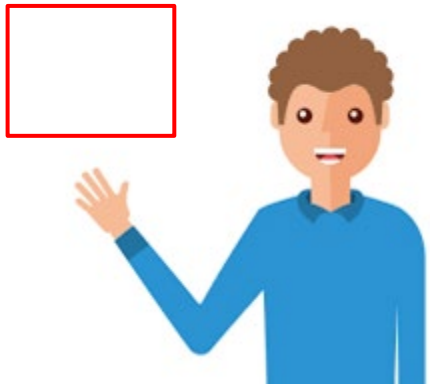
- Part One
  - First let’s define some global variables.
  - Afterwards, we’ll set up a function that updates a running average of the background values in an ROI.
  - This will later on allow us to detect new objects (hand) in the ROI

# Computer Vision

- Strategy for counting fingers
  - Grab an ROI
  - Calculate a running average background value for 60 frames of video
  - Once avg value is found, then the hand can enter the ROI.

# Computer Vision

- Set an ROI and calculate the average running value for some amount of frames.



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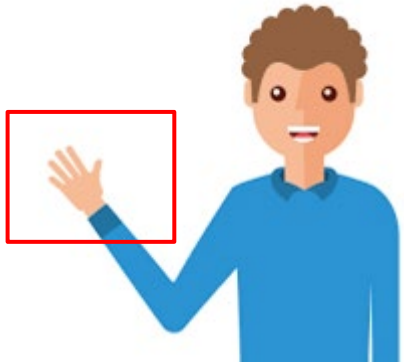
- Then once a hand enters, we can detect a change and apply thresholding.



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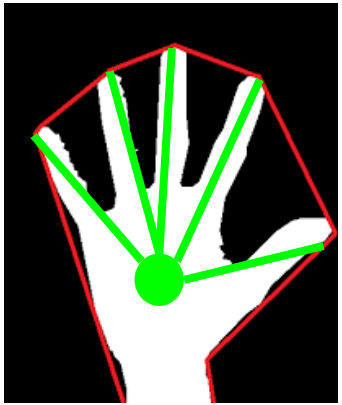
  - Using some math, we'll calculate the center of the hand against the angle of outer points to infer finger count.



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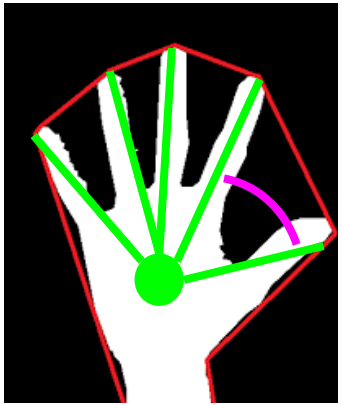

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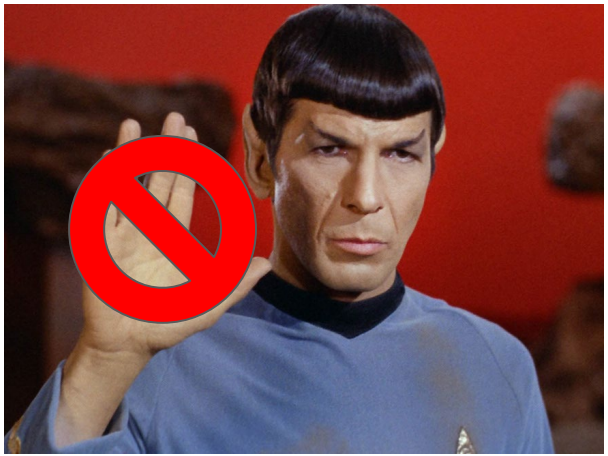

# Computer Vision

- Let’s get started!

# Capstone Project

## Part Two - Segmenting the Hand in ROI

# Computer Vision

- The next step is to use thresholding to grab the hand segment from the ROI.
- Let’s create a function that can do this!

