CloudCV: Fast Addition of New Classes to a Pre-trained ConvNet

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Train a New Category

Method

- Weights and biases for new classes are computed using Linear Discriminant Analysis.
- Equivalent to learning a Gaussian Naive Bayes classifier (with equal covariance matrices for all classes)
- All other weights and biases are kept same as BVLC CaffeNet Model.
- LDA weight vector and bias are given as:
  \[ w = \Sigma^{-1}\mu_k \]
  \[ b = \log \pi_k - \frac{1}{2}\mu_k^T\Sigma^{-1}\mu_k \]
- Co-variance matrix \( \Sigma \) can be calculated once and stored.
- Calculating mean (\( \mu_k \)) of fc7 vectors for new training images can be done in real time!

Experiments and results

- We created a caffemodel by calculating the weights between fc7 and fc8 layers for all 1000 classes using LDA.

<table>
<thead>
<tr>
<th>Models</th>
<th>Top-1 Accuracy</th>
<th>Top-5 Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>BVLC CaffeNet Model</td>
<td>57.4</td>
<td>80.4</td>
</tr>
<tr>
<td>LDA Model</td>
<td>49.8</td>
<td>66.8</td>
</tr>
</tbody>
</table>

- We created various caffemodels with 1001 classes.

<table>
<thead>
<tr>
<th>Additional Class</th>
<th>Top-1 Accuracy (Existing classes)</th>
<th>Top-5 Accuracy (Existing classes)</th>
<th>Top-1 Accuracy (New class)</th>
<th>Top-5 Accuracy (New class)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>54.1</td>
<td>79.9</td>
<td>78.4</td>
<td>80.6</td>
</tr>
<tr>
<td>Skateboard</td>
<td>47.4</td>
<td>79.4</td>
<td>91.5</td>
<td>93.7</td>
</tr>
<tr>
<td>Cake</td>
<td>31.0</td>
<td>78.5</td>
<td>94.5</td>
<td>96.5</td>
</tr>
<tr>
<td>Sandwich</td>
<td>51.1</td>
<td>79.6</td>
<td>91.2</td>
<td>92.7</td>
</tr>
</tbody>
</table>

CloudCV Framework

- Finding important People in Group Images
- Image Classification
- Gigapixel Image Stitching
- Decaf server
- 16 Features including DeCAF features for 1.2 million ImageNet images.
- Deformable parts models (DPM) trained on 200 classes of the ILSVRC 2013 detection dataset.