Proofpoint
Logo Detection & Classification

4th March 2021

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Agenda

- Training Data Re-annotation
- University Webpages (used only to train detector!)
- Model Retraining (Faster RCNN & YOLO) using re-annotated data
- Detector Results and Error Analysis
- Closed-Set Classifier Results
- Open Set Learning Progress (kNN)

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Reannotation

- Double-checked all our annotations
  - Catch missing logos
  - Improve training data quality
- 1100 additional logos captured
- Hopefully, detector performance improves (it does!)

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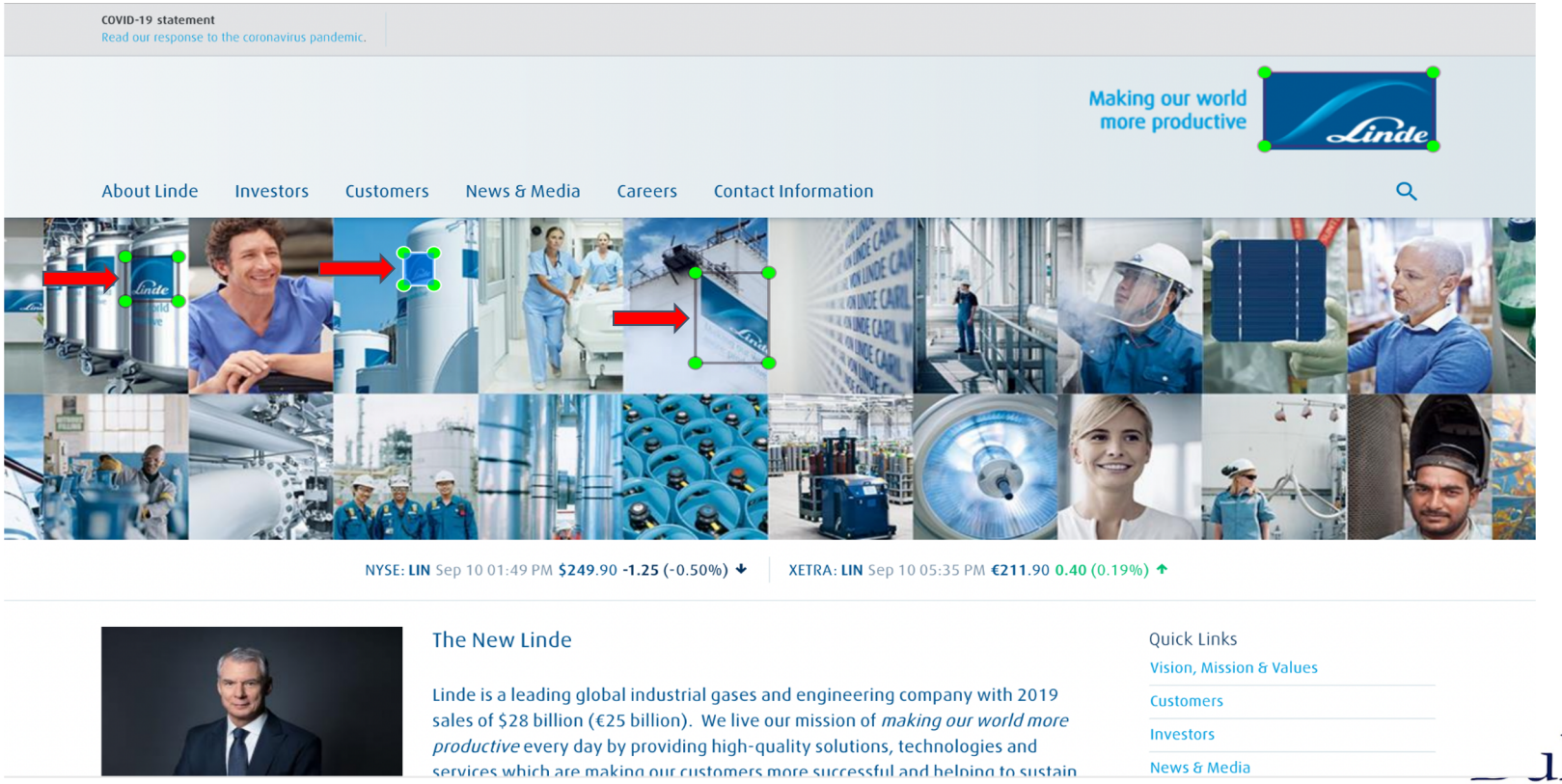
Example


COVID-19 statement
Read our response to the coronavirus pandemic.
Making our world more productive
Linde
About Linde
Investors
Customers
News & Media
Careers
Contact Information
NYSE: LIN Sep 10 01:49 PM $249.90 -1.25 (-0.50%)
XETRA: LIN Sep 10 05:35 PM €211.90 0.40 (0.19%)
The New Linde
Linde is a leading global industrial gases and engineering company with 2019 sales of $28 billion (€25 billion). We live our mission of making our world more productive every day by providing high-quality solutions, technologies and
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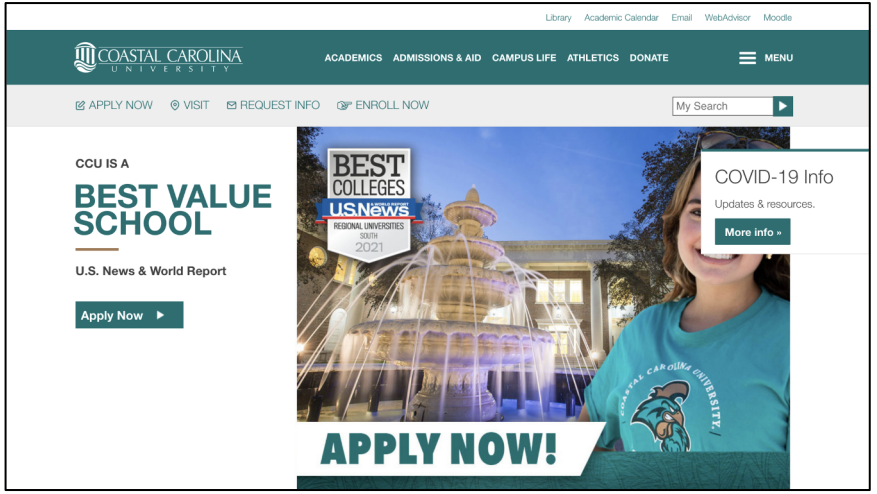
Vision, Mission & Values
Customers
Investors
News & Media

University Webpages

- Scraped ~650 university webpages
- Annotated ~1000 logos
- Retrained RCNN and YOLO on these webpages



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University Screenshots

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MENU
SEARCH
NEWS & EVENTS
APPLY
VISIT
SEE PROGRAMS
JOHNS HOPKINS
UNIVERSITY

See our planning for 2020–21.

