Using Deep Learning Models to Classify Russian Military Vehicles

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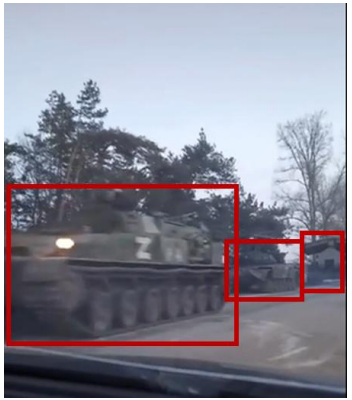
Sponsor:
National Geospatial Agency (NGA)

Problem Statement

- Working with the National Geospatial Agency (NGA) to develop a computer vision model that identifies insignias from images of military vehicles
- Sponsor had the initial goal of labeling insignias, but was unable to obtain/declassify their data
- We moved forward by preparing for two alternative approaches to identify Russian military vehicles (Source: Tuomo Hiippala, University of Helsinki, Finland, Department of Geosciences and Geography)
    - Image Classification
    - Object Detection



Types of Computer Vision Models

Classification

Object Detection

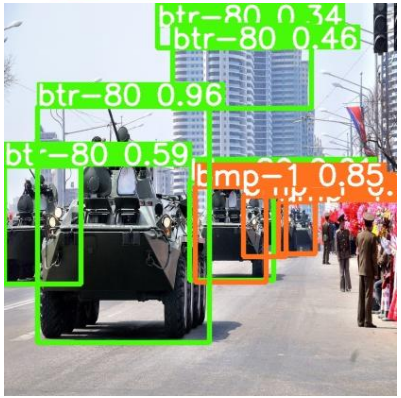
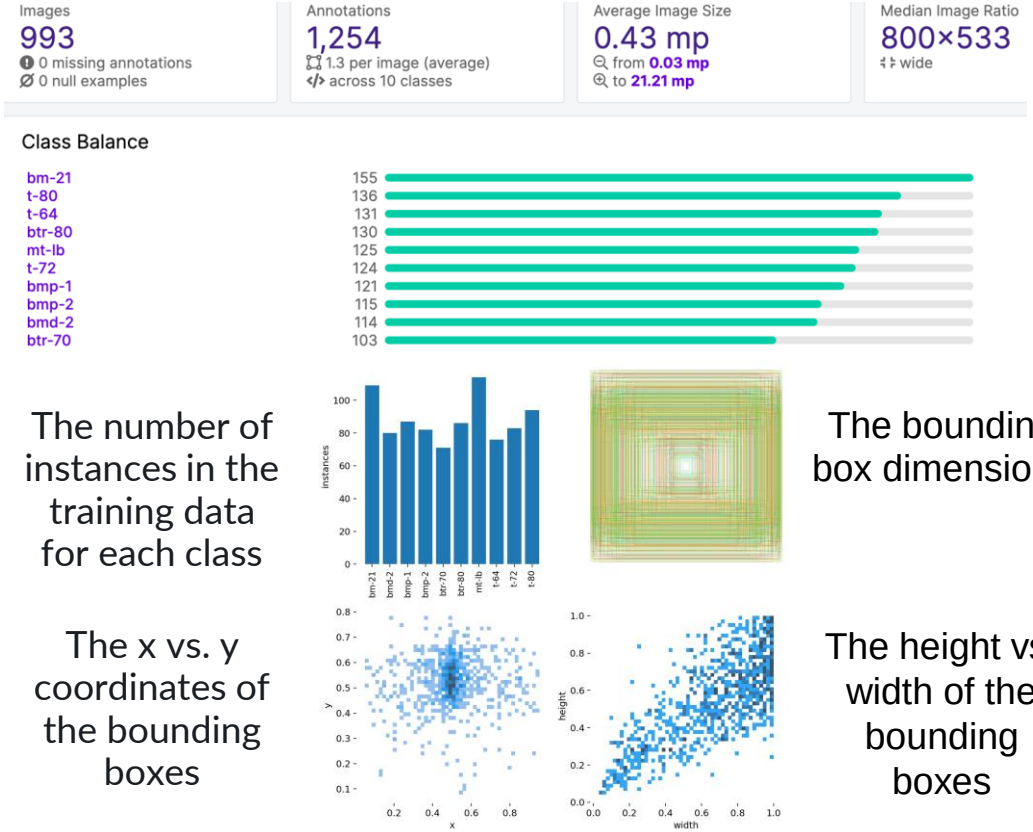


