CV Final Presentation

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Problem statement

For students working on learning the number line, getting feedback is important. Teachers often provide this feedback, but in a big classroom, teachers can't be everywhere at once. Any sort of agent capable of providing feedback as accurately as a teacher while being more available would contribute to the classroom experience.

Why is it important

- Butterworth, Brian in 2005 pointed out that the poor performance in arithmetic skill (mathematics) could be much worse than poor literacy skill
- It is better for the children to have a good foundation before all of the mathematics information becomes "chronic, pervasive, severe, and difficult to remediate"
- it is important to find a way to help the children build up a good mathematical background in the early stages
  - The starting point is learning about number through number lines

Our proposed Process
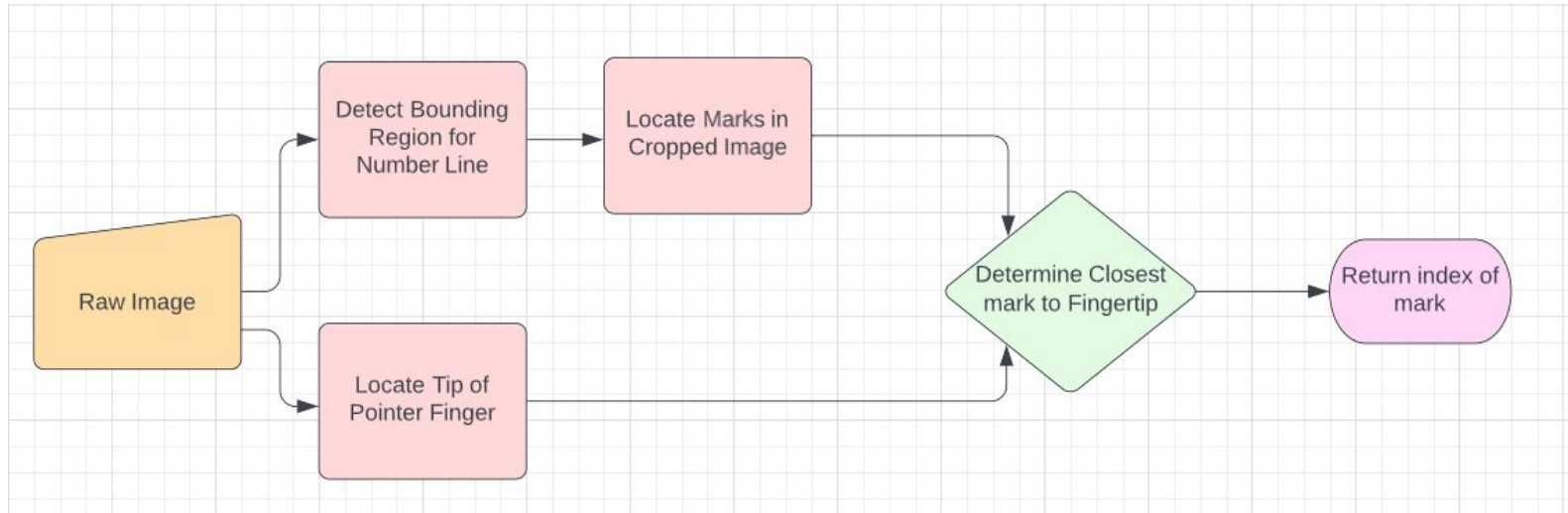
Number line Detection- Finding Candidates

- Take advantage of distinct shape of the number line - straight and parallel edges
- Canny Edge Algorithm to isolate edges
- Hough Transform to find lines
- Iterate pair-wise through lines, assign a likelihood score to each pair
- Return the pair with the highest score
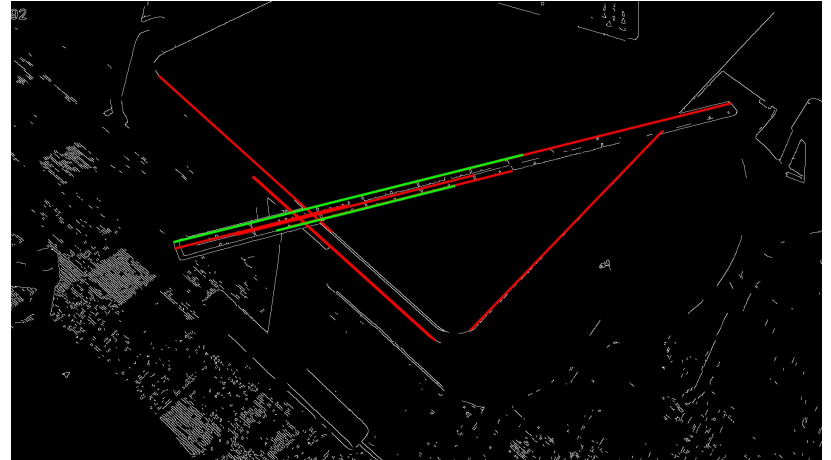
All 10 Candidates shown, most likely pairing shown in green