Hampshire College

APPLY

FIND

MENU

Disrupting Higher Education for 50 Years.

GIVE


HARVARD
UNIVERSITY
Latest COVID Information
Search
Menu
UNEQUAL
A series on race and inequality in America




The Galleries at CSU Spring 2021 Exhibits

Here There Be Monsters by Laura & Gary Dumm and Glimpses by Evie Zimmer run Feb. 23-April 3

TOURO COLLEGE & UNIVERSITY SYSTEM

Where Knowledge and Values Meet

TOURO*One*

Touro Application

We Are Touro

For Questions on Admissions, email: apply.admissions@touro.edu

We offer this Web-based application in hopes that it will make our application process as easy and convenient as possible for you. You can get started right now and won't have to wait for us to mail you a package. With very few notable exceptions, Touro applications can only be submitted electronically.

This application is part of the ApplyYourself Application Network. You will receive a PIN and Password so that you can return to work on your application over several sessions. Your information is transmitted through a secured server and is kept confidential until you submit your application. Only after you submit your application will it be available for review by our admissions staff.

When you have completed your application and are ready to submit it, you can pay your application fees via credit card online. Applications cannot be submitted or processed until the fee is paid or waived.

Please carefully read the instructions that appear throughout the application pages. You can only submit your application one time. If you have updates to any information you have submitted, please notify the admissions office at once.

To get started on your application, create an account to the right.

If you have previously submitted a Touro Application, you would be required to create a new account with a unique PIN for that application. Please select the Create Account tab on the right to begin this process. (Each school, program or location in Touro Apply Yourself requires a separate application even within the same semester.)

Best of luck. We look forward to reviewing your application.

Create Account | User Login

Please input your login information below to open your application.

PIN

Password

login

Forgot your PIN or password?

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For the latest COVID-19 news, plans, and resources, please visit covid.iu.edu.

Faster RCNN - Data Augmentation

- Data Augmentation code incorporated
  - Brightness
  - Contrast
  - Rotation
  - Flip

- ResNeXt 101 + FPN **->** Not enough GPU

- ResNet 50 + FPN **->** Works! **->** Very Poor Performance

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Exploring Options

Duke UNIVERSITY RESEARCH COMPUTING

Max 16 GB :(

$100

Google Cloud

$300

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Error Analysis

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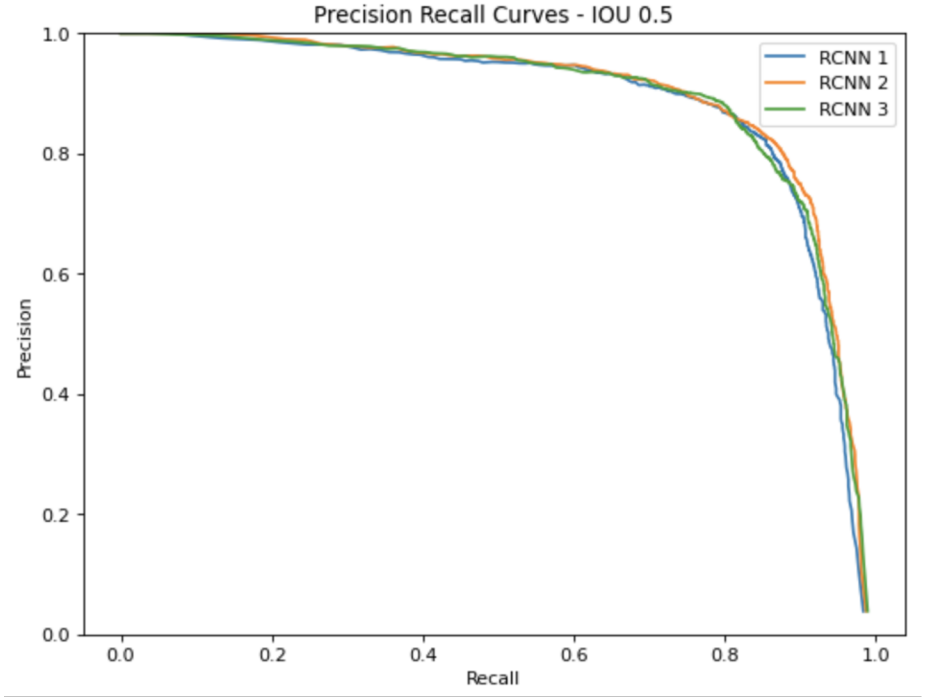
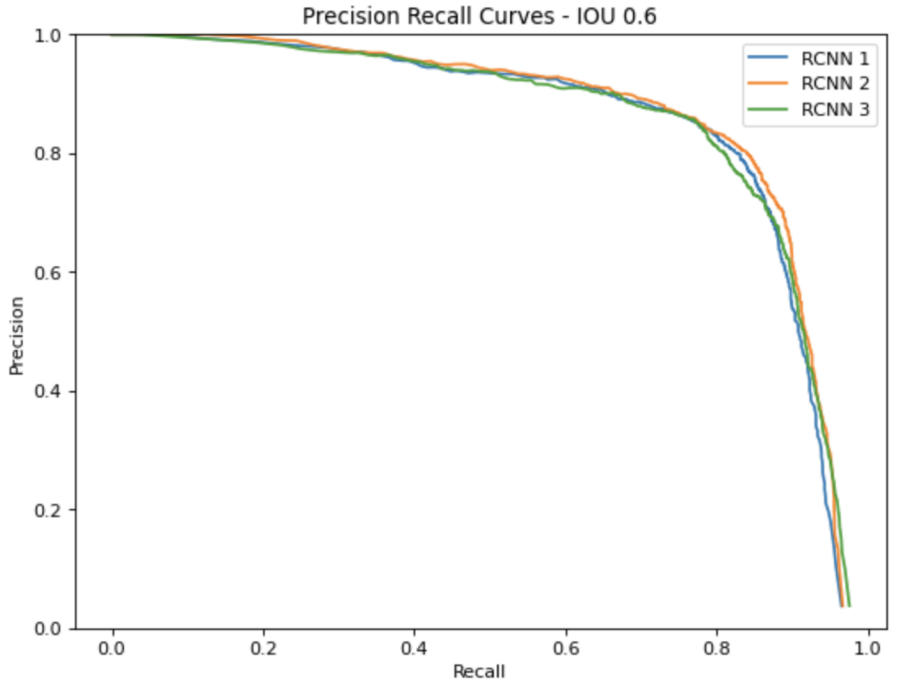

