

# Proofpoint Logo Detection and Classification Models

4th February 2021

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# Agenda

- Project Recap
- Phase 1 Precision-Recall Curves
- Phase 1 Error Analysis (Preliminary)
- Phase 2 Updates

# Recap

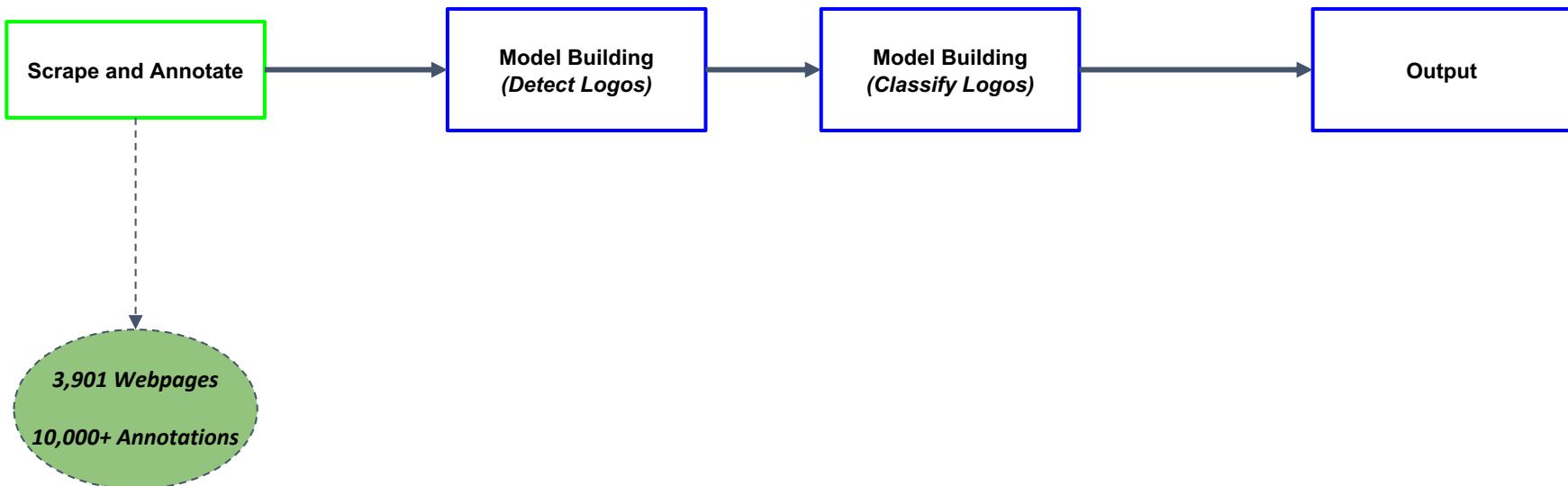
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# Pipeline



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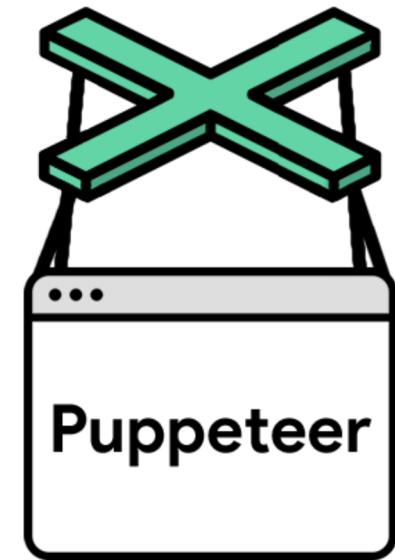
# Pipeline



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# S&P 500 Screenshot Collection

- Images scraped from web pages using **Pypeteer (Puppeteer's Python API)**.
- Resolution: **1440x2560**.
- High resolution chosen for clarity of smaller logos.
- Scraped 3,901 images from:
  - a. Official Company Websites
  - b. Google Images Search Results
  - c. Wikipedia Articles.



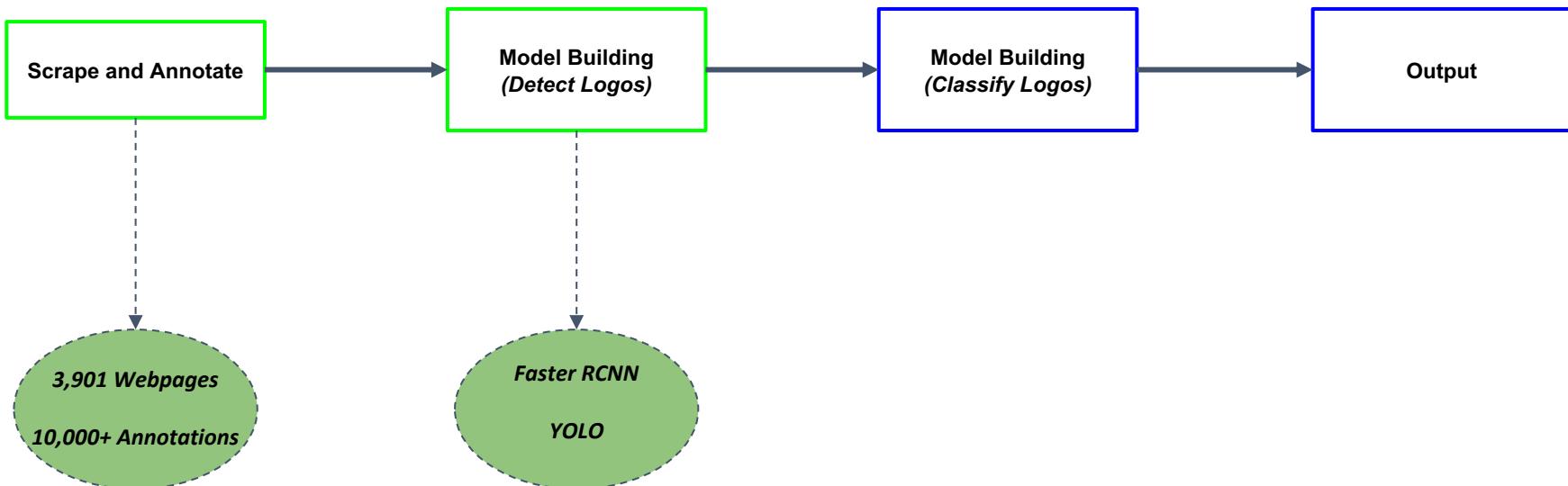
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# Image Annotation

- Undertaken using labellImg.
- Pascal VOC format used for annotations - can be easily converted to other formats e.g. COCO and YOLO.
- Images with no logos not annotated.
- Over **10,000** logos annotated.



