RBN Detection for Order of Finish

Hello!

I’m Eric Bayless

Data Science Student at
General Assembly

You can find me at:

ericbayless.github.io

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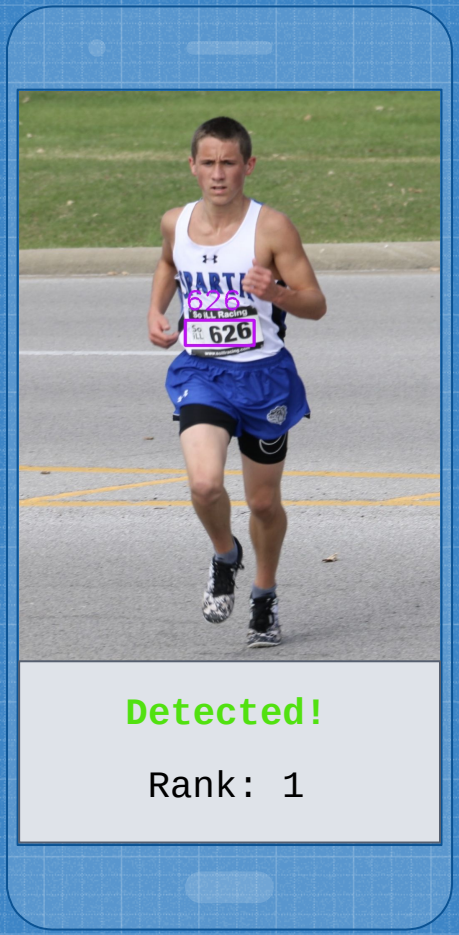
Problem Statement

Purpose and background

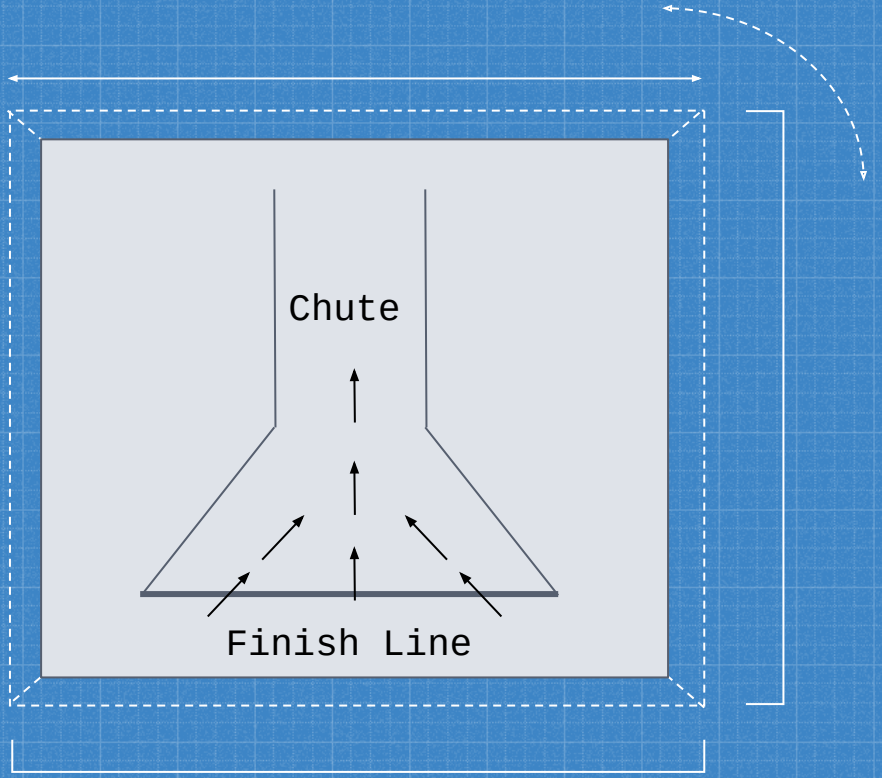
Proof Of Concept

Create a model that can detect race bib numbers in a manner that demonstrates its viability in a mobile app.



