Deep Learning with Big Data: Alabama Highway Infrastructure

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04 December, 2017


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What is big data?

- Images and Video are big data
  1. Need to explore quickly and accurately
  2. Possible efficiency gains (better questions, better answers)
  3. In globally competitive environment huge gains to first movers.
- Big data source examples:
  1. Google Streetview: Road infrastructure detection (guardrails, traffic lights, rumble strips, lane information)
  2. Drones: Storm Damage assessment (tree mapping, structure changes, power line status)
  3. Traffic cameras: Traffic congestion and accident identification from traffic cameras.
  4. Crowdsourced instagram photos, etc.

Big data challenges:

- Costly to understand the meaning and information in the pictures.
  1. How to classify? (students/employees, etc.)
  2. Prone to human error and missing information.
  3. If new category is added must go back and reclassify all previous images.
  4. Need real time abilities (24 hours/day 7 days/week)
- Solution:
  1. Automate using rapidly advancing deep learning algorithms.

Application

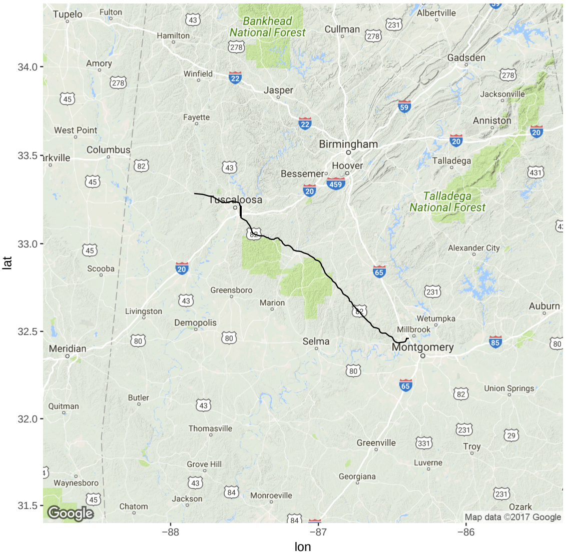
This application focuses on using big data and deep learning to cheaply and efficiently classify infrastructure on Alabama highway 82 between Tuscaloosa and Montgomery.

This process will illustrate the following:

1. How to build a big data set using free/low-cost data
   - Publicly available road shapefiles.
   - Google Streetview images
2. How to train and classify images using free and simple algorithms
   - Google Tensorflow
   - Inception v3 algorithm and retraining

Start with any freely available road shapefile.

* Here, we use Alabama Highway 82



Find all google streetview snapshots locations

- A bit of coding, processing, and downloading streetview metadata to aim the cameras, set the zoom levels.
- There are 20104 camera locations with a rear and forward camerabearing set for each.
- Here are the first 6.

snap_date	pano_id	order	lat	lng	bear.lead	bear.lag
2016-05	lk4vKW941erchBtIeRqenA	2	33.28436	-87.84009	92.64210	-87.35684
2016-05	8sR6h5ILqzn3NSvXhYhP_g	3	33.28435	-87.84000	100.73244	-87.35785
2016-05	5YeX5au5BuKvr-VE8mnHYg	4	33.28434	-87.83991	98.83936	-79.26751
2016-05	7ixd4IHZEO1aUZSMVo_OcQ	5	33.28433	-87.83982	97.23829	-81.16059
2016-05	LMB6s5_qe2463PujYfHafw	6	33.28432	-87.83973	97.02418	-82.76167
2016-05	6TTjtyYJ1NmTOpE0T-_Yzg	7	33.28431	-87.83964	96.80426	-82.97577

Take Google Streetview snapshots

- We then feed the location and variable parameters to the google streetview api and download all 40208 pictures.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Human Classification of streetview photos

- To start the classification we must teach the machine to recognize different features.
- Human selects 30-50 photos for each class.

1. 30 photos from streetview downloads with guardrails
2. 30 photos from streetview downloads with traffic lights
3. 30 photos from streetview downloads with rumble strips

- Each set of photos is put into its own folder (guardrail, etc.)

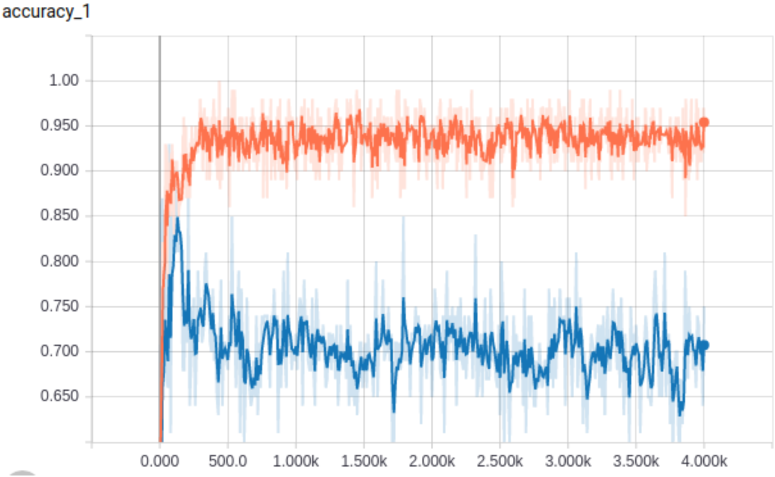
Training machine to recognize classes

- We use transfer learning on google's Inception v3 algorithm for this demonstrations
- Inception v3 is a deep learning machine that takes a long, long, time to build a model
- We retrain the last step to recognize the guardrails, traffic lights, rumble strips, etc.

Best analogy: Inception v3 is a toddler. We do not want to waste time and resources raising a toddler. We just want to teach a toddler to recognize a set of new objects such as a spoon. Show the toddler 30 spoons and they gain the ability to classify spoon objects.

Training Diagnostics

- Training diagnostics through tensorboard.



Classify all photos

- The next step is to classify how each of the 40207 photos using the trained model.
- The overall probability of all classes sum to 1 for each photo.

$$\sum_{classes} Pr(class_i) = 1$$

Classification: Rumble Strips only

fName	category	score
pano_id:zZ39CumiCqaxS9-1n6erDg_lead.jpg	rumble	0.95842
pano_id:zZ39CumiCqaxS9-1n6erDg_lead.jpg	guardrail	0.04124
pano_id:zZ39CumiCqaxS9-1n6erDg_lead.jpg	signals	0.00033

Classification: Traffic Signal only

fName	category	score
pano_id:-km7JQTMeLsO9k7uF_cnsg_lag.jpg	signals	0.99850
pano_id:-km7JQTMeLsO9k7uF_cnsg_lag.jpg	guardrail	0.00149
pano_id:-km7JQTMeLsO9k7uF_cnsg_lag.jpg	rumble	0.00001

Classification: Rumble Strips and Guardrail

fName	category	score
pano_id:zZq1fNpgOGCGAWylAjnidw_lag.jpg	rumble	0.54766
pano_id:zZq1fNpgOGCGAWylAjnidw_lag.jpg	guardrail	0.45233
pano_id:zZq1fNpgOGCGAWylAjnidw_lag.jpg	signals	0.00001

Results:

Classified images from this example project can be used in a variety of ways:

1. Highway infrastructure inventory accounting.
2. Interactive mapping.