# Pipeline



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# Faster RCNN Results

<b>Intersection over Union (IoU)</b>	<b>Mean Average Precision (mAP %)</b>
0.5	87.6%

# YOLO

- Delivered strong performance on clear logos.
- Performs faster at test time than Faster R-CNN.
- Struggled with:
  - Low quality or deformed logos
  - Darkened logos

Intersection over Union (IoU)	Mean Average Precision (mAP %)
0.5	80.9%

# Precision-Recall Analysis

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# Faster RCNN Manual Process

IoU

TP, FP, FN

Prec, Rec

PR Curve

# Faster RCNN

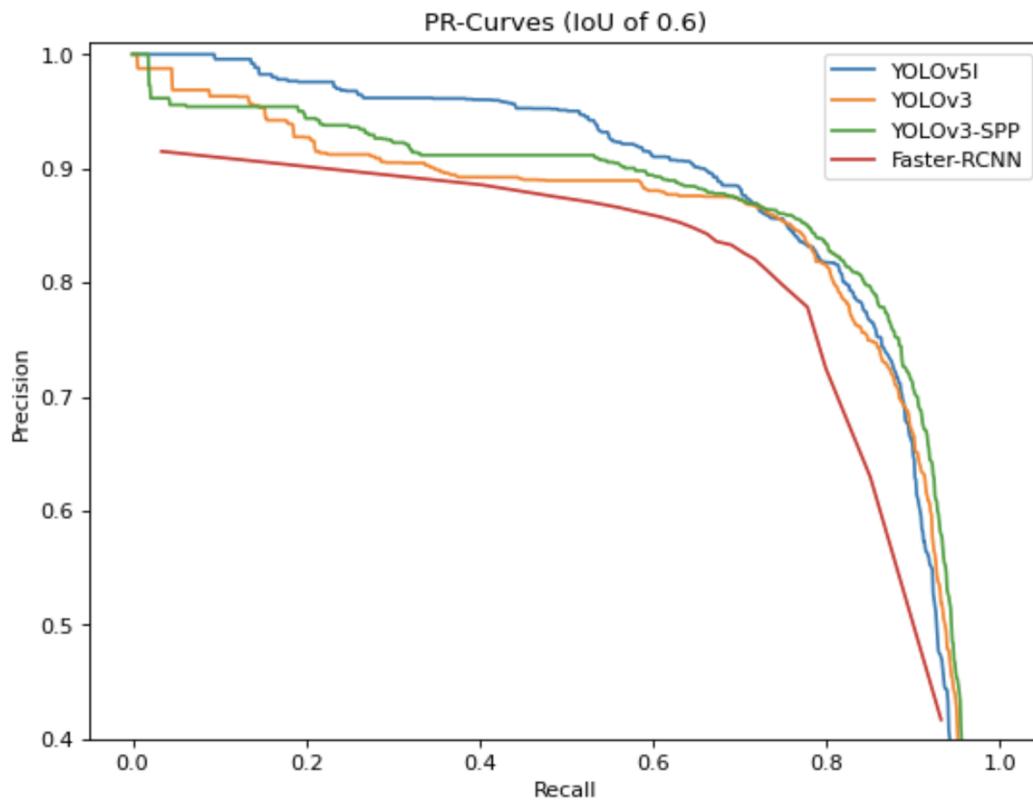
- Using IoU of 0.6
- Confidence Threshold of 0.1
- Tesla T4

Model	Precision	Recall	mAP @ 0.5	Detection Speed
Faster RCNN (ResNeXt+FPN)	0.48	<b>0.88</b>	<b>0.872</b>	<b>0.293 s</b>

# YOLO Models

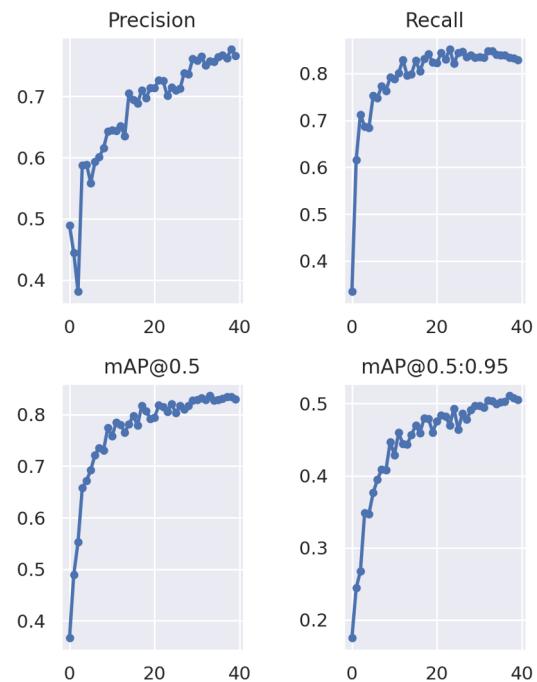
- Using IoU of 0.6
- Trained for 40 epochs
- Confidence Threshold of 0.1
- Tesla V100-SXM2-16GB

Model	Precision	Recall	mAP @ 0.5	Detection Speed
Faster RCNN	0.48	<b>0.88</b>	<b>0.872</b>	<b>0.293 s</b>
YOLO v3	0.763	0.833	0.754	0.043s
YOLO v3 - SPP	0.778	0.867	0.790	0.045s
YOLO v5 - Large	<b>0.816</b>	0.813	0.828	<b>0.036s</b>

