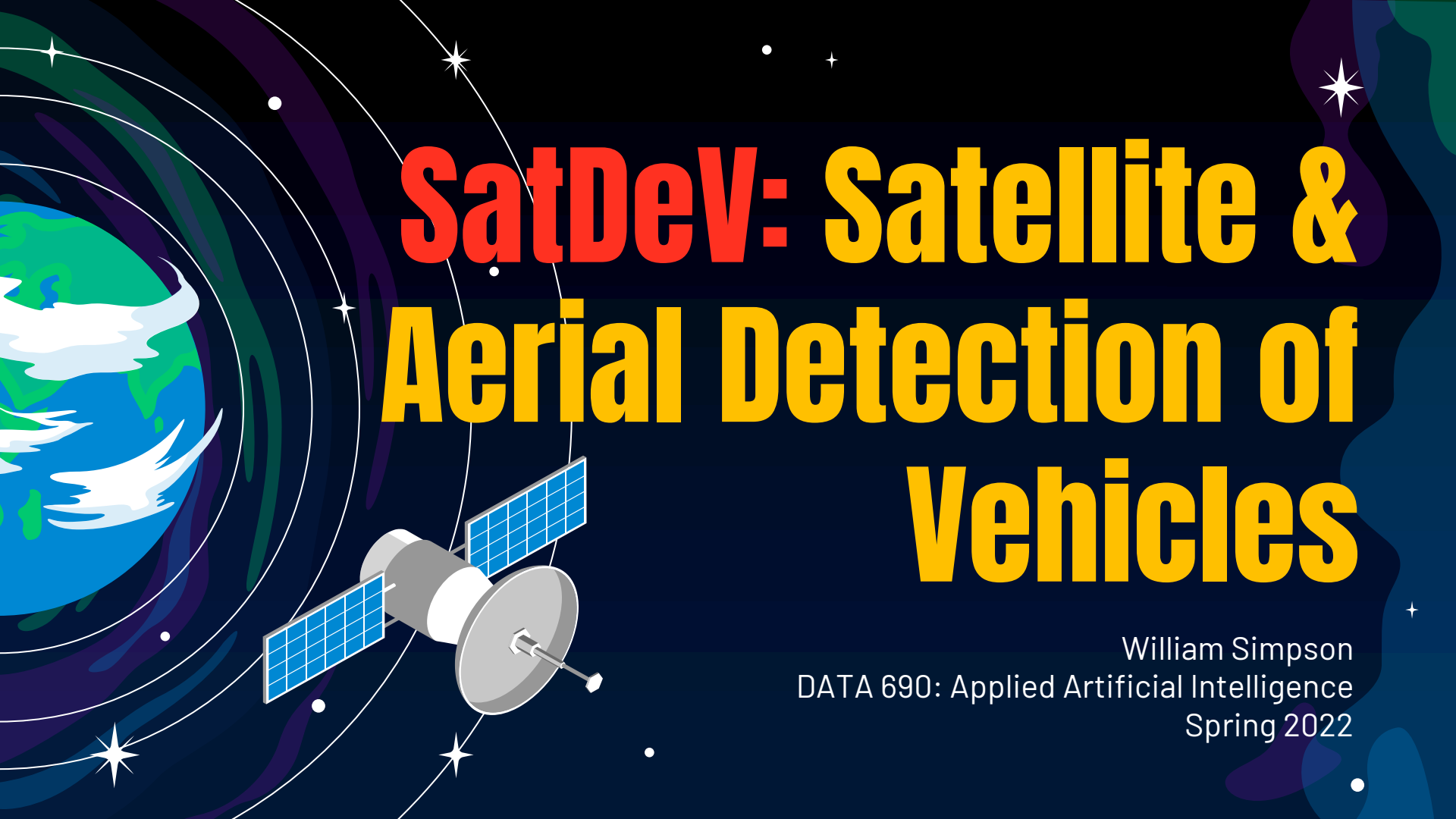


SatDeV: Satellite & Aerial Detection of Vehicles

William Simpson

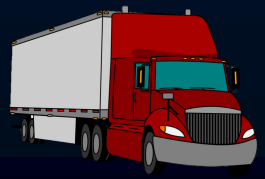
DATA 690: Applied Artificial Intelligence