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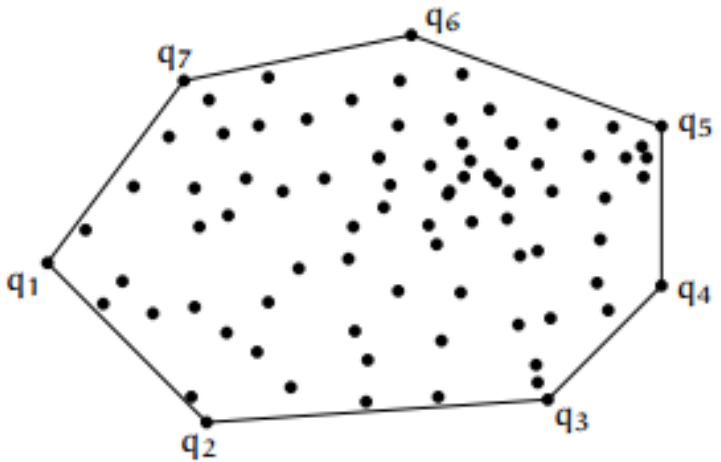
## Part Three - Finger Counting with Convex Hull

# Computer Vision

- Now that we have the hand segment, the next step is to actually count the fingers being held up.
- We can do this by utilizing a Convex Hull.
- A convex hull draws a polygon by connecting points around the most external points in a frame.

# Computer Vision

(a) Input.




(b) Output.

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- In our case, this set of points is actually just our thresholded image of a hand (and the external contour information)

# Computer Vision

- We can expect a general shape of our polygon to be something like this:

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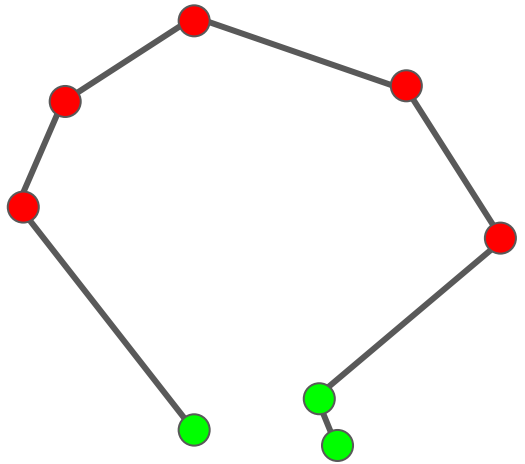

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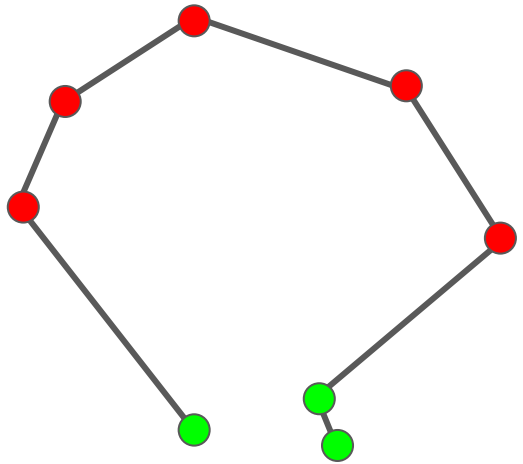
- Notice that we'll need to account for lines from the wrist.



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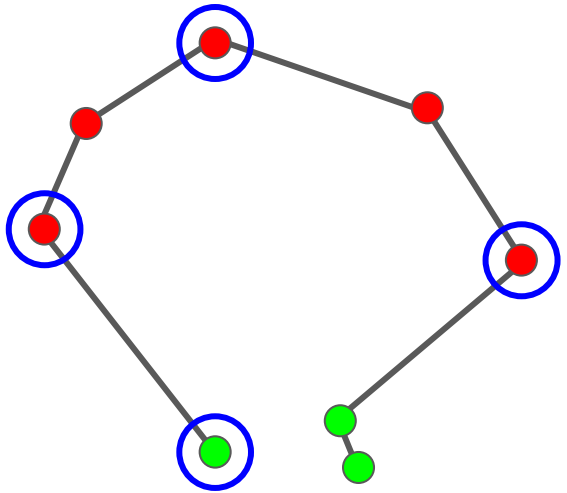
- First we will calculate the most extreme points (top, bottom, left, and right).



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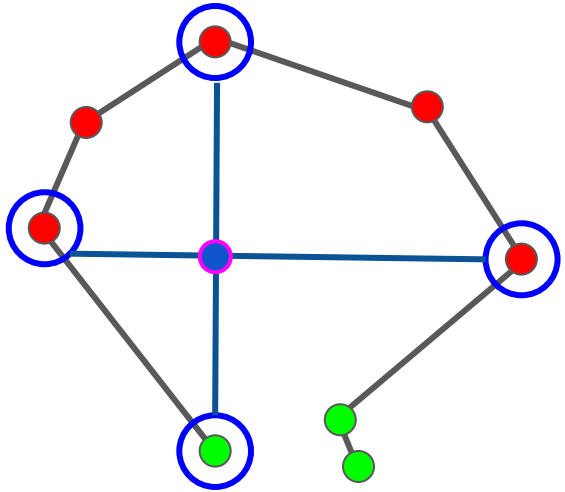
- We can then calculate their intersection and estimate that as the center of the hand