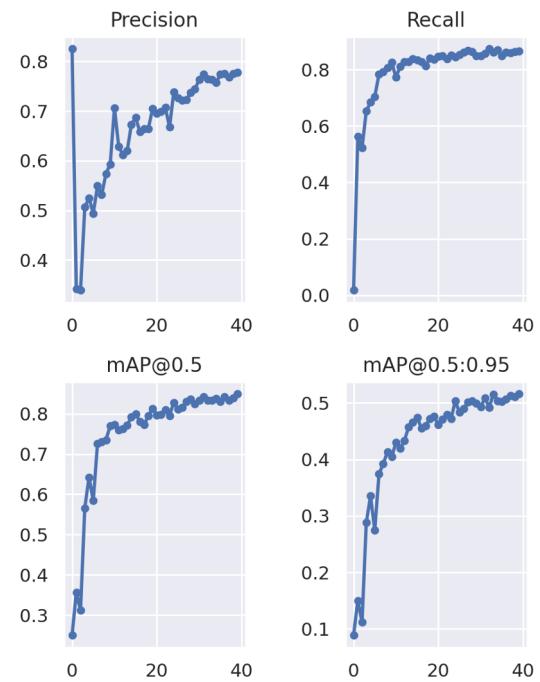


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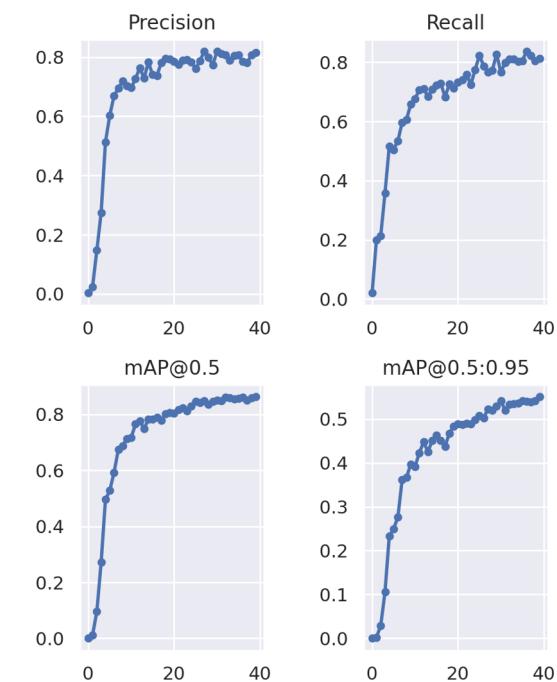
### YOLO v3



### YOLO v3 - SPP



### YOLO v5 - Large



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BLOG

PREVIOUS

← The Best and Worst Thrill Rides in Each Walt Disney World Park

NEXT

You Won't Believe these → Seven Bizarre Things that Used to be at Epcot

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Would You Rather: Walt Disney World Resort Edition

The Ultimate Guide to the Hotels at Universal Orlando Resort

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Harry Potter Eats in Universal Orlando!

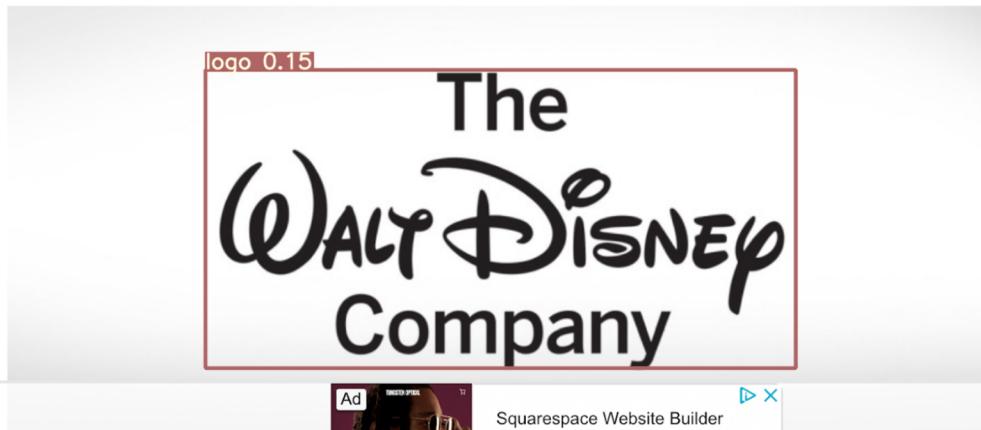
Seven Signs You've Ridden Tower of Terror Too Many Times

## How Declining Stock Could Change the Future of The Walt Disney Company



By [Sarah Fournier](#)  
Posted on [March 28, 2020](#)

While the global threat of the current health crisis forces people around the world to [adhere to curfews](#), and businesses to close for what is yet an unknown length of time or [lay off employees](#), the ramifications of this novel coronavirus are being felt by the Walt Disney Company as well.



The worldwide closure of Disney Parks has had a significant impact as "a disruption in our business," Disney CEO Bob Iger said in a statement. "We have described the impact on our various

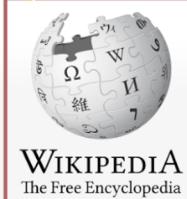
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# Kraft Heinz

From Wikipedia, the free encyclopedia

**The Kraft Heinz Company** (KHC), commonly known as **Kraft Heinz**, is an American food company formed by the merger of **Kraft Foods** and **Heinz** and is co-headquartered in **Chicago, Illinois**, and **Pittsburgh, Pennsylvania**.<sup>[4][5]</sup> Kraft Heinz is the third-largest food and beverage company in North America and the fifth-largest in the world with \$25.0 billion in annual sales as of 2019.<sup>[6][7]</sup>

In addition to Kraft and Heinz, over 20 other brands are part of the company's profile including **Boca Burger**; **Gevalia**; **Grey Poupon**, **Oscar Mayer**, **Philadelphia Cream Cheese**, **Planters**, and **Wattie's** of which eight have total individual sales of over \$1 billion.<sup>[8]</sup> Kraft Heinz ranked No. 114 in the 2018 **Fortune 500** list of the largest United States corporations based on 2017 total revenue.<sup>[9]</sup>

## Contents [hide]

- 1 History
- 2 Brands
- 3 Finance
- 4 See also
- 5 References
- 6 Further reading
- 7 External links

## History [edit]

The merger of Kraft Foods and H.J. Heinz was agreed by the boards of both companies, with approval by shareholders and regulatory authorities in early 2015.<sup>[10][11]</sup> The new Kraft Heinz Company became the world's fifth-largest food and beverage company<sup>[12]</sup> and the third-largest in the United States.<sup>[10][13]</sup> The Kraft Heinz co-headquarters are in **Chicago** at the **Aon Center** and in **Pittsburgh** at **PPG Place**, with other offices across the United States, Canada, South America,



Kraft Heinz co-headquarters at the **Aon Center** in the **Chicago Loop**<sup>[1]</sup>

