

# Estimating Parking Capacity in Somerville

## Progress Report

AC297r Fall 2019

To accomplish the city of Somerville's goal of a comprehensive audit of parking, we aim to provide assistance in evaluating the city's residential parking capacity in driveways. Our current goal is to build a system using a convolutional neural network to classify a parcel as either containing a driveway or not containing a driveway.

## Data

Up to this point, we have been working with data provided by the City of Somerville, including:

1. Satellite imagery from Mass Orthoimagery Consortium (Spring 2015) with assessment information. This raster data was converted to over 14,000 individual files in tagged image file format (TIFF), each representing one parcel.
2. Parking permits data (2018)
3. Registered vehicles (2017-18)
4. Parcel-level assessment data (FY 2019)

For more information on these datasets, see this [notebook](#) that contains some data exploration.

## Model

We use convolutional neural networks (CNN), a type of deep learning model well-suited for computer vision tasks. Intuitively, the model passes small, cubical filters over the image and learns increasingly abstract representations of the contents of the image. For instance, early layers may pick up on edges and shapes while later layers hopefully pick up on . Our initial model uses the following architecture:

- 2 convolutional blocks consisting of a two-dimensional convolutional layer, a dropout layer, and a max pooling operator
- One additional two-dimensional convolutional layer followed by a flatten layer
- Two final dense layers to translate the CNN's representation of the image into a final prediction of whether or not there is a driveway in the image

The model was trained on 60 images that were manually tagged to indicate whether they contain a driveway or not. Note that there was a class imbalance, the majority of parcels tagged contain driveways and that we only consider three of the five available channels in the satellite imagery.

## Results

While our initial model should be viewed as very preliminary, our results are promising. However, even though the 2015 satellite imagery we are working with is high resolution, the quality of the images at the parcel-level is not uniform across all the parcels in Somerville. For some, it is possible to see whether there is a driveway present. For the ones that it is not possible to see, it can be for a variety of reasons, such as that the image is cropped too closely to the house, that there is tree coverage, or that the image is too blurry to tell if there is a driveway or not.



*Figure 1. The parcel on the left has a driveway and received a model score of 0.99 while the picture on the right does not have a visible driveway and received a model score of 0.01.*

## Next Steps

We will attempt to follow a swimming pool detection project conducted by ESRI to utilize the recent satellite imagery available on ArcGIS, along with tools in the software that make manual tagging and export of train and test sets easier. This task will also involve consolidating information from different tabular data sources to only focus on residential parcels.

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