Background-Cross Country

- Chute
  - Single file
- Order of finish
  - Collect tags
  - Scan barcode



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Data Acquisition

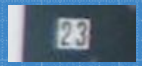
Description, challenges,
and solutions

Race Bib Number (RBNR) Dataset

- 217 images containing 290 bibs
- Split into 3 sets from 3 races
- Mostly action shots

Street View House Number (SVHN) Dataset

- Over 600,000 images available
- Low resolution
- Has been used for bib number detection



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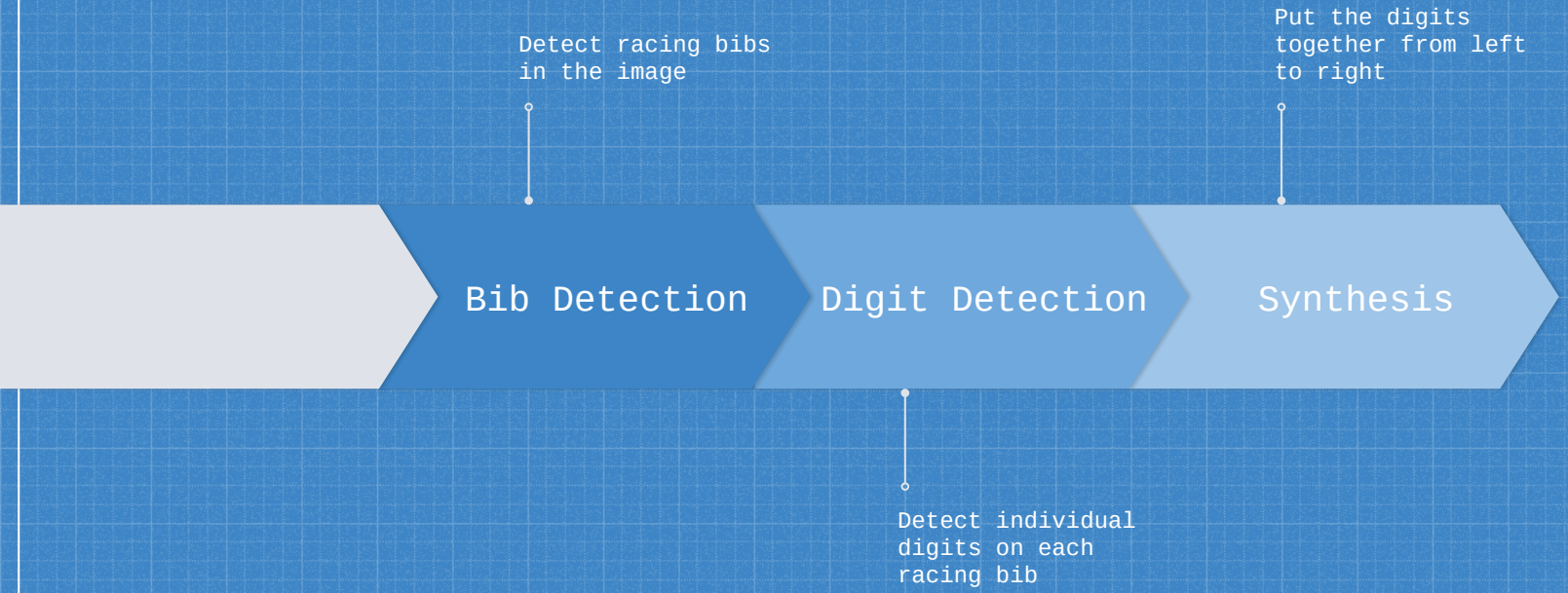
Model Selection