Type **Public**

Traded as **NASDAQ: KHC**   
**NASDAQ-100 component**   
**S&P 100 component**   
**S&P 500 component**



logo 0.77



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## NASDAQ OMX Group

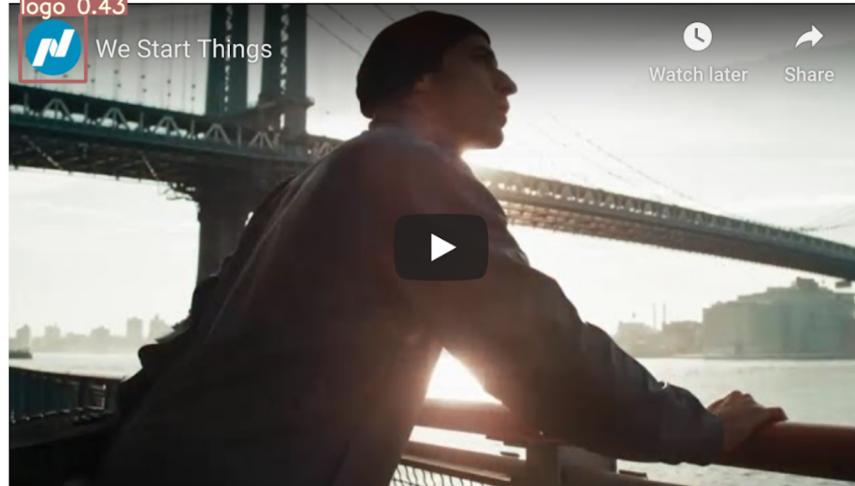
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Ceresit

Henkel

BAUTECHNIK

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Canadian Natural Resources

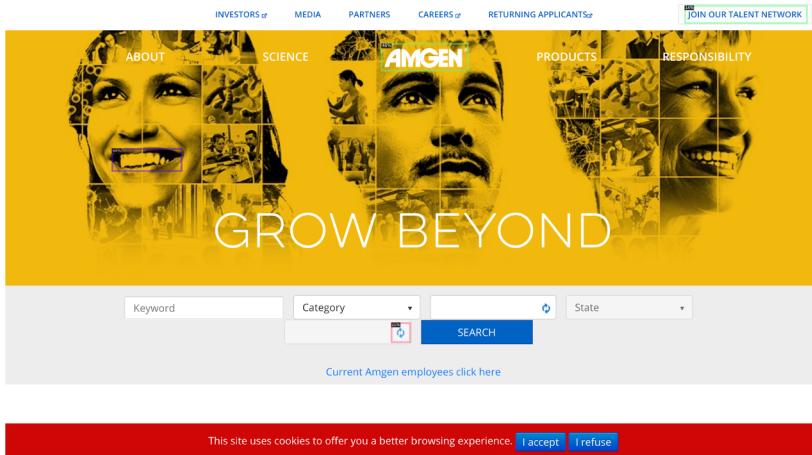
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Metafrax

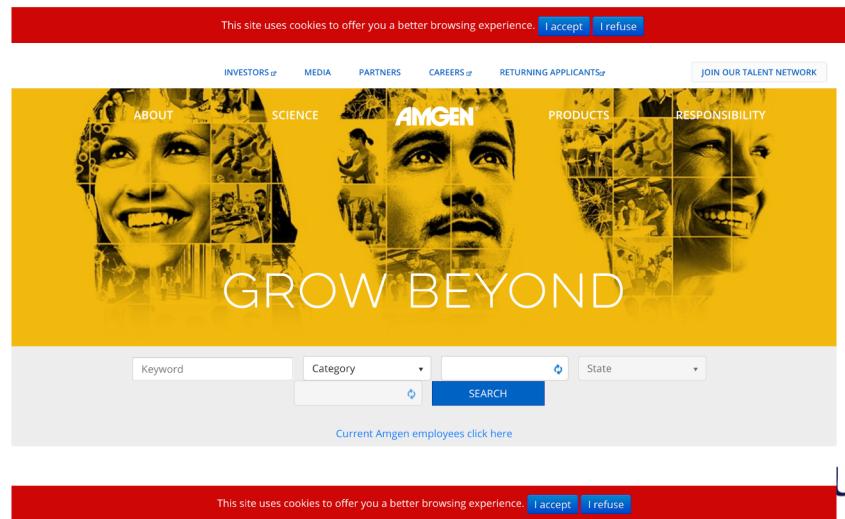
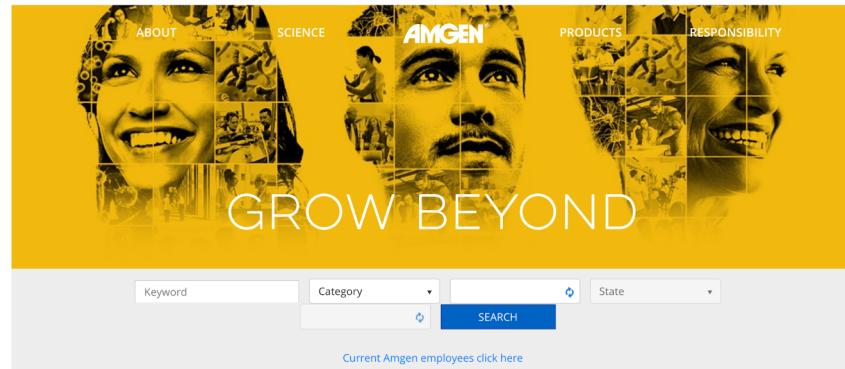
# Error Analysis

- Large logos
- Logos blended into background
- Small and low quality logos
- Darkened logos
- Large Text
- Logos within logos

