Selected Topics in Image Understanding
Project Presentation 3
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Concept

Configurations

- Manual, step-by-step parameter Optimization

HOG	PCA	SVM
· All objects fill the entire image and are oriented in same way · Edges are good features · Suggested in the lecture	· Reduce number of dimensions of feature space · Avoid overfitting · Commonly used	· Often used before neural networks became popular · Non-generative model was sufficient

Adjustments: HoG parameters changed to reduce computation time

- On the web one can find recommendations for the parameters used to create the HoG features

- We made adjustments to speed up the calculations:

o Size of the cells: 25x25 pixels

o Size of the normalization blocks: 3x3

Adjustments: Class scatter as SVM class weights

- After receiving a 30-dimensional feature space with the help of PCA, compute the covariance matrix for each class

- Use the determinant of the covariance matrix to determine the weight of each class: A larger determinant corresponds to more scatter within a class and, thus, the class is weighted less

- Formula: $w_i = 1 - \dfrac{c}{\max\limits_{j} \sqrt[n]{\left|\sum_j\right|}} \sqrt[n]{\left|\sum_i\right|}$

  ○ w_i: Weight of each class

  ○ $\sum_i$: Covariance matrix of each class

  ○ n : Size of the feature space (30)

  ○ c : Threshold that defines lowest
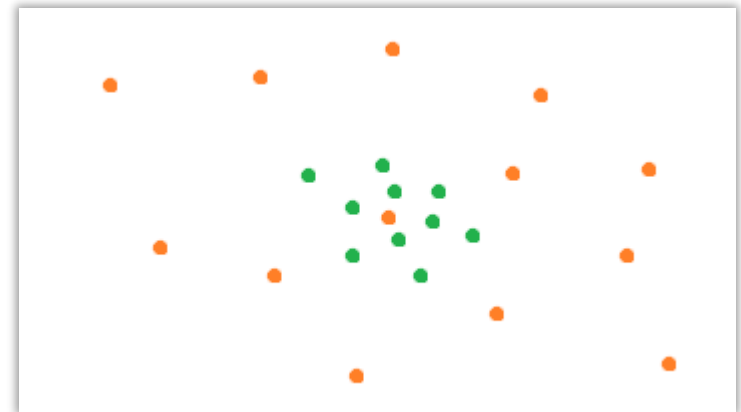   possible class weight (0.5)

Figure: Two classes with low/high class scatter

Alternative Approach: Transfer Learning

- Use weights of pre-trained Convolutional Neural Network (VGG16 trained on ImageNet dataset)

- Extract first fully connected layer of the network for each image (4096 dimensions) and use it as the feature vector

- Direct use of linear SVM for classification without dimensionality reduction leads to 90% accuracy but is computationally expensive
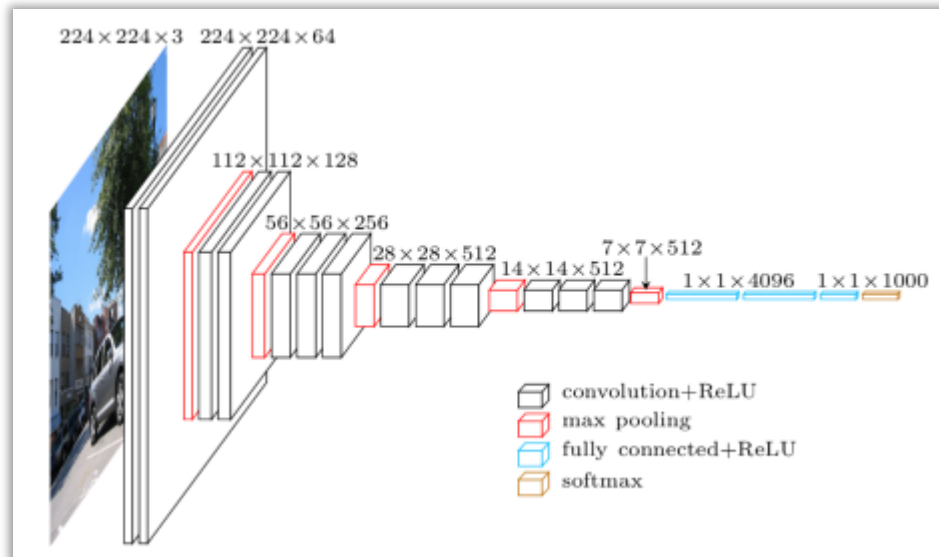