What and why

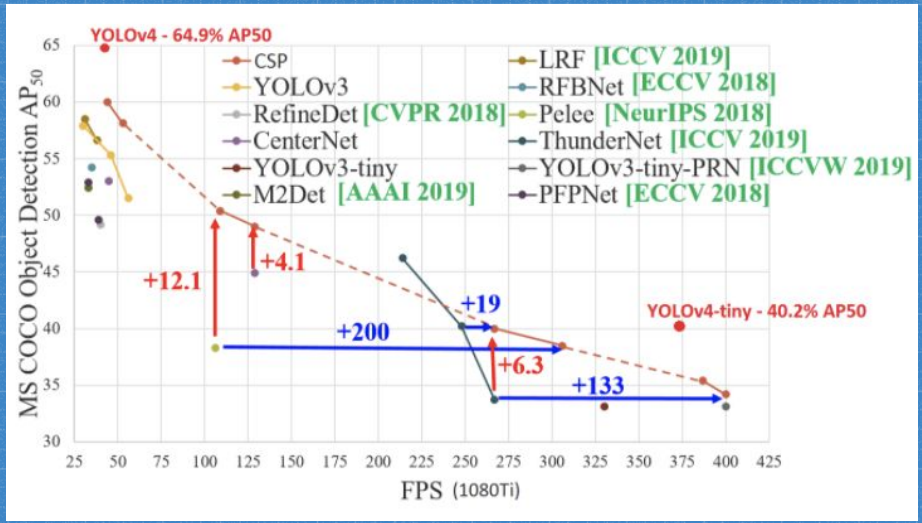
Process


Detect racing bibs in the image
Put the digits together from left to right
Bib Detection
Digit Detection
Synthesis
Detect individual digits on each racing bib

YOLOv4-tiny

Why?

- Relatively small footprint
- 8X as fast as YOLOv4 with ⅔ the performance on MS COCO
- Even less of a performance hit with fewer classes



*from: https://blog.roboflow.com/train-yolov4-tiny-on-custom-data-lighting-fast-detection/

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Training Results

How did the models do individually?

Bib Detection

- Initial results limited by size of dataset
- Image augmentation used to create 5,088 images from initial 127
- Initial mAP@0.5 = **76.03%**
- Final mAP@0.5 = **94.42%**

Digit Detection - SVHN

```
 calculation mAP (mean average precision)...
13068
 detections_count = 95055, unique_truth_count = 26032
class_id = 0, name = 0, ap = 86.72%       (TP = 1512, FP = 304)
class_id = 1, name = 1, ap = 74.05%       (TP = 3789, FP = 884)
class_id = 2, name = 2, ap = 86.74%       (TP = 3485, FP = 425)
class_id = 3, name = 3, ap = 82.89%       (TP = 2200, FP = 364)
class_id = 4, name = 4, ap = 84.72%       (TP = 2040, FP = 297)
class_id = 5, name = 5, ap = 86.79%       (TP = 1958, FP = 256)
class_id = 6, name = 6, ap = 85.75%       (TP = 1625, FP = 276)
class_id = 7, name = 7, ap = 83.91%       (TP = 1608, FP = 258)
class_id = 8, name = 8, ap = 85.98%       (TP = 1395, FP = 214)
class_id = 9, name = 9, ap = 83.61%       (TP = 1324, FP = 286)

 for conf_thresh = 0.25, precision = 0.85, recall = 0.80, F1-score = 0.83
 for conf_thresh = 0.25, TP = 20936, FP = 3564, FN = 5096, average IoU = 62.52 %

 IoU threshold = 50 %, used Area-Under-Curve for each unique Recall
 mean average precision (mAP@0.50) = 0.841158, or 84.12 %
Total Detection Time: 61 Seconds
```

Digit Detection - Race Bibs

- Cropped all bibs from RBNR dataset
- Only complete match counted
- Accuracy = 67.59%

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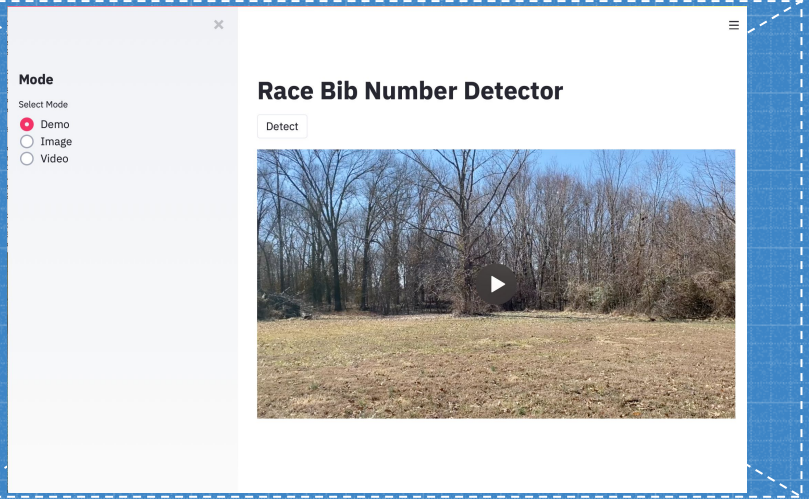
End to End Detection