## Faster-RCNN

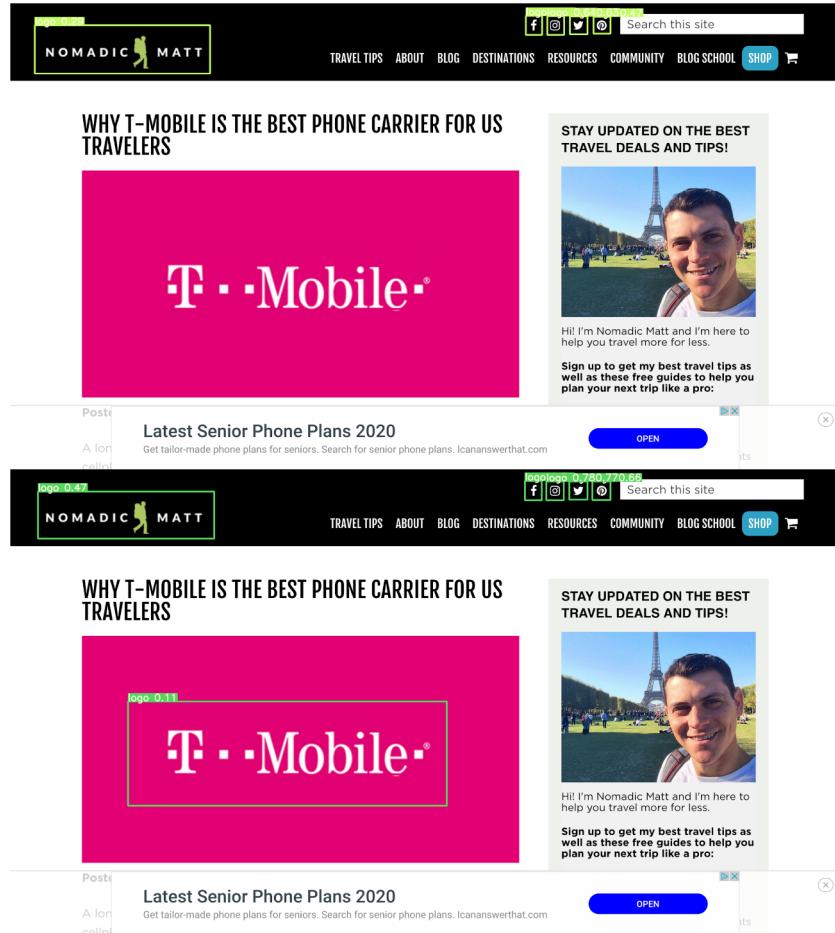
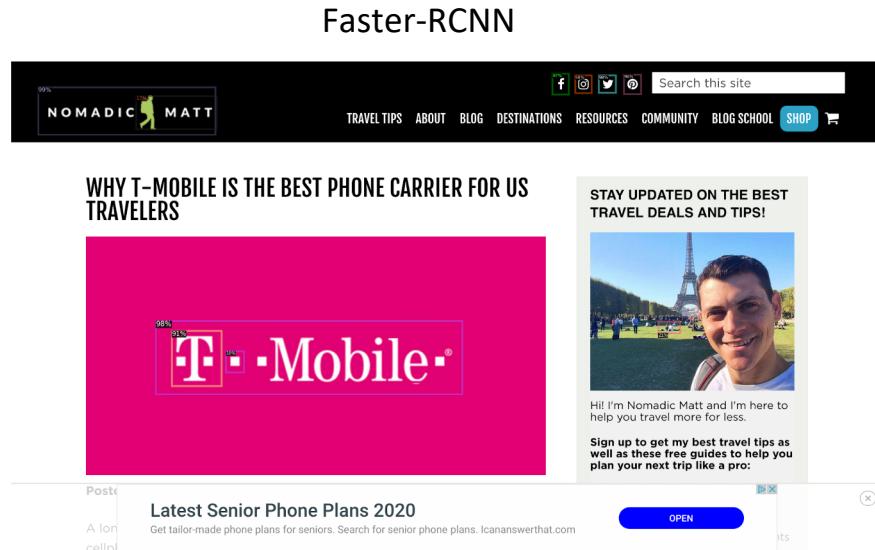


## YOLOv3 - SPP / YOLOv5 - Large

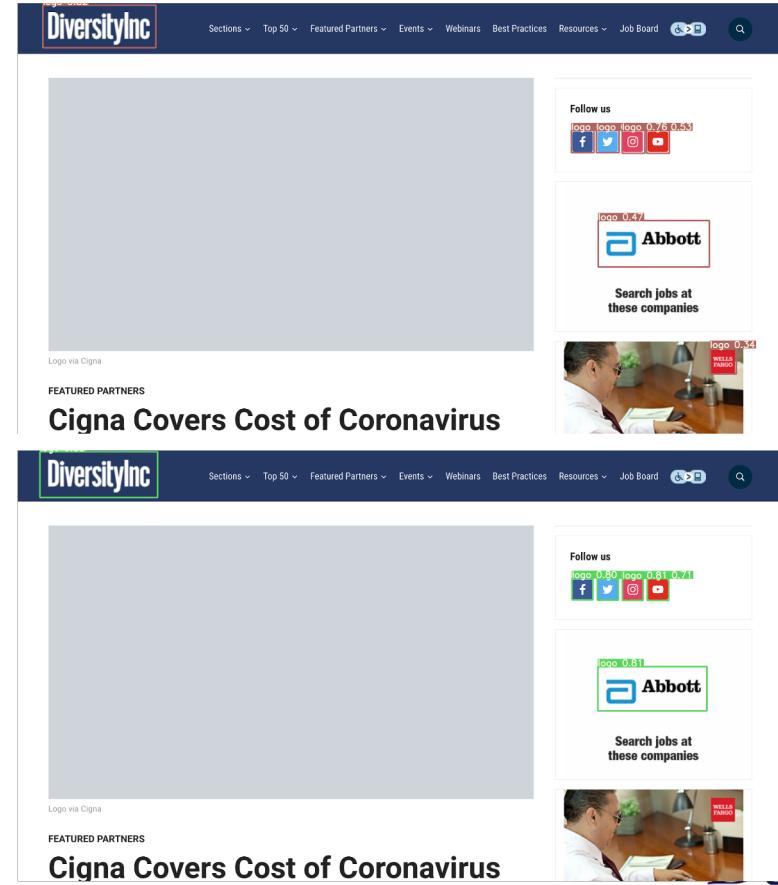
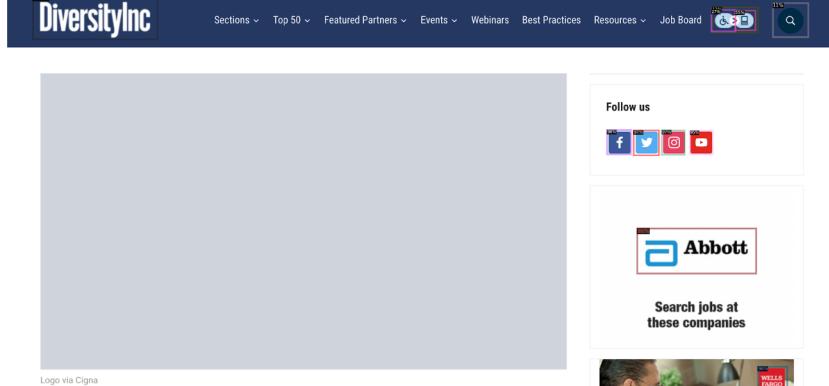