Mark Detection - analyse region of interest

- Using lines we just found, crop the image to a Region Of Interest (ROI)
- Isolate cross sections of ROI - slices
- Calculate average pixel activation for each slice, save results in new array
- Calculate local maxima of array
- Fill in missing gaps
- Project back onto the original image

Raw image above, cropped image below

Mark detection - filling in the gaps

- Determine the median gap size between marks
- If there exists a gap of roughly *n* times the size of the median, space out *n-1* new marks in the space between
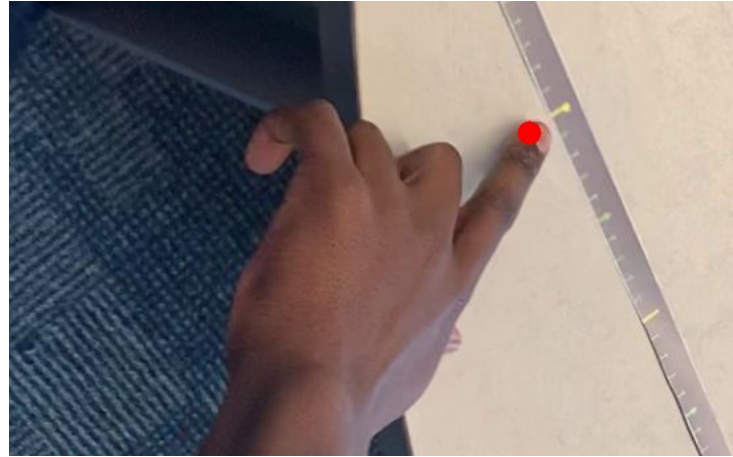
Hand detection

Using Mediapipe hand modules:

Static image option set to be true

Need to lower that confidence of tracking and detecting to be lower than 0.1

Works well on all skin tones

Results

Number line detection - a weak link

- Everything relies on Number line detection
- Noisy images with patterned background cause great issue, but poor results happen even in simple inputs from time to time

Mark detection - Strong but overly reliant

- Works very well when bounding region is accurate
- Meaningless when bounding region is inaccurate
- Relies a bit heavily on dimensional heuristic

Expects 20 marks

Expects 3 marks

Expects 100 marks

Hand detection

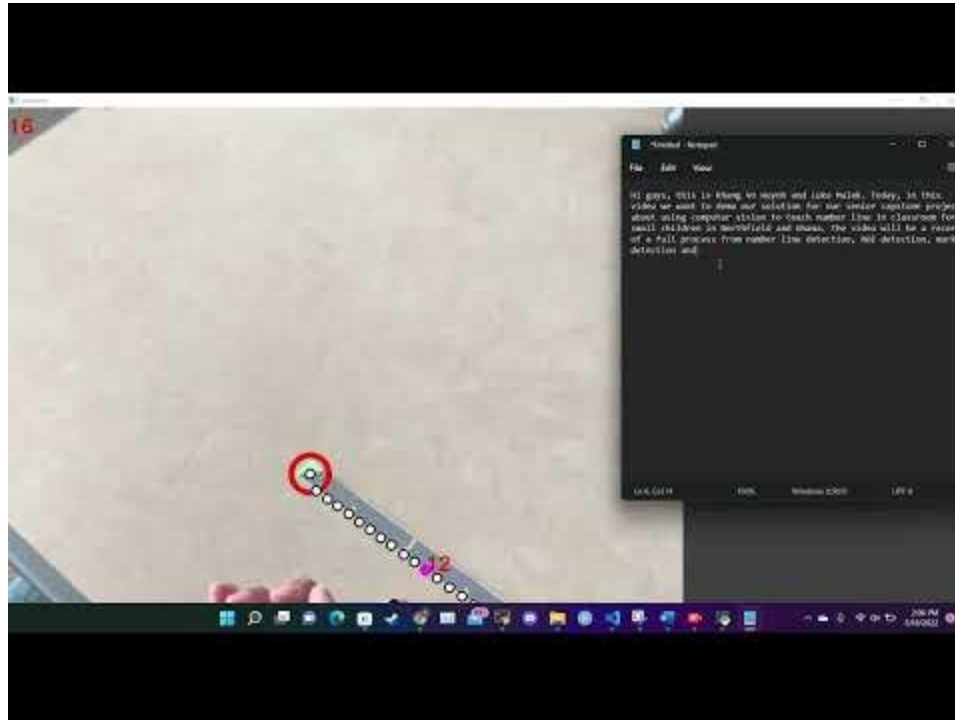This is one of the strongest component in our solution:

Pros:

- It was developed by Google so credibility is somewhat guaranteed
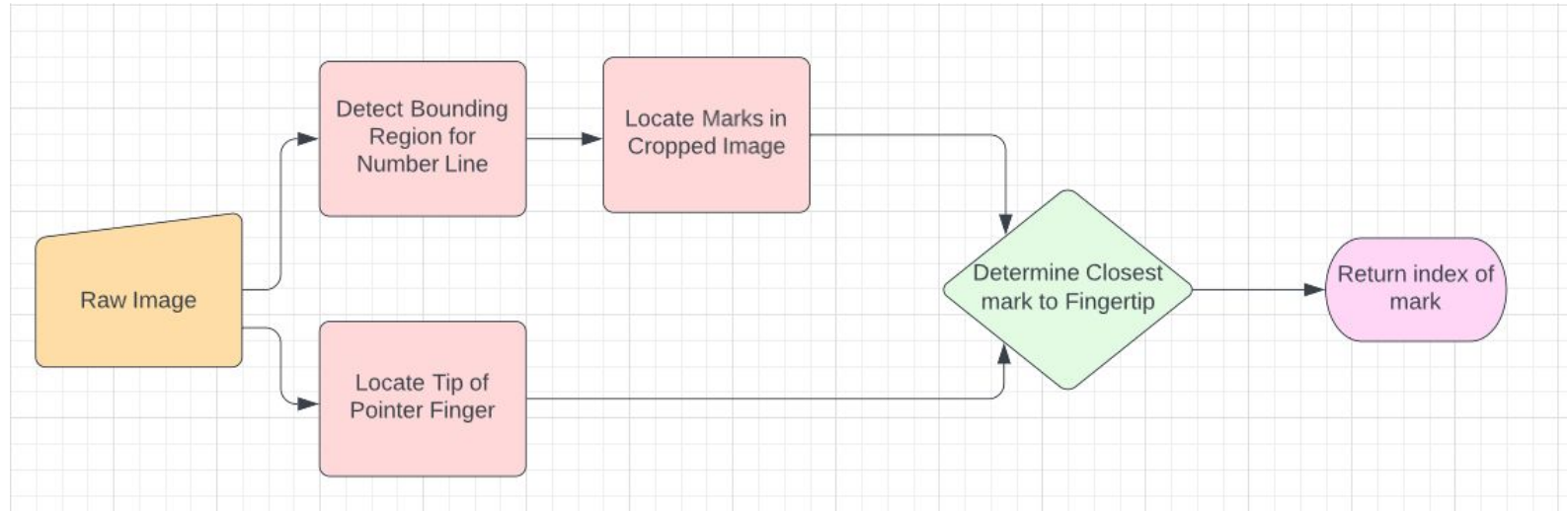- Pretrained deep learning model which result in a higher accuracy.

Cons:

- We do not have the control over the output

Holistic Process

Recap of the full process

Future works

- Improve the robustness of number lines (ROI) detection:
    - Find out a way to check whether either one of the two lines that bounded the number line is in the top candidates
    - Other possible solution could be integrating machine learning and deep learning into the model

Concluding remarks

- An end-to-end solution to resolve our problem statement earlier in the presentation about providing feedback as accurately as a teacher while being more available
- Work well in decent quality image
  - By "decent", we mean, as a human, we could see the small mark on the number line
  - Not having a lot of pattern background

Acknowledgement