Image classification labels an image as a whole

Object detection assesses specific regions of an image that are identified within bounding boxes

- ResNet50 is used for image classification
- YOLOv5 is used for object detection

Data, Data Prep, and Exploratory Analysis



The number of instances in the training data for each class

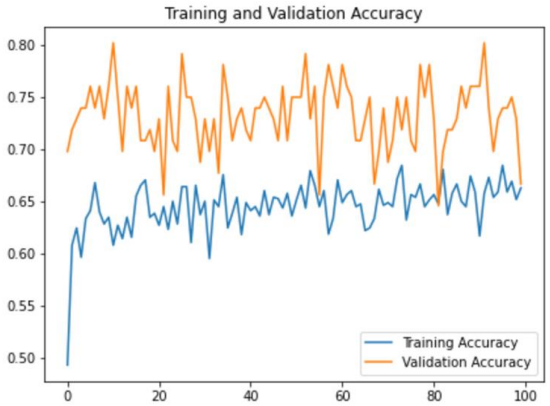
The bounding box dimensions

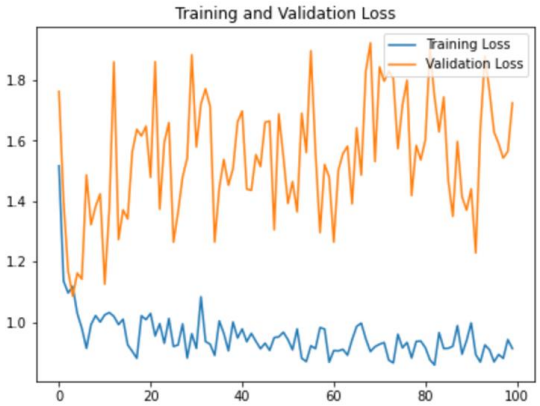
The x vs. y coordinates of the bounding boxes

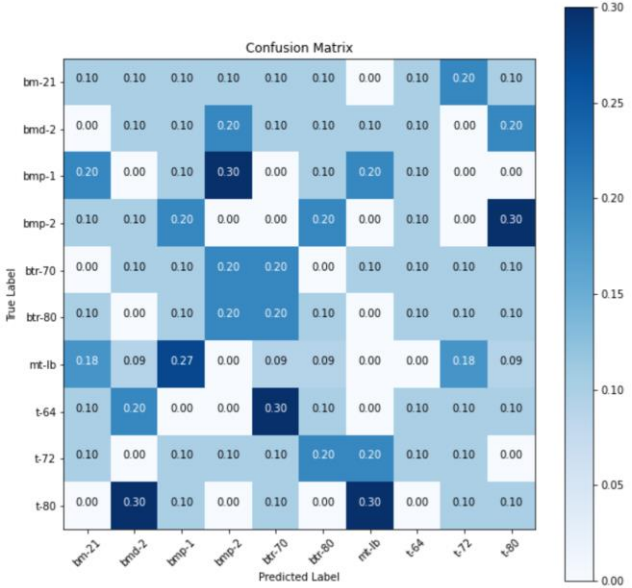
The height vs. width of the bounding boxes

Results for ResNet50

```
x = model_resnet.output
x = BatchNormalization()(x)
x = Dropout(0.5)(x)
x = Dense(64, activation = 'relu')(x)
x = BatchNormalization()(x)
x = Dropout(0.5)(x)
x = Dense(32, activation = 'relu')(x)
x = BatchNormalization()(x)
output_layer = Dense(n_classes,
activation='softmax')(x)
```