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## YOLOv3 - SPP / YOLOv5 - Large



## YOLOv3 - SPP / YOLOv5 - Large



## YOLOv3 - SPP / YOLOv5 - Large



ke

# YOLOv3 - SPP / YOLOv5 - Large

## Faster-RCNN

The screenshot shows a web page for Robert Half. At the top left is the logo "rn Robert Half". To its right are search and navigation buttons: "Contact us", "Search jobs", "Request talent", and language links "JA | EN". Below this is a breadcrumb navigation: "Employers > Jobseekers > Expertise and Advice >". The main headline "The right role, the right person, the right fit." is displayed in a large, bold font. Below it is a photograph of a woman working at a desk with a computer monitor showing a video call interface. Two red rectangular boxes highlight specific UI elements: one over the "REQUEST TALENT" button and another over the "SEARCH JOBS" button.

### Recruitment specialists and employment services

As a leading recruitment agency in Japan, Robert Half connects highly skilled candidates with employers in temporary and permanent positions, for a variety of fields including accounting, finance, financial services and technology. Whether you're looking for your next career opportunity or looking to hire new talent,

This screenshot shows the same Robert Half page but with UI element detection results overlaid. Red boxes labeled "logo 0.35" and "rn Robert Half®" highlight the logo area. Other boxes labeled "Employers", "Jobseekers", "Expertise and Advice", and "JA | EN" highlight the breadcrumb and language links. A large red box labeled "The right role, the right person, the right fit." highlights the main headline. Below the headline is a photograph of a woman at a desk with a computer monitor showing a video call. Two red rectangular boxes highlight the "REQUEST TALENT" and "SEARCH JOBS" buttons.

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This screenshot shows the same Robert Half page with UI element detection results. Red boxes labeled "logo 0.67" and "rn Robert Half®" highlight the logo area. Other boxes labeled "Employers", "Jobseekers", "Expertise and Advice", and "JA | EN" highlight the breadcrumb and language links. A large red box labeled "The right role, the right person, the right fit." highlights the main headline. Below the headline is a photograph of a woman at a desk with a computer monitor showing a video call. Two red rectangular boxes highlight the "REQUEST TALENT" and "SEARCH JOBS" buttons.

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## YOLOv3 - SPP / YOLOv5 - Large

WORLDVECTORLOGO

ALPHABETICAL MOST DOWNLOADED + ADD LOGO

For example: Facebook, Tesla or Coca Cola



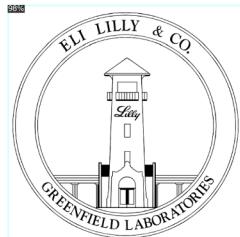
## Faster-RCNN

WORLDVECTORLOGO

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For example: Facebook, Tesla or Coca Cola

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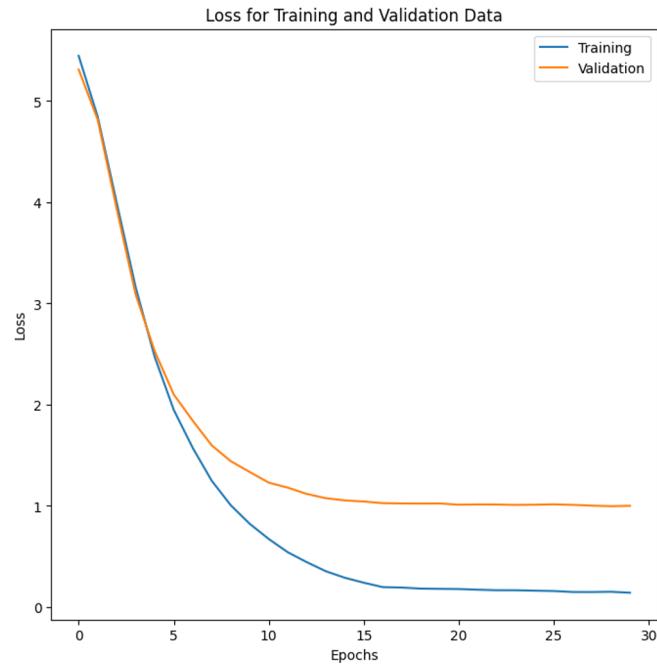
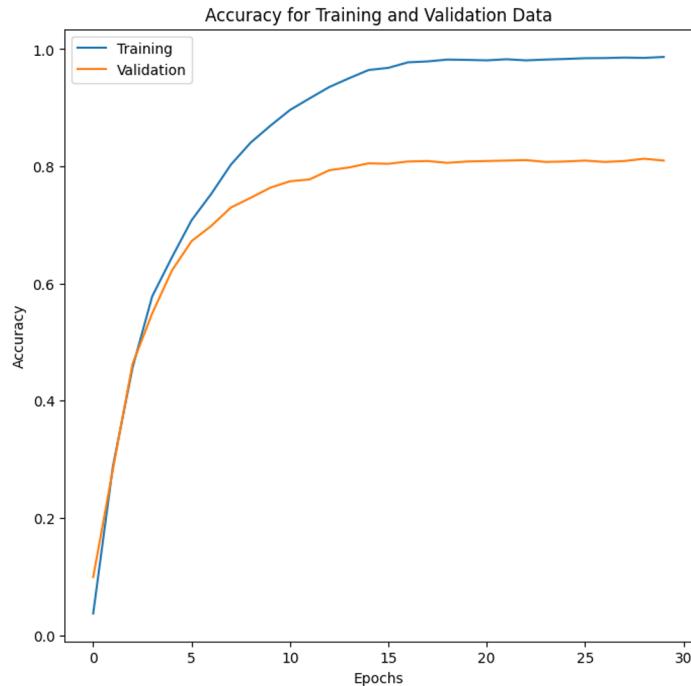
# Phase 2: Logo Classification

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# Preliminary Logo Classification Model

- EfficientNetB0 using timm library and Pytorch
- Hyperparameters
  - Learning rate: 1e-4
  - Epochs: 30
- Data Augmentation
  - RandomCrop, ColorJitter, RandomRotation(90 degrees)
- 261 classes
  - Approximately 20 logos per class (split 15 training, 5 validation)
  - Internet, financial, payment systems
- Metrics of best model
  - Accuracy
    - Training: 98.51%
    - Validation: 81.3%

