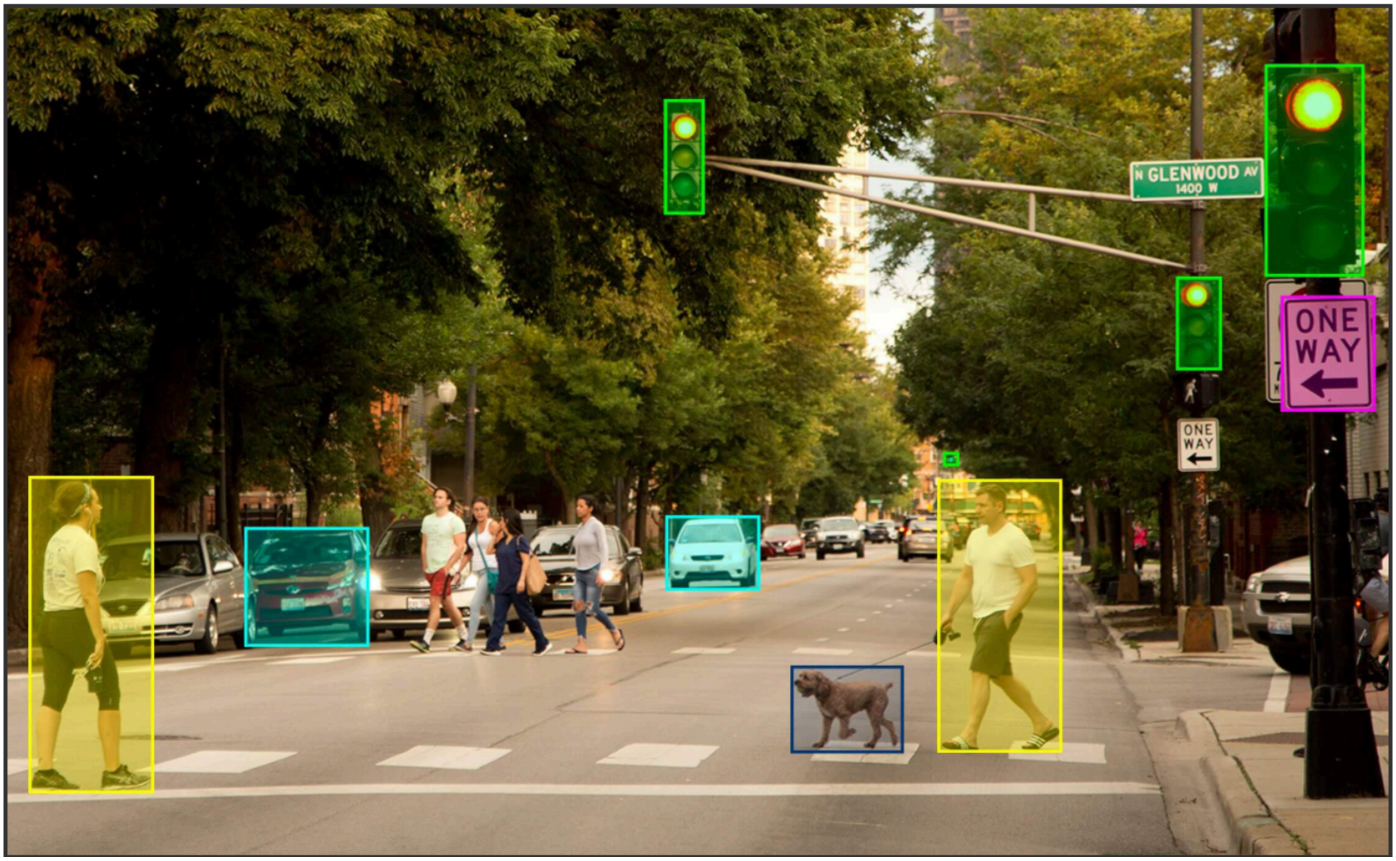
IMAGE RECOGNITION WITH DRIVERLESS-VEHICLES



Minimum Viable Product

Prepared for: Metis Staff Instructors(Richard Chiou, Brian McGarry)
Prepared by: Rahul Raju
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EXECUTIVE SUMMARY

An initial proposal was made to aid the auto-industry in realizing the long sought after goal of producing fully autonomous vehicles. Key to this endeavor is the ability of driverless software applications to accurately classify commonly and uncommonly encountered objects during drives. The idea behind the project was to illustrated the various methodologies and models available within the realm of deep learning that can enhance these applications. Uniformly distributed target classes allowed for the use of *accuracy* as metric to evaluate the overall model.