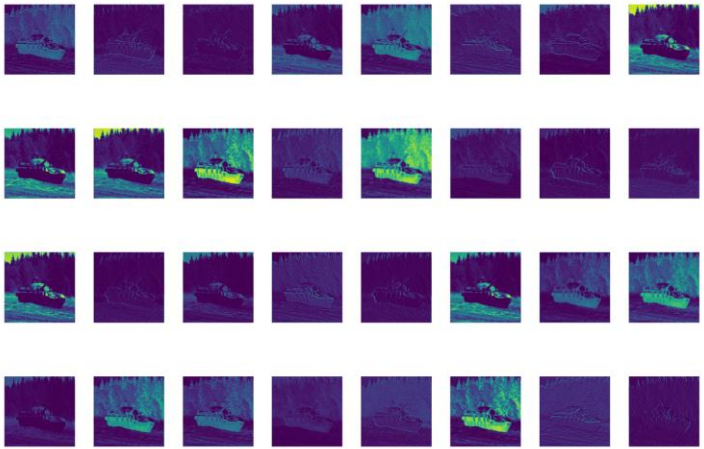


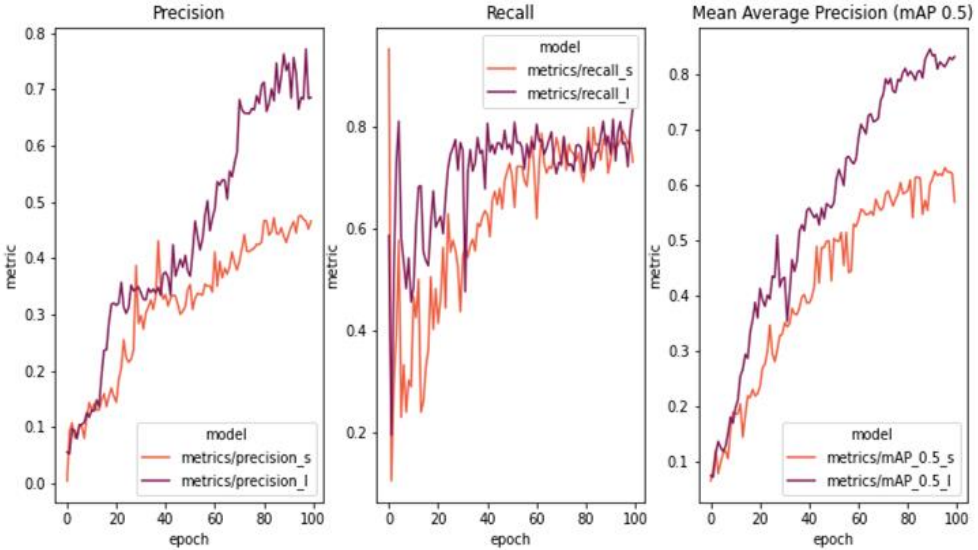




Results for YOLOv5

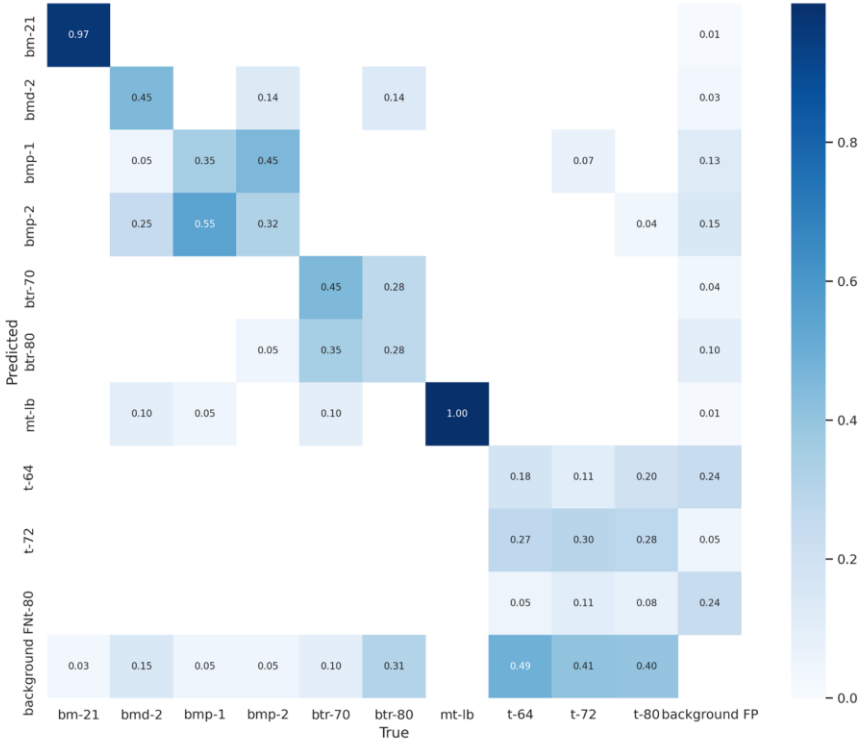
- Ensemble two learners
- Test-Time Augmentation