Precision Recall Curves - IOU 0.5
RCNN 1
RCNN 2
RCNN 3
Precision
Recall
0.0
0.2
0.4
0.6
0.8
1.0


Precision Recall Curves - IOU 0.6
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RCNN 2
RCNN 3
Precision
Recall
0.0
0.2
0.4
0.6
0.8
1.0

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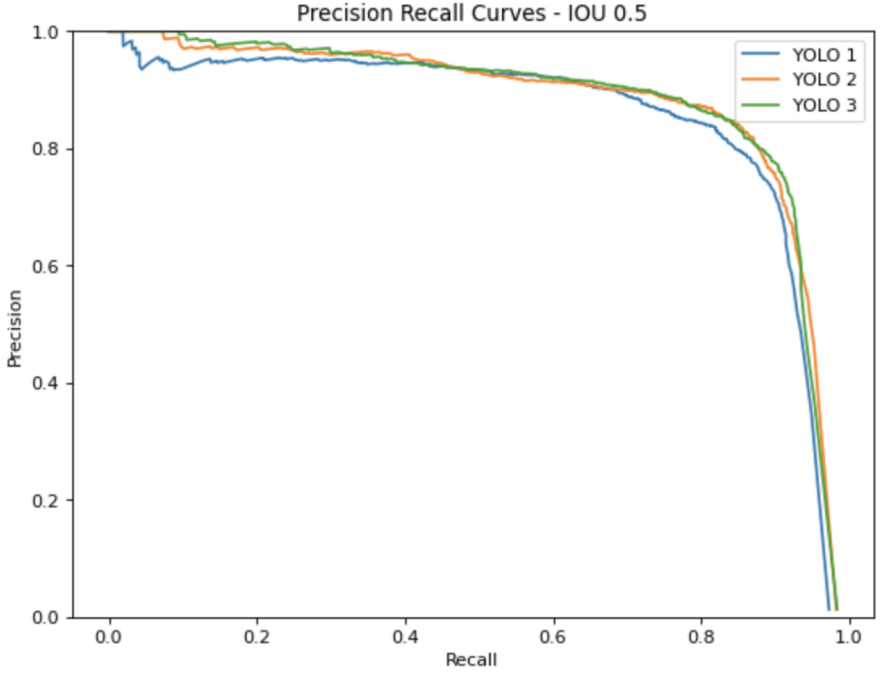
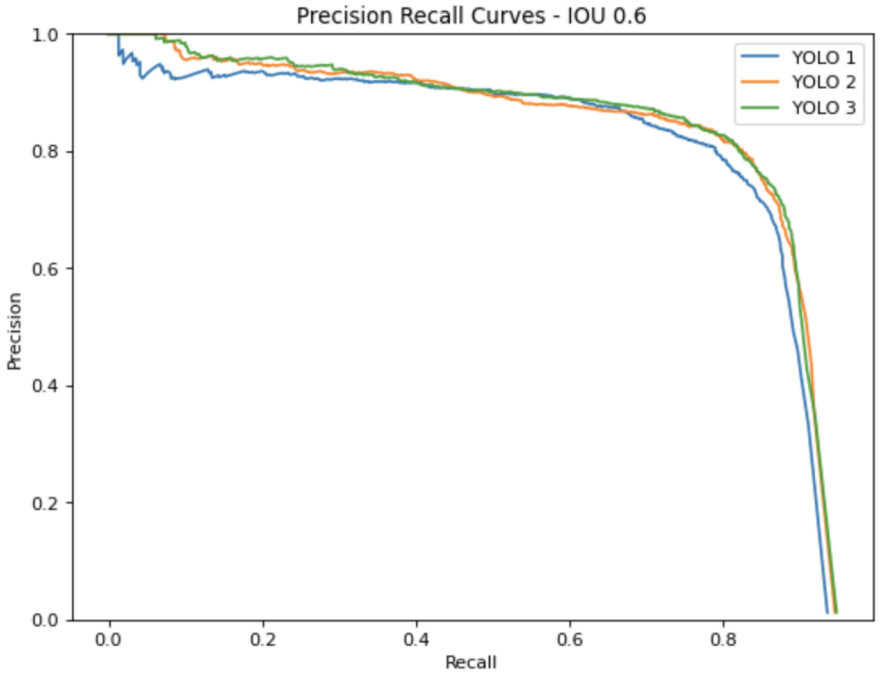