Spring 2022

Project Description

- Leverage transfer learning to retrain an object detection model to identify 5 classes of vehicles in satellite and aerial imagery:

Small vehicles



Large vehicles

Ships

Planes

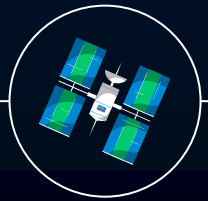
Helicopters

- Dataset for Object deTection in Aerial images (DOTA):
  - 2806 images across 15 categories

Business Problem

Context

Military Intelligence and Data Collection on foreign militaries

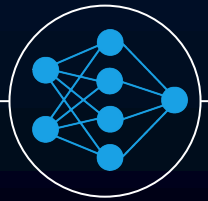


Challenge

Manual review of satellite and aerial photography is time and resource intensive.

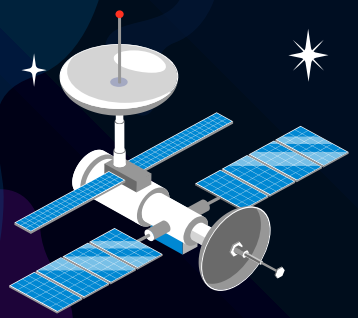
Solution

Automated Aerial Object Detection



Example Application

Tracking Russian military build up prior to invasion of Ukraine



Deep Learning Model: You Only Look Once (YOLO) v4-tiny

Pretrained on MS COCO

Using the Darknet framework

Retrained on DOTA

Limited to 803 satellite images containing instances of the 5 classes

Prediction

Horizontal bounding boxes with labels for each class

Model Accuracy

Mean Average Precision: **19.34%**

Avg. Loss: **~5%**

Pros

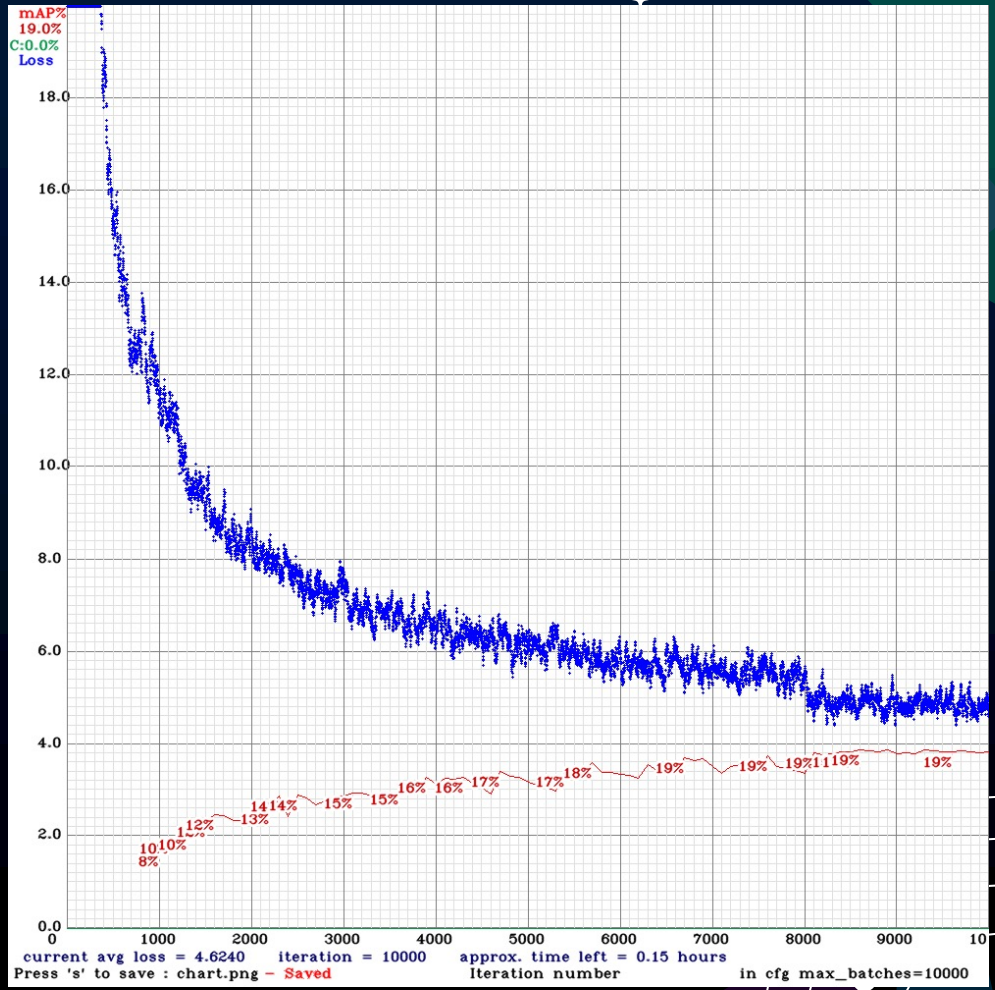
I selected this model for its **SPEED**!