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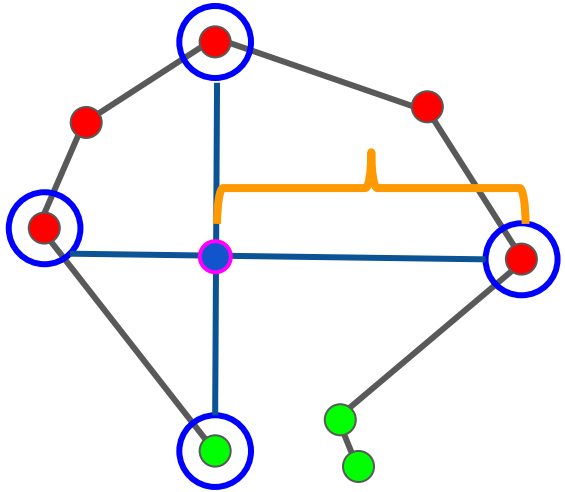
- Next we will calculate the distance for the point furthest away from the center



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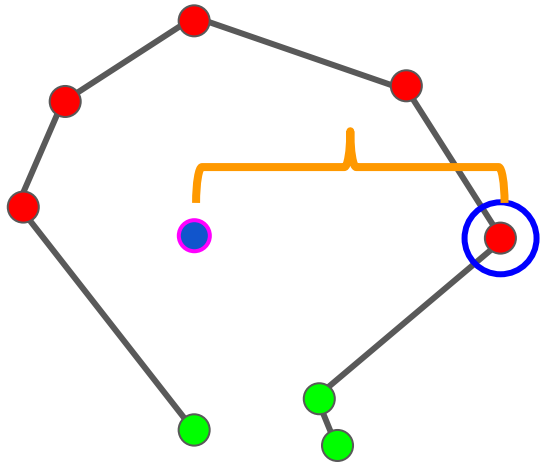

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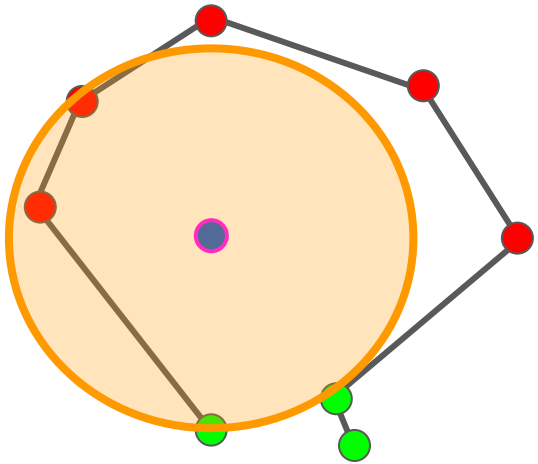
- Then using a ratio of that distance we create a circle



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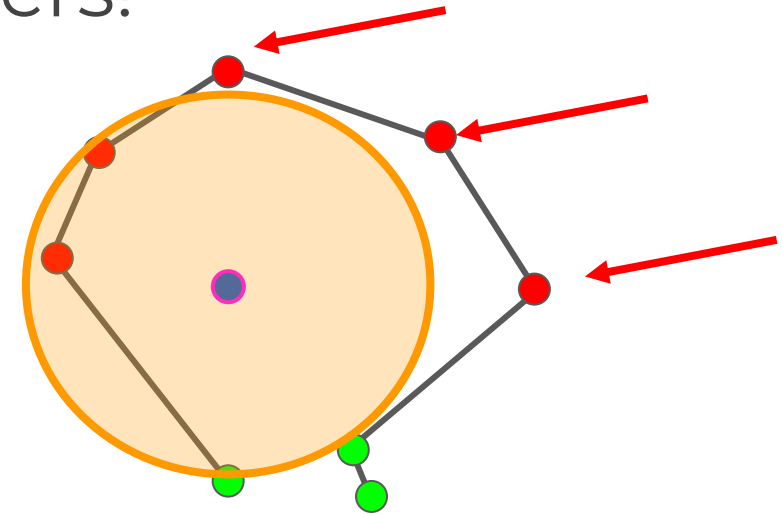
- Any points outside of this circle and far away enough from the bottom, should be extended fingers!



# Computer Vision

- Let’s create a function that does all of this!

# Capstone Project

## Part Four - Bringing it all Together