Precision Recall Curves - IOU 0.5
YOLO 1
YOLO 2
YOLO 3
Precision
Recall
0.0
0.2
0.4
0.6
0.8
1.0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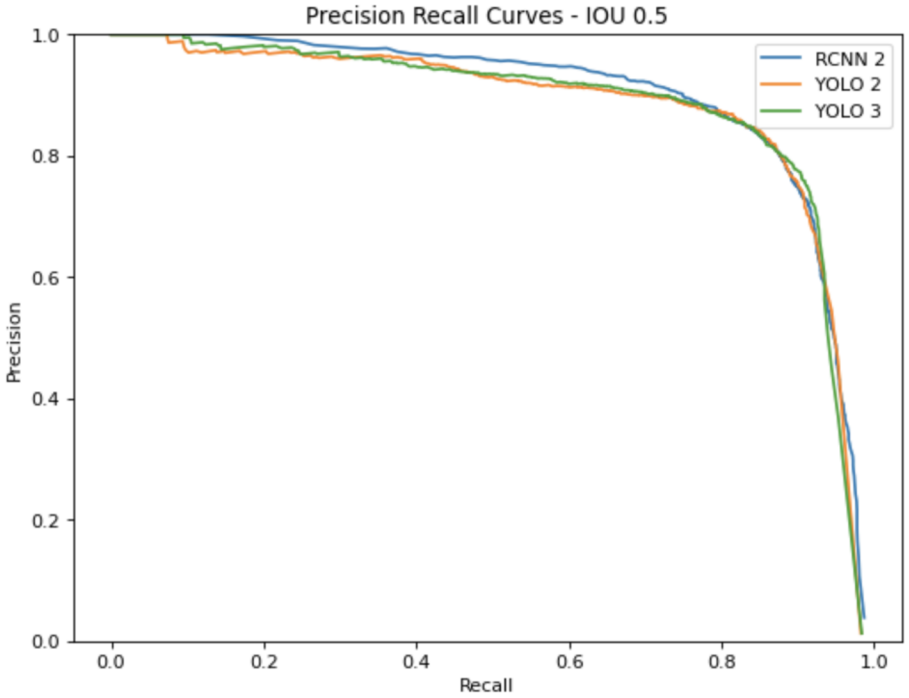
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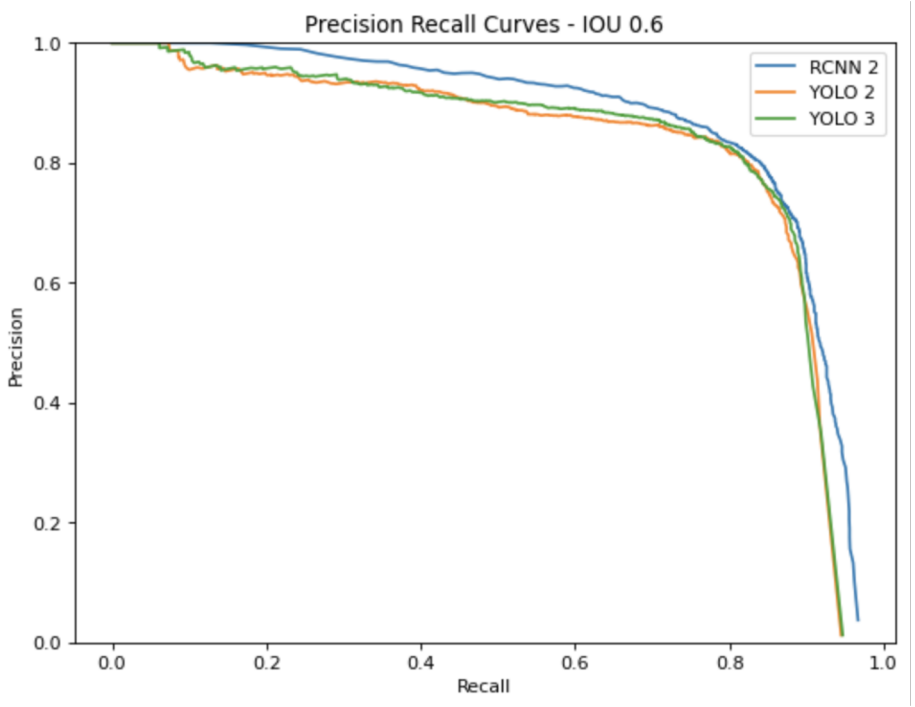
0.8
1.0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Recall
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0

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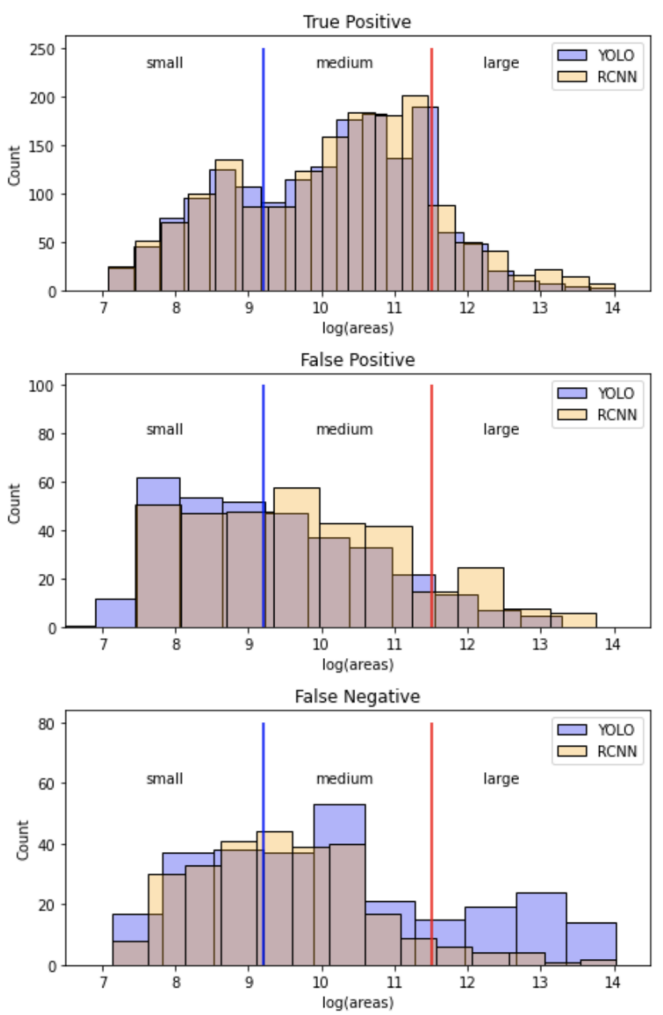
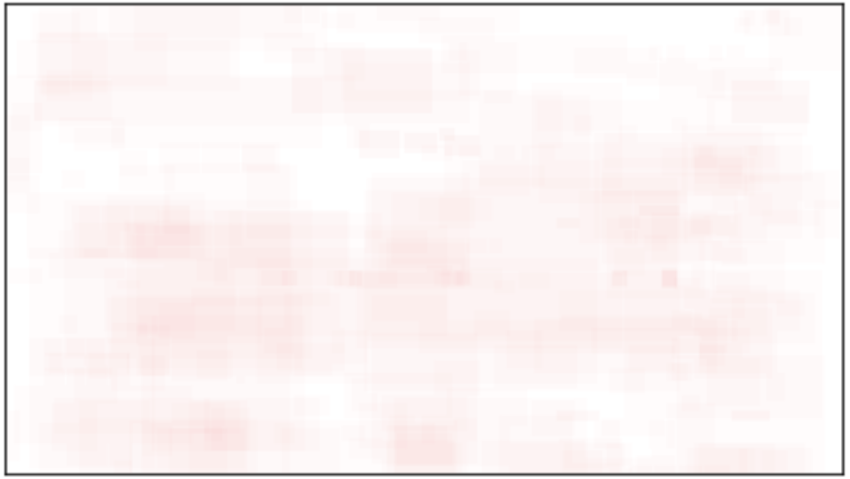
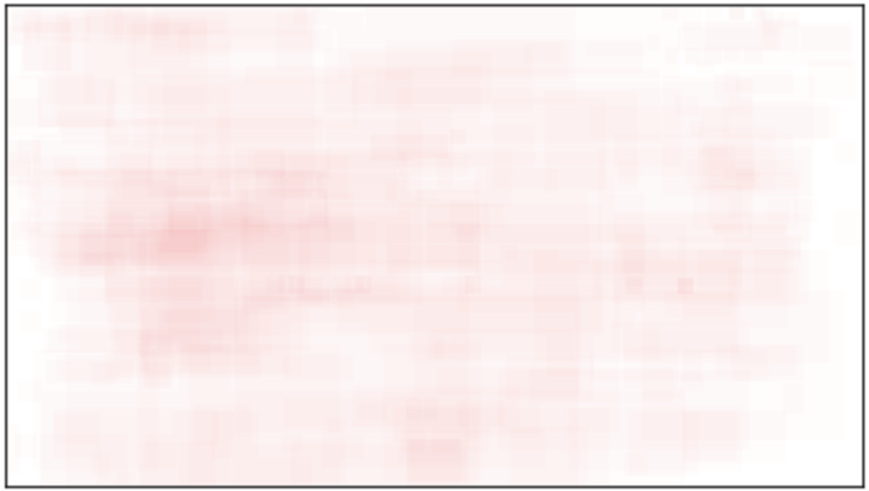
- YOLO struggles with larger logos.
- Faster RCNN is more prone to false positives.