Figure 1: Architecture of the VGG16 model (taken from http://www.cs.toronto.edu/~frossard/post/vgg16/)

Results

There are huge differences in recognizing the different classes:

- cannon, crocodile, mayfly close to 0% accuracy
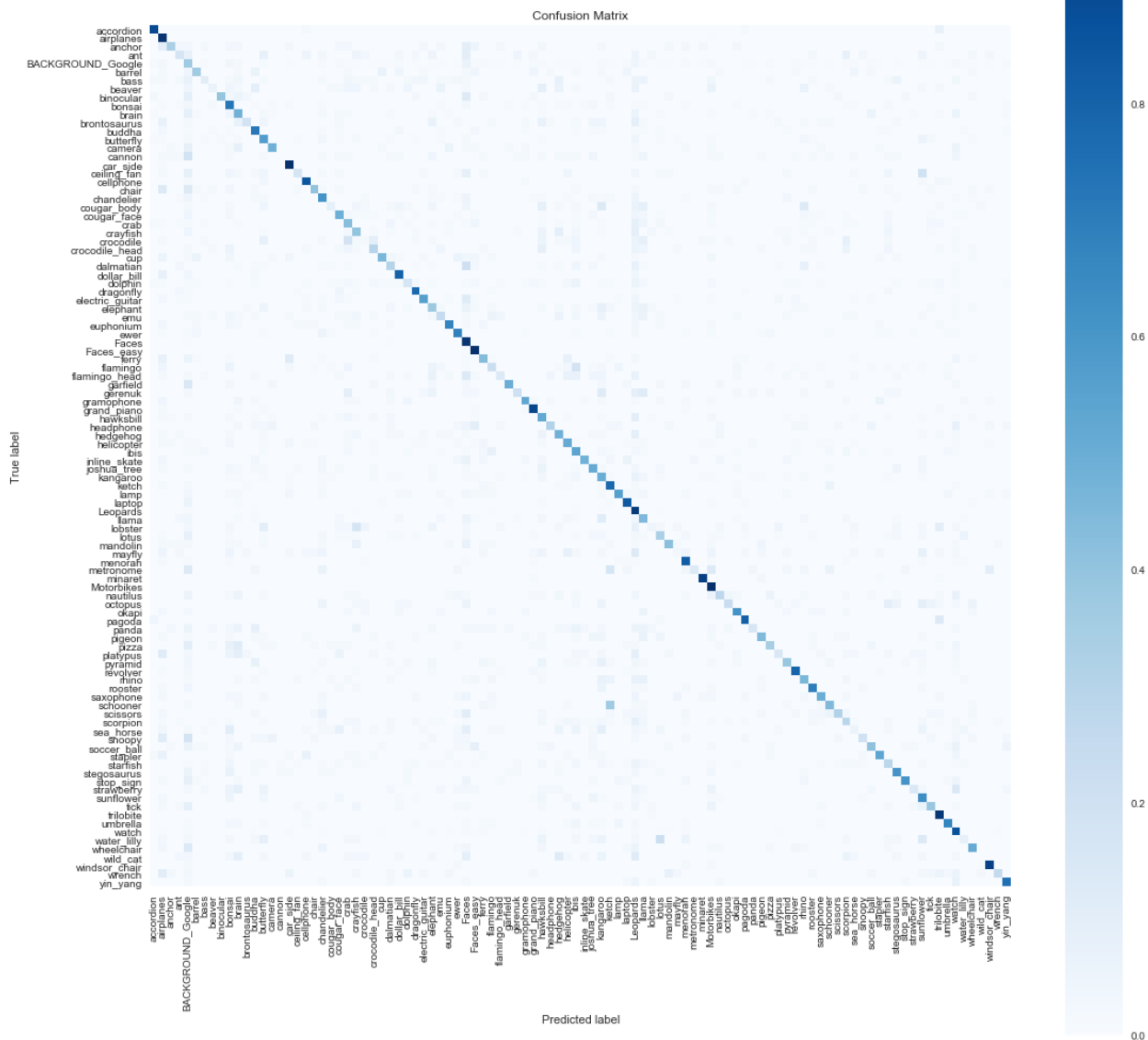- accordion, airplanes, leopards, motorbikes close to 100% accuracy