# Accuracy and Loss Curves



# Correctly Predicted Test Images



**WIKIPEDIA**  
The Free Encyclopedia  
*luke*

# Incorrectly Predicted Test Images



Baidu



Behance



Citigroup



Citibank

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# Potential Sources of Misclassification

- Some classes have many unrepresentative images
  - i-Account Money Platform
    - None of the collected logos are of the proper logo
- Classes with nearly identical logos (essentially repeated classes)
  - Citi, Citigroup, Citibank
  - PricewaterhouseCoopers, PwC
- Model architecture, hyperparameter, data augmentation, optimizer
  - Explore further

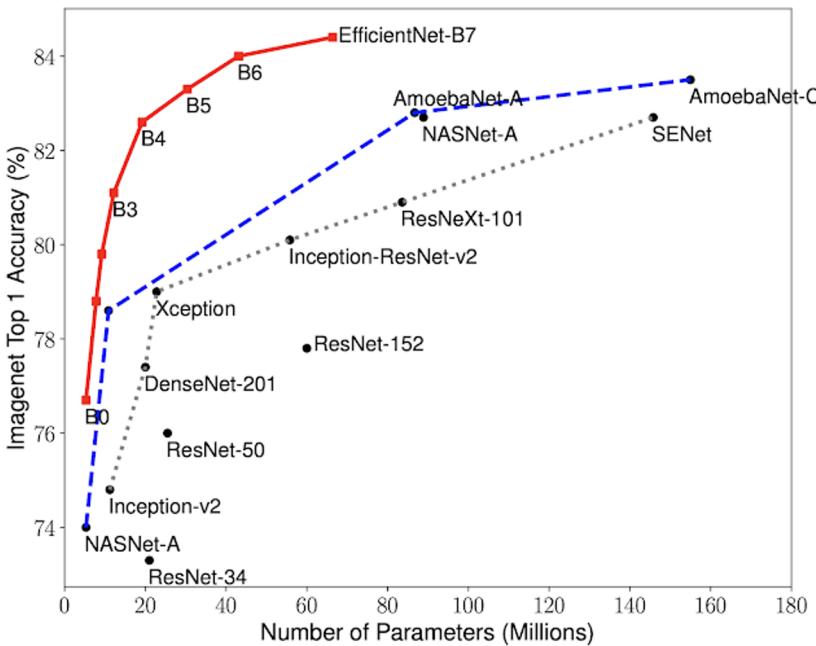
# Next Steps

- Reduce overfitting
- Obtain more metrics
- Adjust dataset to remove unrepresentative images
  - Remove repetition between classes
- Experiment with other architectures
  - Adjust hyperparameter settings
  - Additional data augmentation
- Open-set learning

# Appendix

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# EfficientNet B0



Model	Top-1 Acc.	Top-5 Acc.	#Params	Ratio-to-EfficientNet	#FLOPs	Ratio-to-EfficientNet
<b>EfficientNet-B0</b>	<b>77.1%</b>	<b>93.3%</b>	<b>5.3M</b>	<b>1x</b>	<b>0.39B</b>	<b>1x</b>
ResNet-50 (He et al., 2016)	76.0%	93.0%	26M	4.9x	4.1B	11x
DenseNet-169 (Huang et al., 2017)	76.2%	93.2%	14M	2.6x	3.5B	8.9x
<b>EfficientNet-B1</b>	<b>79.1%</b>	<b>94.4%</b>	<b>7.8M</b>	<b>1x</b>	<b>0.70B</b>	<b>1x</b>
ResNet-152 (He et al., 2016)	77.8%	93.8%	60M	7.6x	11B	16x
DenseNet-264 (Huang et al., 2017)	77.9%	93.9%	34M	4.3x	6.0B	8.6x
Inception-v3 (Szegedy et al., 2016)	78.8%	94.4%	24M	3.0x	5.7B	8.1x
Xception (Chollet, 2017)	79.0%	94.5%	23M	3.0x	8.4B	12x
<b>EfficientNet-B2</b>	<b>80.1%</b>	<b>94.9%</b>	<b>9.2M</b>	<b>1x</b>	<b>1.0B</b>	<b>1x</b>
Inception-v4 (Szegedy et al., 2017)	80.0%	95.0%	48M	5.2x	13B	13x
Inception-resnet-v2 (Szegedy et al., 2017)	80.1%	95.1%	56M	6.1x	13B	13x
<b>EfficientNet-B3</b>	<b>81.6%</b>	<b>95.7%</b>	<b>12M</b>	<b>1x</b>	<b>1.8B</b>	<b>1x</b>
ResNet-101 (Xie et al., 2017)	80.9%	95.6%	84M	7.0x	32B	18x
PolyNet (Zhang et al., 2017)	81.3%	95.8%	92M	7.7x	35B	19x
<b>EfficientNet-B4</b>	<b>82.9%</b>	<b>96.4%</b>	<b>19M</b>	<b>1x</b>	<b>4.2B</b>	<b>1x</b>
SENet (Hu et al., 2018)	82.7%	96.2%	146M	7.7x	42B	10x
NASNet-A (Zoph et al., 2018)	82.7%	96.2%	89M	4.7x	24B	5.7x
AmoebaNet-A (Real et al., 2019)	82.8%	96.1%	87M	4.6x	23B	5.5x
PNASNet (Liu et al., 2018)	82.9%	96.2%	86M	4.5x	23B	6.0x
<b>EfficientNet-B5</b>	<b>83.6%</b>	<b>96.7%</b>	<b>30M</b>	<b>1x</b>	<b>9.9B</b>	<b>1x</b>
AmoebaNet-C (Cubuk et al., 2019)	83.5%	96.5%	155M	5.2x	41B	4.1x
<b>EfficientNet-B6</b>	<b>84.0%</b>	<b>96.8%</b>	<b>43M</b>	<b>1x</b>	<b>19B</b>	<b>1x</b>
<b>EfficientNet-B7</b>	<b>84.3%</b>	<b>97.0%</b>	<b>66M</b>	<b>1x</b>	<b>37B</b>	<b>1x</b>
GPipe (Huang et al., 2018)	84.3%	97.0%	557M	8.4x	-	-

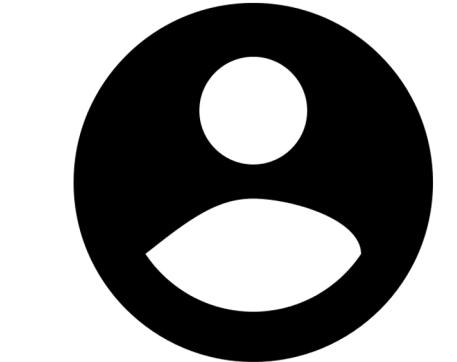
We omit ensemble and multi-crop models (Hu et al., 2018), or models pretrained on 3.5B Instagram images (Mahajan et al., 2018).