YOLO False-Positives



RCNN False-Positives



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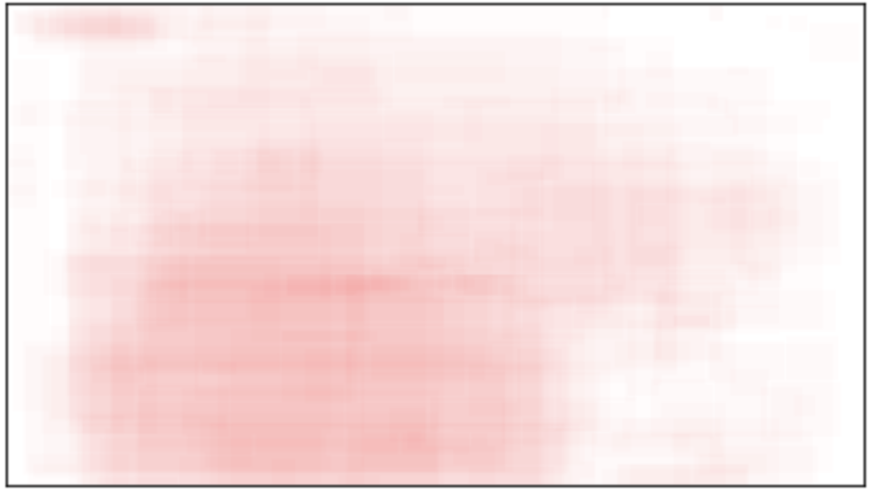
YOLO False-Negatives



Faster-RCNN False-Negatives

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Faster RCNN - Retraining

- Precision at Recall of 0.87 and **IOU 0.5**

	V1	**V2**	**V3**
Faster-RCNN	0.787	0.812	0.770
YOLO-v3	0.776	0.818	0.809
Ensemble	**0.82**	**0.844**	**0.8717**

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Faster RCNN - Retraining

- Precision at Recall of 0.87 and **IOU 0.6**

	Iteration 1	**Iteration 2**	**Iteration 3**
Faster-RCNN	0.702	**0.730**	0.695
YOLO-v3	0.661	0.708	**0.724**
Ensemble	**0.760**	**0.800**	**0.805**