Cons

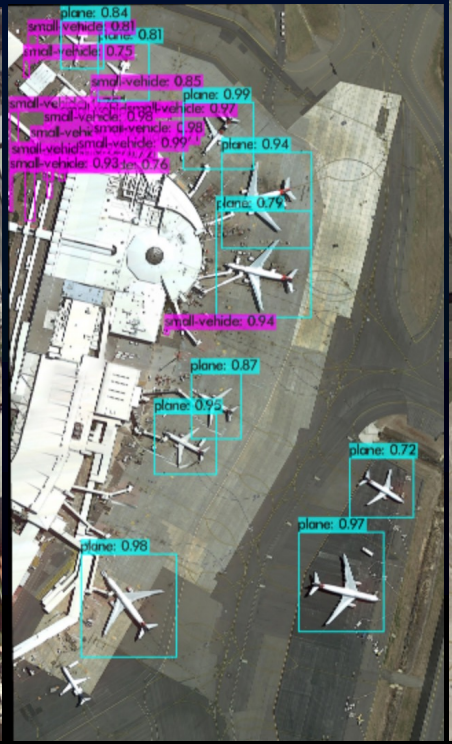
YOLOv4-tiny sacrifices accuracy for training and inference speed

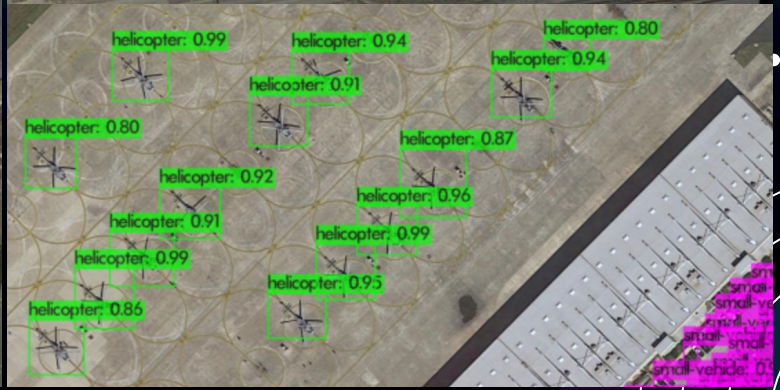
Model Results

```
class_id = 0, name = small-vehicle, ap = 10.36%
class_id = 1, name = large-vehicle, ap = 28.66%
class_id = 2, name = plane, ap = 42.47%
class_id = 3, name = ship, ap = 15.23%
class_id = 4, name = helicopter, ap = 0.00%
```