Score and Demo

Digit Detection - Race Bibs

- Used set 3 of RBNR dataset
- Only complete match counted
- Accuracy = 38.05%



Demo

The proof is in the pudding

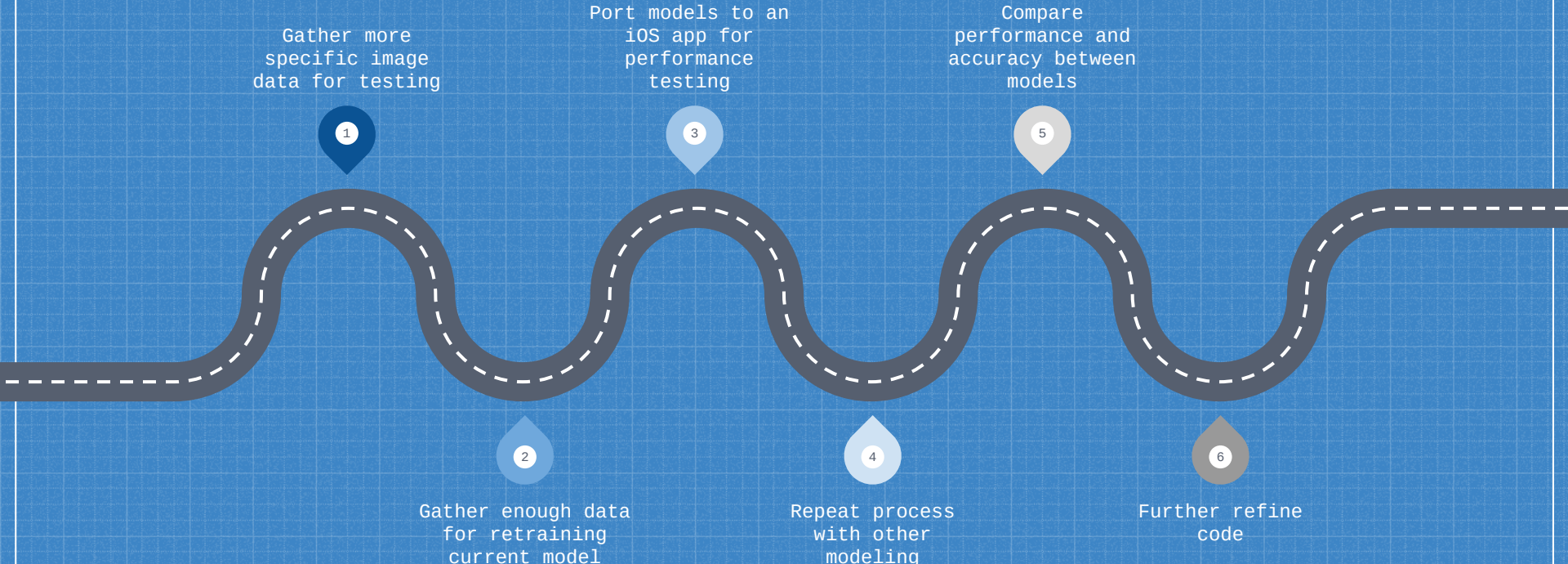
6 Conclusions

Does it work?

Summary

- Accuracy scores limited by data
- Demo and live webcam detection indicate viability
- Further work is needed to validate these assumptions

Next steps


Gather more specific image data for testing
1
2
Gather enough data for retraining current model
Port models to an iOS app for performance testing
3
4
Repeat process with other modeling algorithms
Compare performance and accuracy between models
5
6
Further refine code

Thanks!

ANY QUESTIONS?

You can find me at:
ericbayless.github.io

Resources

- https://people.csail.mit.edu/talidekel/RBNR.html
- http://ufldl.stanford.edu/housenumbers/
- https://www.researchgate.net/publication/335234017_Racing_Bib_Number_Recognition_Using_Deep_Learning
- https://blog.roboflow.com/train-yolov4-tiny-on-custom-data-lighting-fast-detection/
- https://www.slidescarnival.com/valentine-free-presentation-template/234
- https://share.streamlit.io/ericbayless/bib-detector/main