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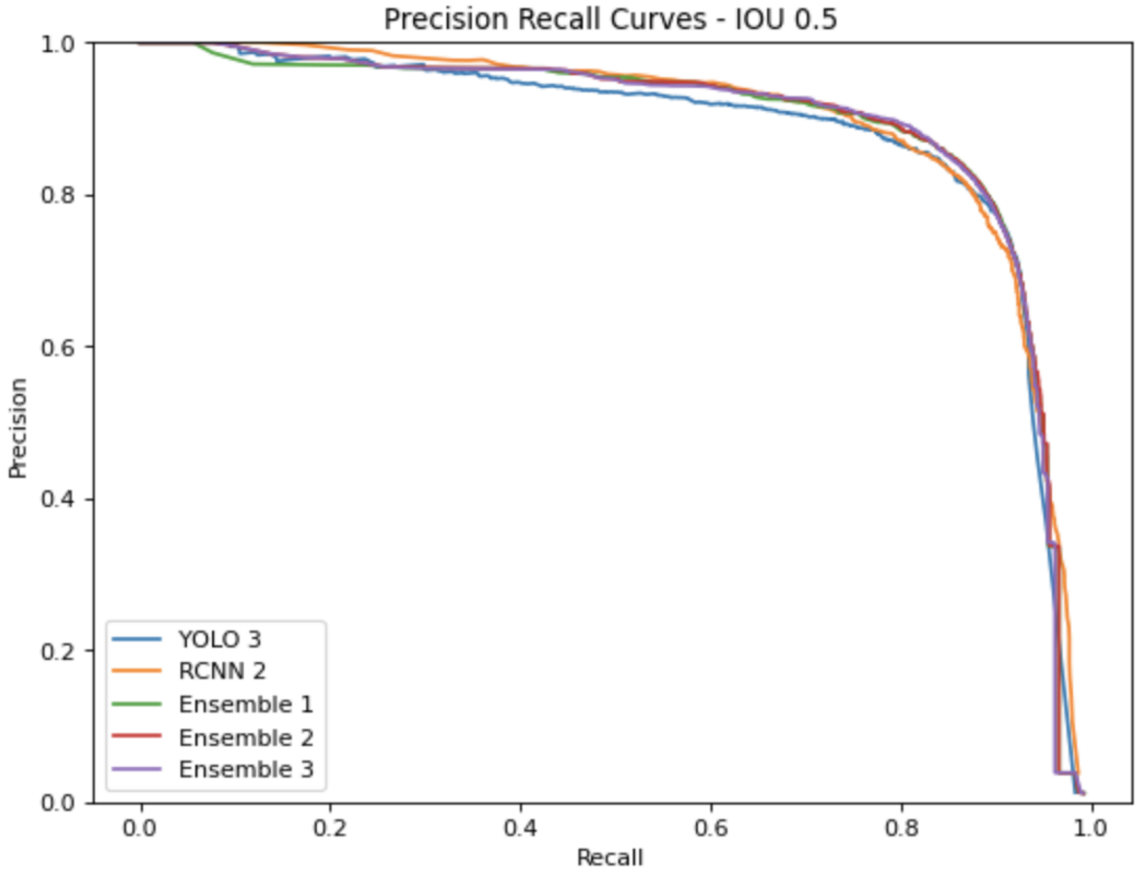
Ensemble 1: RCNN2 + YOLO2

Ensemble 2: RCNN2 + YOLO3

Ensemble 3: RCNN3 + YOLO3



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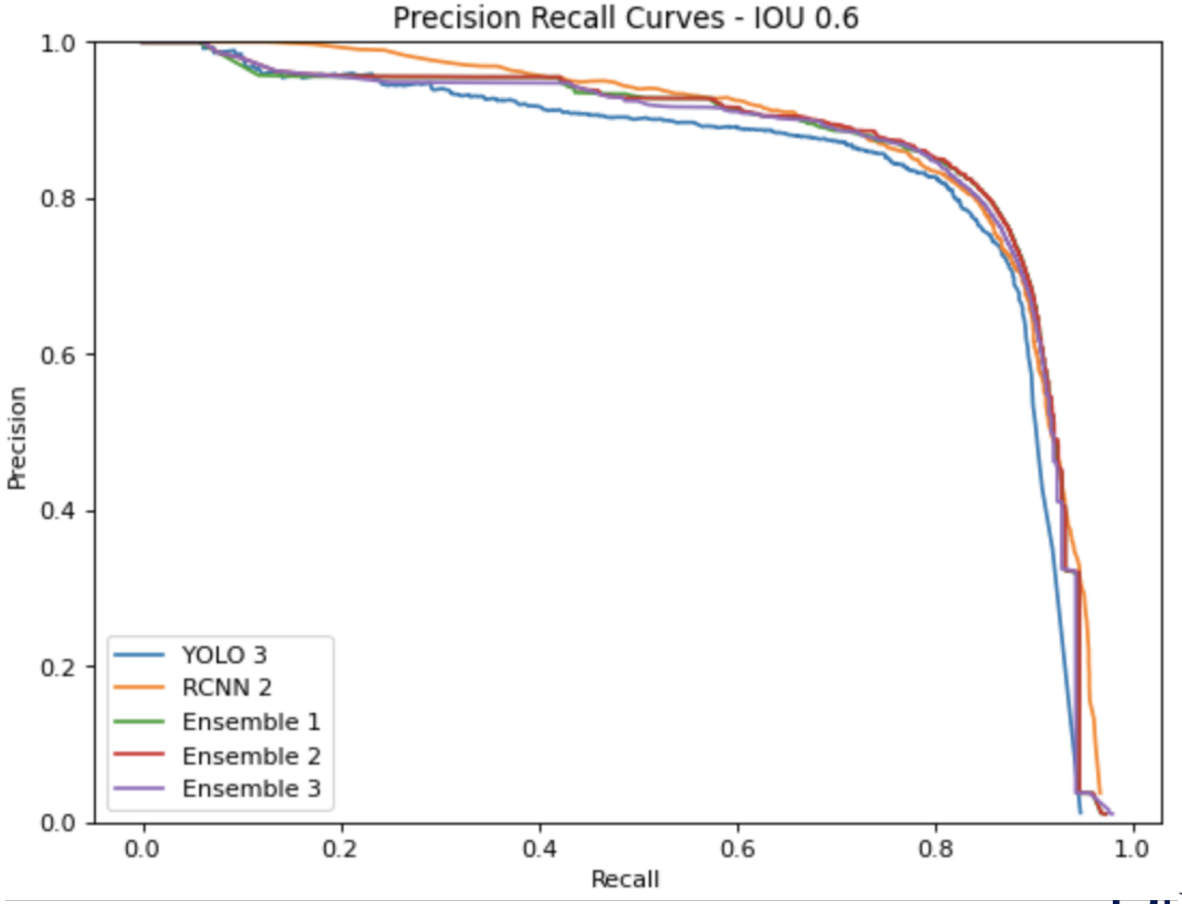
Ensemble 1: RCNN2 + YOLO2

Ensemble 2: RCNN2 + YOLO3

Ensemble 3: RCNN3 + YOLO3



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False Positives of Ensemble

Category 1

Category 2

Category 3

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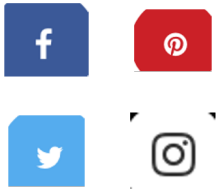
False Negatives of Ensemble

Category 1

Category 2

Category 3

Category 4



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Images with No Logos

- YOLO found logos on 24% of images, finding 1.56 logos per image.

- RCNN found logos on 43% of images, finding 1.75 logos per image.