Variations of two models thus far have been evaluated. The best variation of each type of model will be illustrated.

Model 1: Baseline

The first model was a simple baseline built from the ground-up using a sequential architecture. The table below provides a summary of the sequence of layers along with the number of parameters used in the model.

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_4 (Conv2D)            (None, 30, 30, 45)        1260
_________________________________________________________________
max_pooling2d_4 (MaxPooling2 (None, 15, 15, 45)        0
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 13, 13, 70)        28420
_________________________________________________________________
max_pooling2d_5 (MaxPooling2 (None, 6, 6, 70)          0
_________________________________________________________________
flatten_2 (Flatten)          (None, 2520)              0
_________________________________________________________________
dense_6 (Dense)              (None, 3000)              7563000
_________________________________________________________________
dense_7 (Dense)              (None, 1000)              3001000
_________________________________________________________________
dense_8 (Dense)              (None, 10)                10010
=================================================================
Total params: 10,603,690
Trainable params: 10,603,690
Non-trainable params: 0
_________________________________________________________________
```

The model produced an accuracy of ***0.689***, which will serve as a baseline metric for comparison to all other models.

Model 2: Transfer Learning

This model made use of a commonly used methodology in deep learning named *transfer learning,* which uses pre-trained models. The convolutional bases of these pre-trained models are used in conjunction with customizable fully connected dense layers of neurons. The generalized pre-extraction of features allows for quicker training time and more accurate predictions with respect to specialized tasks. In this instance the *MobileNet* base model was used. The table below provides a summary of the sequence of layers along with the number of parameters used in the model.

```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
mobilenetv2_1.00_224 (Functi (None, 1, 1, 1280)        2257984
_________________________________________________________________
dropout_26 (Dropout)         (None, 1, 1, 1280)        0
_________________________________________________________________
flatten_33 (Flatten)         (None, 1280)              0
_________________________________________________________________
dense_99 (Dense)             (None, 1000)              1281000
_________________________________________________________________
dense_100 (Dense)            (None, 750)               750750
_________________________________________________________________
dropout_27 (Dropout)         (None, 750)               0
_________________________________________________________________
dense_101 (Dense)            (None, 500)               375500
_________________________________________________________________
dropout_28 (Dropout)         (None, 500)               0
_________________________________________________________________
dense_102 (Dense)            (None, 250)               125250
_________________________________________________________________
dropout_29 (Dropout)         (None, 250)               0
_________________________________________________________________
dense_103 (Dense)            (None, 125)               31375
_________________________________________________________________
dropout_30 (Dropout)         (None, 125)               0
_________________________________________________________________
dense_104 (Dense)            (None, 10)                1260
=================================================================
Total params: 4,823,119
Trainable params: 4,789,007
Non-trainable params: 34,112
_________________________________________________________________
```

The model produced an accuracy of ***0.737*** versus 0.689 for the base model.

Further Work

- The transfer learning model was prone to overfitting therefore certain steps will be taken to reduce complexity. This will include reductions in the number of neural layers and nodes, adjustment of dropout rates and recalibration of other parameters.

- A 10 x 10 confusion matrix will be produced that will enable us to judge the model's performance according to each individual class across a spectrum of metrics. In addition to the overall assessment of the model it is important to judge it's efficacy with respect each class. Each object type will require its own metric to fully appreciate the impact of the model. For example, whilst *accuracy* may prove to be fine with the 'bird' object, *recall* will be more appropriate for larger objects such as trucks.