



Natural Scene Race Bib Number Detection

DATA690: Applied Artificial Intelligence

Final Project, Spring 2022

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Hello! I'm Lee Whieldon!



- Data Science Graduate Student in UMBC's Data Science Program
- Consulting Manager at SC&H Group
- I really like Data!
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 - GitHub:
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Creating a model to detect race bib numbers in a natural scene that demonstrates the use of Convolutional Neural Networks for future edge compute purposes

PROBLEM STATEMENT

Dataset Details

- **Street View House Number (SVHN) Dataset:**
 - 10 Class, 1 for each digit
 - 73257 digits for training, 26032 digits for testing, and 531131 addt'l sample for extra training
 - Comes in 2 formats
 - Original images with character level bounding boxes.
 - MNIST-like 32-by-32 images centered around a single character (many of the images do contain some distractors at the sides)
- **Racing Bib Number Recognition (RBNR) Dataset:**
 - Contains 217 color images and ground truth RBNs per image divided into three sets, each taken from a different race. If you use these datasets in any publication, please refer to our paper.
 - Different sets & their Resolution in table Below:

| | Resolution | # of Images | # of RBNs |
|--------|--------------------|-------------|-----------|
| Set #1 | 342x512 - 480x720 | 92 | 100 |
| Set #2 | 800x530 - 850x1260 | 67 | 77 |
| Set #3 | 768x1024 | 58 | 113 |

SVHN Data Prediction Sample



RBNR Data Prediction Sample



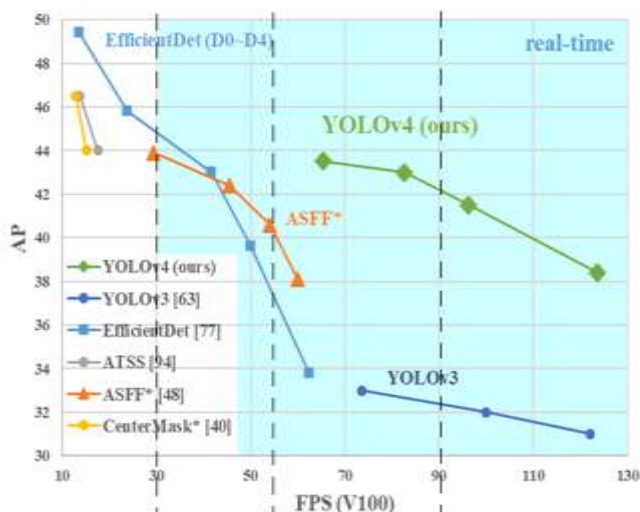
Model Review

Darknet's YOLOv4 - tiny



- YOLOv4-tiny is small in comparison to other CV models
- 8X as fast as YOLOv4 with 66% better performance on the Microsoft COCO Object Detection Classes
- Achieve even better performance when using only 10 classes I leveraged for this project.
- See the image to understand the performance impacts

MS COCO Object Detection



real-time (30 FPS) on
TitanV/TeslaV100 (server)
250 Watt
\$2250 - \$8000

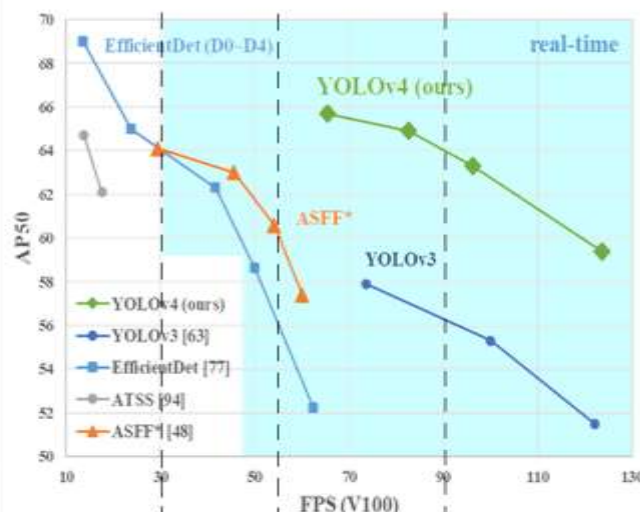
real-time (30 FPS) on
RTX 2070 (desktop)
175 Watt
\$450

real-time (30 FPS) on
RTX 2060 MXM (Mobile)
80 Watt
\$700

9 FPS on
Jetson AGX Xavier (embedded)
30 Watt
\$700

FPS is measured on the Tesla V100 GPU.
For other GPUs with 7.x architecture,
the FPS is estimated based on the TFlops ratio.