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Logo Classifier

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Classifier Updates

- Combined Bing images with extracted annotations from training data
  - Note: before annotations were updated
- Most common classes of train and test annotations (excluding generic logo)
  - Facebook, Twitter, Instagram, Wikipedia, Youtube, Pinterest, LinkedIn, Wikimedia Commons, Google Plus
    - Random sample of 30 annotations added to training dataset
- 1098 classes
  - Added more S&P 500 to improve coverage
  - 12848 train, 4655 validation
  - No “unknown” class
- Trained both EfficientNetB0 and B3
  - B3 showed improved performance

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EfficientNetB3 Results on Val and Test Sets

	Accuracy	Precision	Recall	F1-Score	Support
Val	0.9386	0.9496	0.9386	0.9362	4655
Test	0.9373	0.9780	0.9373	0.9532	1165

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Closed-Set Classifier

- 32 classes plus unknown
  - More than 5 samples in test set
  - Train/val data a mix of Bing images and extracted train annotations
- Unknown class
  - Randomly sampled from generic logos and YOLO false positives
    - Train and test
  - Removed any images representative of the other 32 classes
  - Generally diverse but some similar samples (Cision, MotleyFool)
- Two EfficientNetB3 Models
  - Trained on 32 classes
  - Trained on 32 classes plus unknown

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Examples of “Unknowns”

Different Classes

businesswire
A BERKSHIRE HATHAWAY COMPANY

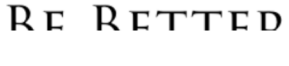
CISION
PR Newswire

BRITA

The Motley Fool

E*TRADE
FINANCIAL

Non-Logos



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Closed-Set Classifier Performance

	Accuracy	Precision	Recall	F1-Score	Support
Without Unknown	0.9532	0.9613	0.9532	0.9543	706
With Unknown	0.8950	0.9120	0.8950	0.8978	886

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Predictions on Unknown Test Class

Correct Predictions

Cardiovascular News

basis

BIRDWELL CLINIC
Healthcare Centre

TECH CHARTS
Research & Trading

CISION
PR Newswire

Incorrect Predictions

 ⇨ squarespace

IWF Internet Watch Foundation ⇨ pinterest

 ⇨ wikimedia_commons

 ⇨ cdw

HEFF ⇨ cdw

Cerner ⇨ otis_worldwide

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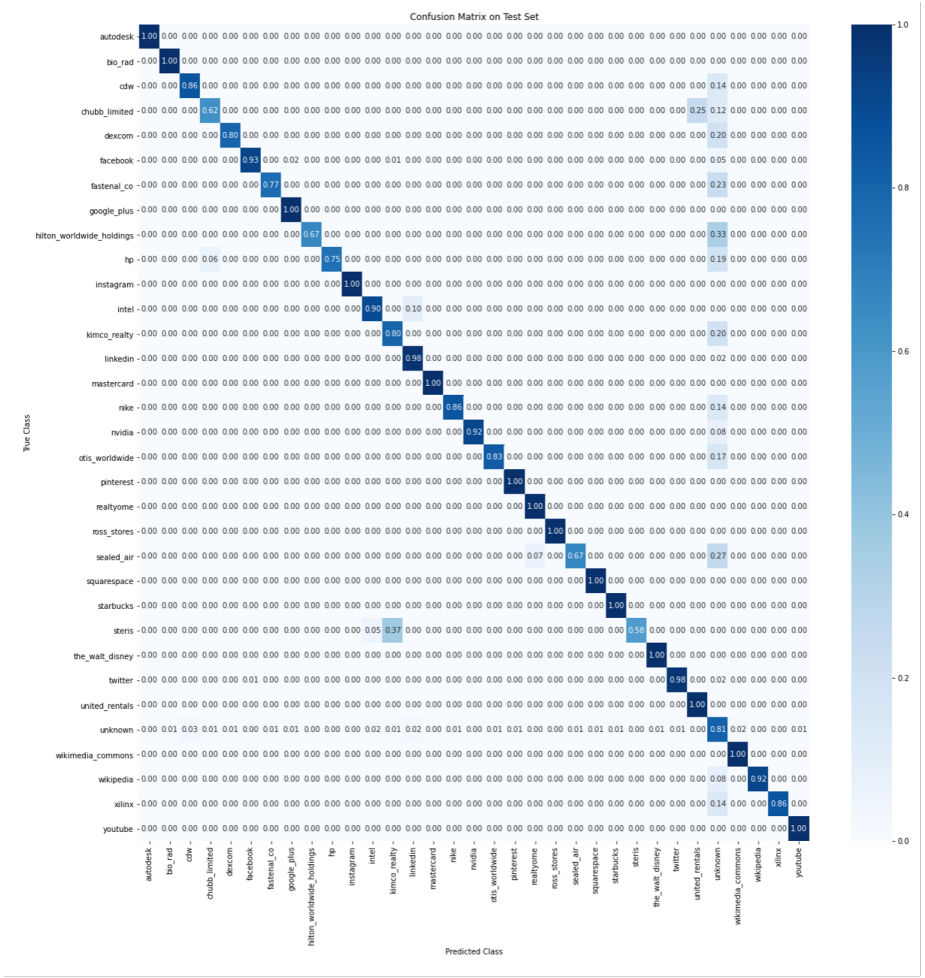
Confusion Matrix on Test Set
True Class
Predicted Class
autodesk
bio_rad
cdw
chubb_limited
dexcom
facebook
fastenal_co
google_plus
hilton_worldwide_holdings
hp
instagram
intel
kimco_realty
linkedin
mastercard
nike
nvidia
otis_worldwide
pinterest
realtyome
ross_stores
sealed_air
squarespace
starbucks
steris
the_walt_disney
twitter
united_rentals
unknown
wikimedia_commons
wikipedia
xilinx
youtube
1.0
0.8
0.6
0.4
0.2
0.0

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Open Set Learning

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KNN Based Open Set Learning

- Purely Experimental
- Implementing: Nearest Neighbors Distance Ratio Open-Set Classifier

a. Do KNN with 2 nearest neighbors based on Activation Vectors.

b. If neighbors agree, classify as predicted.

c. Otherwise calculate ratio:
   T = distance to closest neighbor / distance to second neighbor

d. If T < threshold, classify as closest neighbor, otherwise classify as unknown.

e. Choose threshold based on prediction accuracy.