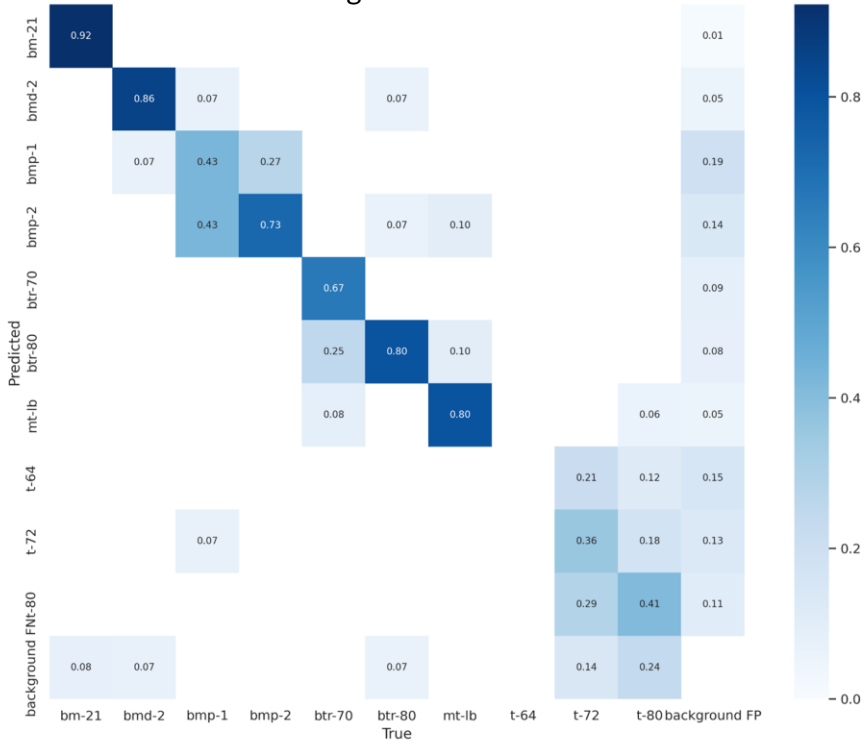


Results for YOLOv5

Train/Val Confusion Matrix



Test/Final hold-out Confusion Matrix
Test-time Augmentation



Summary

- ResNet50 performed with an accuracy of 73% after experimenting with the model's architecture
  - Experimentation allowed us to see the effects of the type of layers and number nodes on the performance of the models
  - Fine tuning method of unfreezing some layers showed how the performance can be enhanced with this small change
- With YOLOv5, unsurprisingly the large model performed better than the small model
  - We were also able to develop an impressive multiple object detection model by ensembling the two models
  - Additionally, we employed test-time augmentation, resulting in a highly performant model that can be deployed on images and video

Sources/References

Imagery Data:

- Russian military vehicles: Tuomo Hiippala, University of Helsinki, Finland, Department of Geosciences and Geography

Slides

- Harding, Luke. “The First Tiktok War: How Are Influencers in Russia and Ukraine Responding?” The Guardian, Guardian News and Media, 27 Feb. 2022, https://www.theguardian.com/media/2022/feb/26/social-media-influencers-russia-ukraine-tiktok-instagram?utm_source=pocket_mylist.
- Hiippala, Tuomo. “Recognizing Military Vehicles in Social Media Images Using Deep Learning.” 2017 IEEE International Conference on Intelligence and Security Informatics (ISI), 2017, https://doi.org/10.1109/isi.2017.8004875.
- Nelson, Joseph. “Your Comprehensive Guide to the Yolo Family of Models.” Roboflow Blog, Roboflow Blog, 19 July 2022, https://blog.roboflow.com/guide-to-yolo-models/.
- Rodriguez, Emanuel. “Resnet50 Image Classification in Python.” A Name Not Yet Taken AB, 28 May 2020, https://www.annytab.com/resnet50-image-classification-in-python/.

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