# Class with Unrepresentative Logos (i-Account)

True Logo



Collected Logos



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# Sample Correct Predictions - eBay



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# Incorrectly Classified Image from Separate but Repetitive Class

Citi logo that was in Citibank class but classified as Citigroup



# ResNet Vs ResNeXt

*Residual Skip Connection*

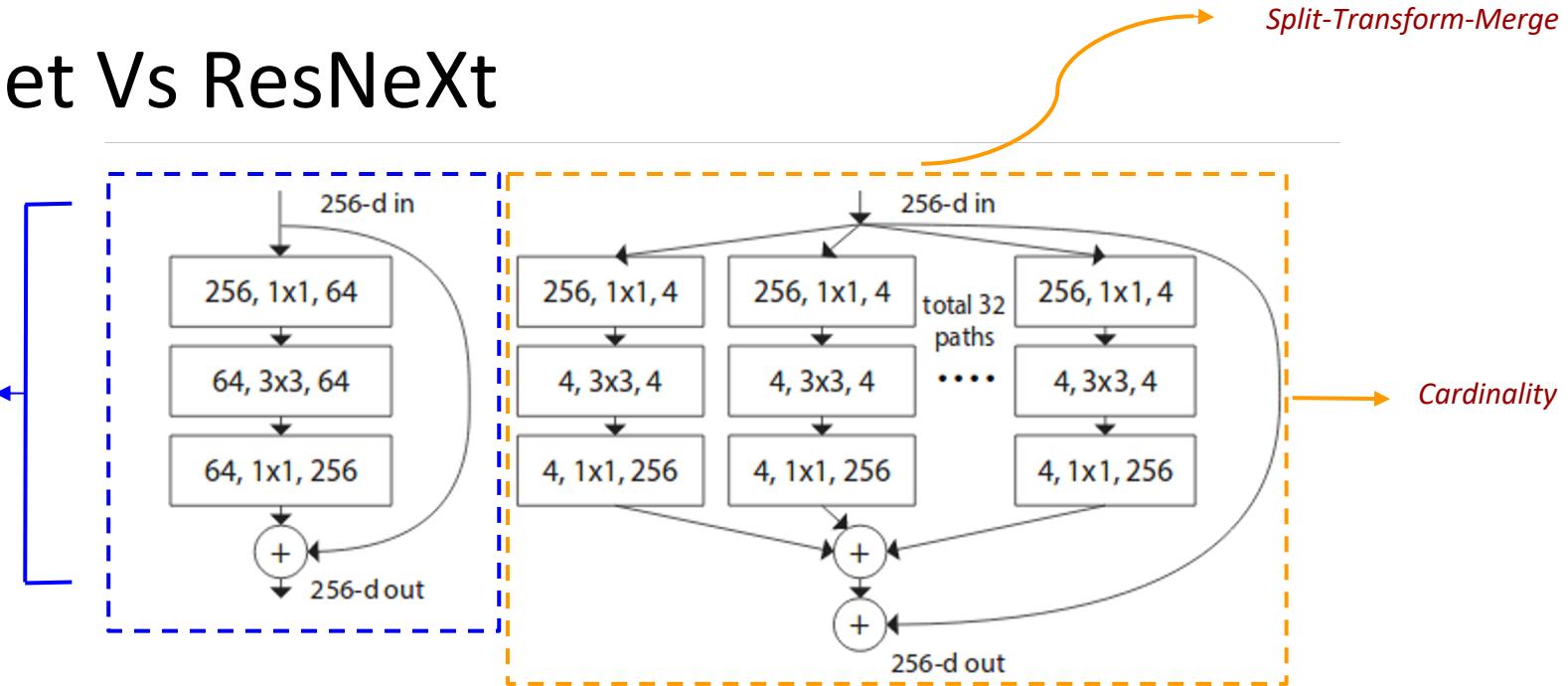
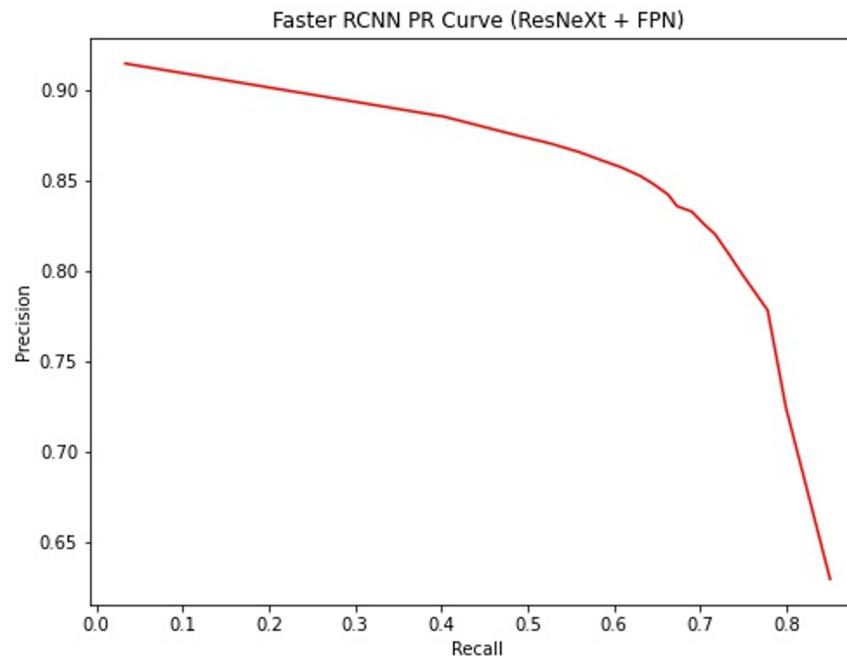


Figure 1. **Left:** A block of ResNet [14]. **Right:** A block of ResNeXt with cardinality = 32, with roughly the same complexity. A layer is shown as (# in channels, filter size, # out channels).

# PR Curve



@ IoU = 0.6

# Feature Pyramidal Network (FPN)