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General KNN Statistics

- 88.7% base closest neighbor accuracy. 88.08% weighted average accuracy.
- 86.5% of known logos have first 2 neighbors matching.
- 35.8% of unknown logos had first 2 neighbors matching

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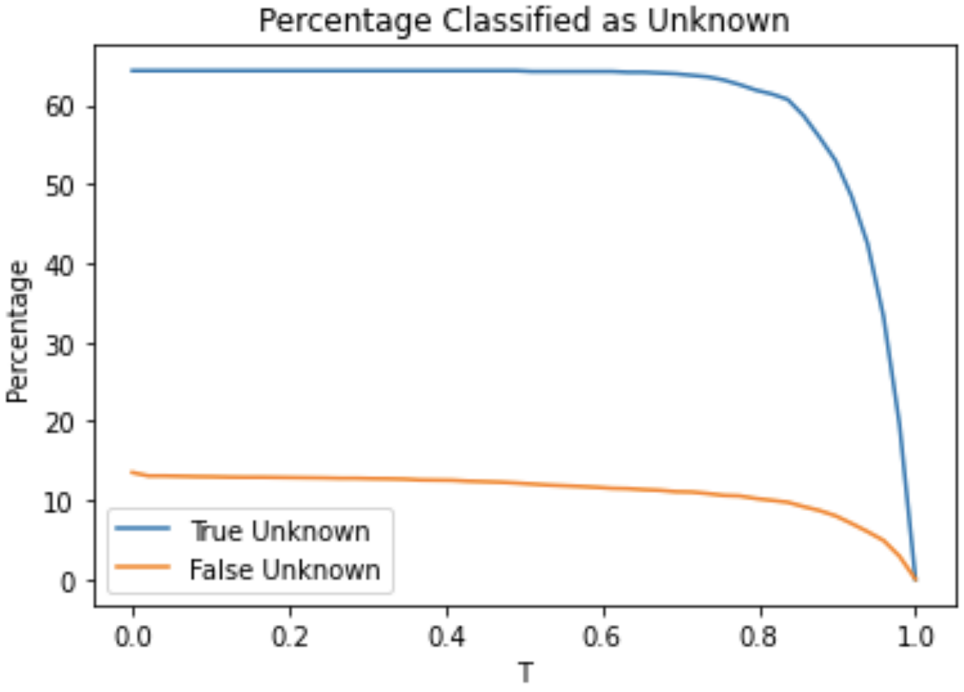
Preliminary Results

- 61.4% of unknown correctly classified as unknown.
- 9.99% of known incorrectly classified as unknown.
- Accuracy for known logos is 85.67%; weighted average of 84.87%.
- Accuracy (including unknown) is 81.3%.



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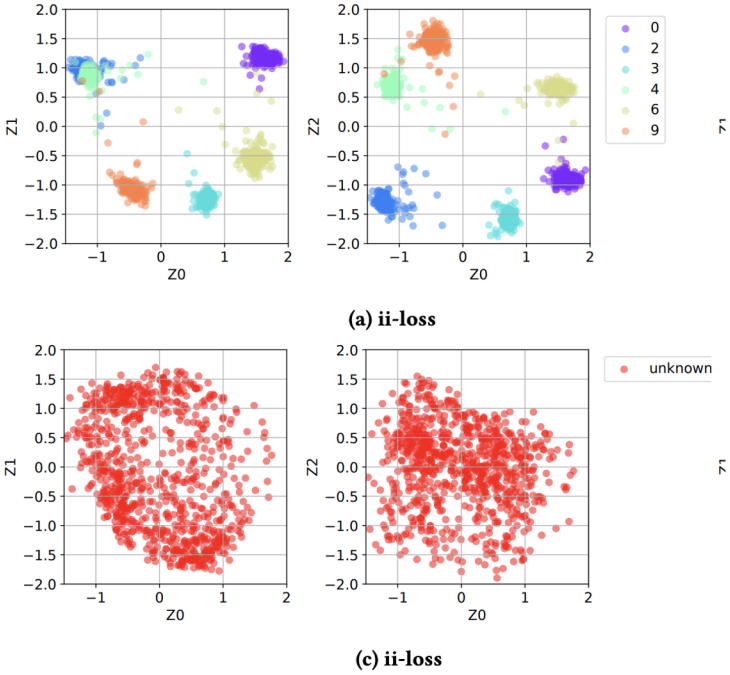
Possible Improvements

- Implement: Learning a Neural-network-based Representation for Open Set Recognition.
- Want to maximize chances of neighbors being same class for known logos.
- Increase distance between classes so T threshold can siphon out more unknowns. Possibly make use of distance threshold too.
- Use loss function to train classifier to put known classes far apart. Maximize class clustering around MAV.



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Appendix

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	brand	precision	recall	f1-score	support
0	unknown	0.793478	0.811111	0.802198	180.0
1	twitter	0.991736	0.975610	0.983607	123.0
2	facebook	0.991071	0.925000	0.956897	120.0
3	wikipedia	1.000000	0.916667	0.956522	84.0
4	linkedin	0.927536	0.984615	0.955224	65.0
5	pinterest	0.978261	1.000000	0.989011	45.0
6	youtube	0.962963	1.000000	0.981132	26.0
7	chubb_limited	0.882353	0.625000	0.731707	24.0
8	steris	1.000000	0.578947	0.733333	19.0
9	instagram	1.000000	1.000000	1.000000	18.0
10	hp	1.000000	0.750000	0.857143	16.0
11	sealed_air	0.909091	0.666667	0.769231	15.0
12	fastenal_co	0.909091	0.769231	0.833333	13.0
13	nvidia	1.000000	0.916667	0.956522	12.0
14	wikimedia_commons	0.785714	1.000000	0.880000	11.0
15	google_plus	0.785714	1.000000	0.880000	11.0
16	intel	0.692308	0.900000	0.782609	10.0
17	mastercard	1.000000	1.000000	1.000000	7.0
18	nike	0.857143	0.857143	0.857143	7.0
19	xilinx	1.000000	0.857143	0.923077	7.0
20	cdw	0.545455	0.857143	0.666667	7.0

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