MS COCO Object Detection



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Results – Bib Detection

Initial Results

- Training on SVHN [mAP@0.5](#) = 96%
- Training on RBNR [mAP@0.5](#) = 99%



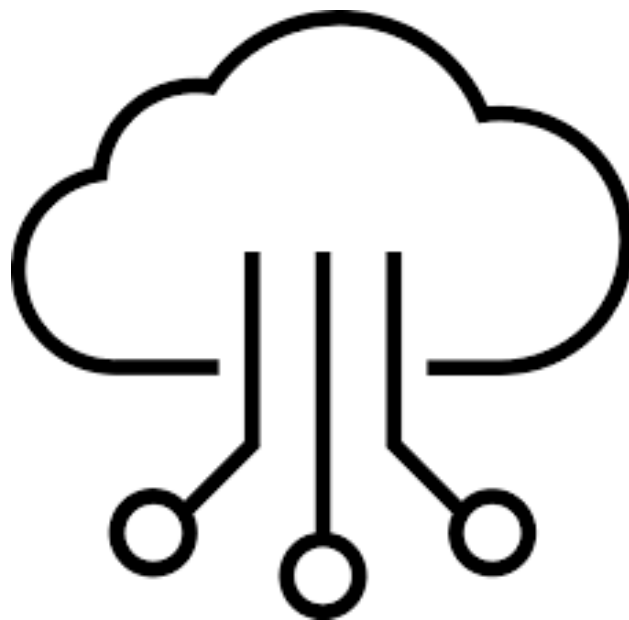
Results & Demo – Digit Detection on Bib

- Cropped bib location on runner before training model
- Only when entire set of numbers was captured was considered a match
- Accuracy in testing dataset = 51%
- Open CV Video Capture Function was unable to detect more than 2 bibs at once. ☹️



Conclusion & Next Steps

- Incorporating Additional Training Images from both Street View House Numbers & more runner images with racing bibs.
- I would like to transfer learning weights to edge compute hardware to display a use case for edge computing with live stream video capture.
- Continue to leverage OpenCV on live video capture to detect more than 2 bibs in an image.



THANK YOU!

Feel free to chat further on my topic at
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Resources

- A. Apap and D. Seychell, “Marathon bib number recognition using deep learning,” in *2019 11th International Symposium on Image and Signal Processing and Analysis (ISPA)*, 2019, pp. 21–26.
- E. Ivarsson and R. M. Mueller, “Racing bib number recognition using deep learning,” 2019.
- P. Hernández-Carrascosa, A. Penate-Sanchez, J. Lorenzo-Navarro, D. Freire-Obregón, and M. Castrillón-Santana, “TGCRBNW: A Dataset for Runner Bib Number Detection (and Recognition) in the Wild,” in *2020 25th International Conference on Pattern Recognition (ICPR)*, 2021, pp. 9445–9451.
- G. Carty, M. A. Raja, and C. Ryan, “Running to Get Recognised,” in *International Symposium on Signal Processing and Intelligent Recognition Systems*, 2020, pp. 3–17.
- N. Boonsim, “Racing bib number localization on complex backgrounds,” *WSEAS Trans. Syst. Control*, vol. 13, pp. 226–231, 2018.
- RoboFlow: <https://blog.roboflow.com/train-yolov4-tiny-on-custom-data-lighting-fast-detection/>
- OpenCV: <https://opencv.org/>