Model Results Test Set





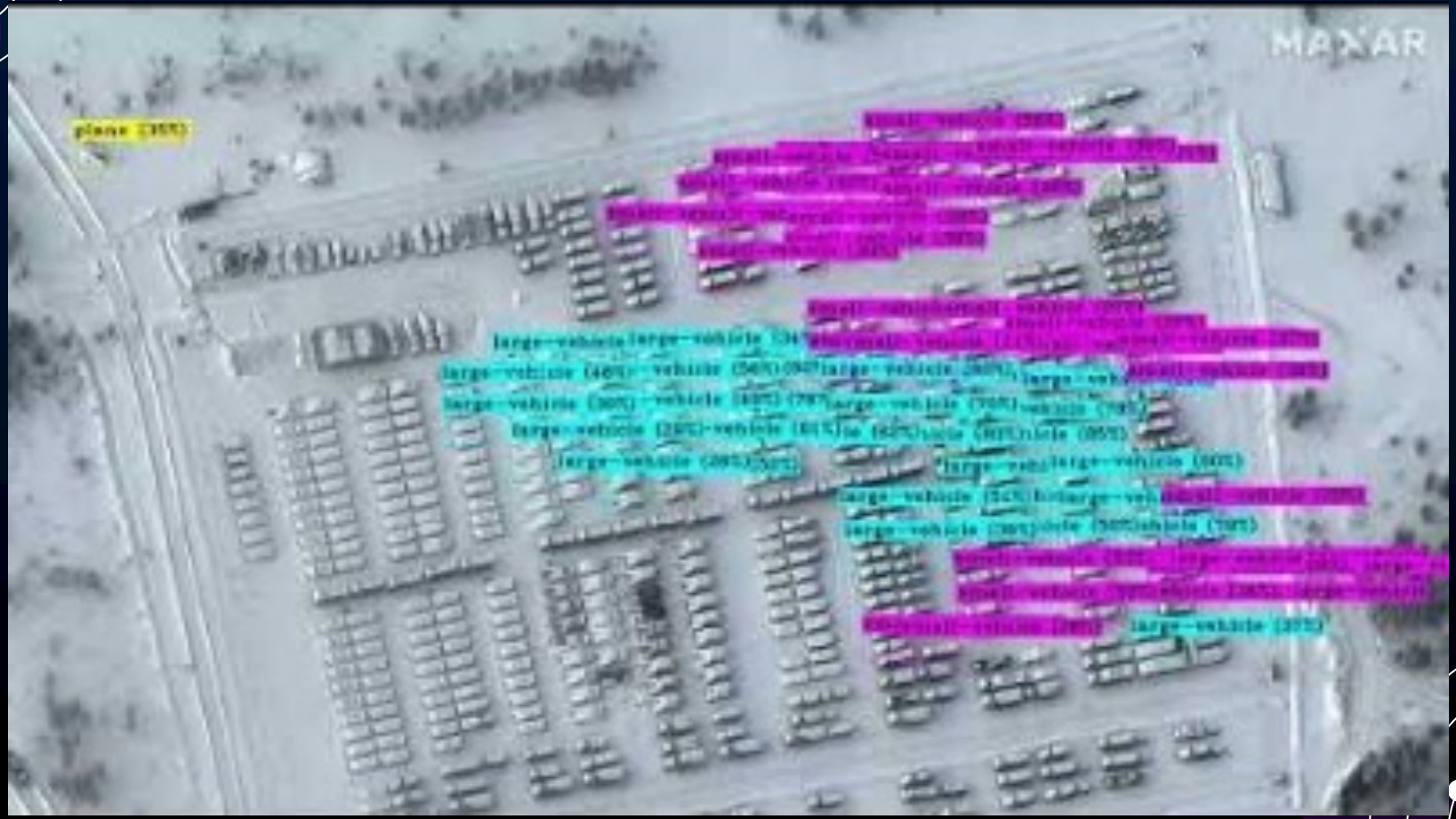
Detection of Russian Military Build up near Ukraine

Russian military planes at Saki Air Base in Crimea

Tanks and other military equipment on the Pogorovo training area near Voronezh, Russia.

Images from: RadioFreeEurope

Video Demo Detecting Russian Military Vehicles



Challenges

01
Bounding Box Annotation Format

02
Limited Resources

03
Low Accuracy

Future Design, Plans, Costs

01
Distinguish Commercial and Military Vehicles

02
Integration into Satellite Networks

03
90% Cost Reduction
(compared to manual annotation)

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