Further Findings:

- Google_Background has maximal class scatter
- Huge standard deviation for some classes (e.g. inline_skate)
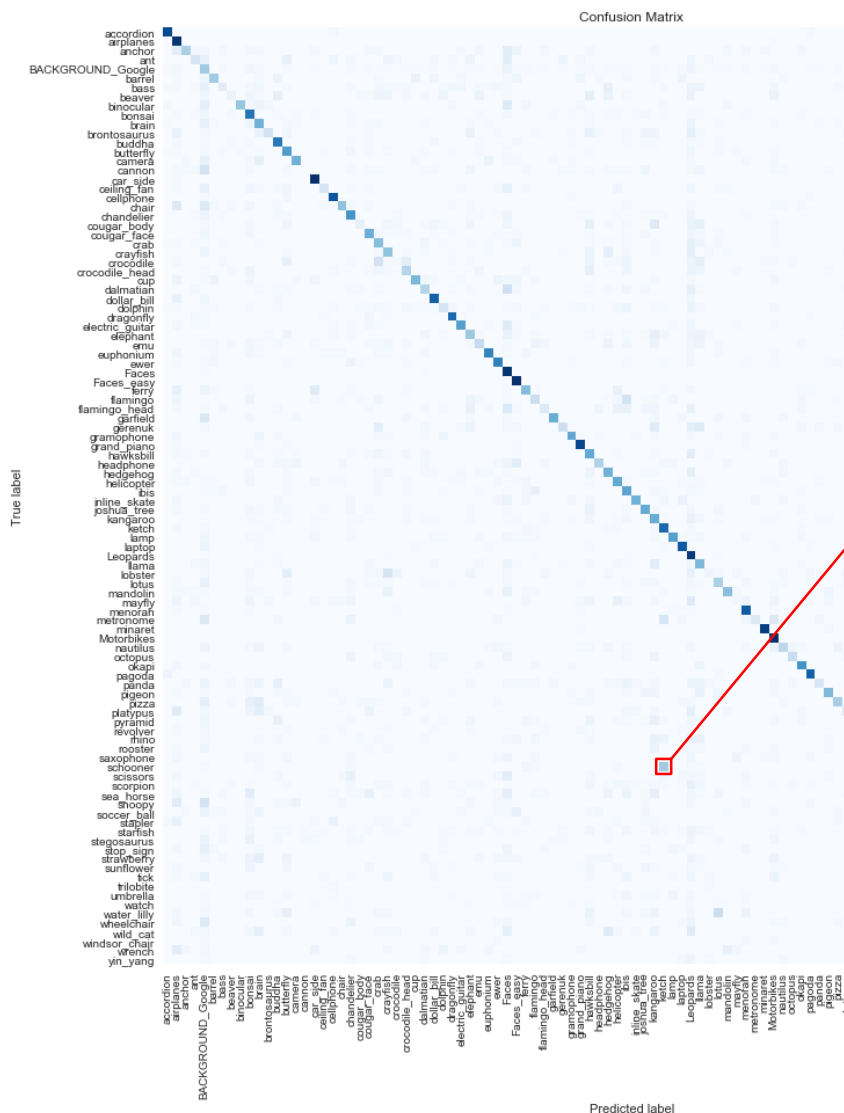- Bigger categories have higher accuracies

Measure	HOG & PCA & SVM	Transfer Learning
Minimum	56,2	
Mean	64,4	90
Maximum	67,7	

Accuracy in percent

Results HOG & PCA & SVM

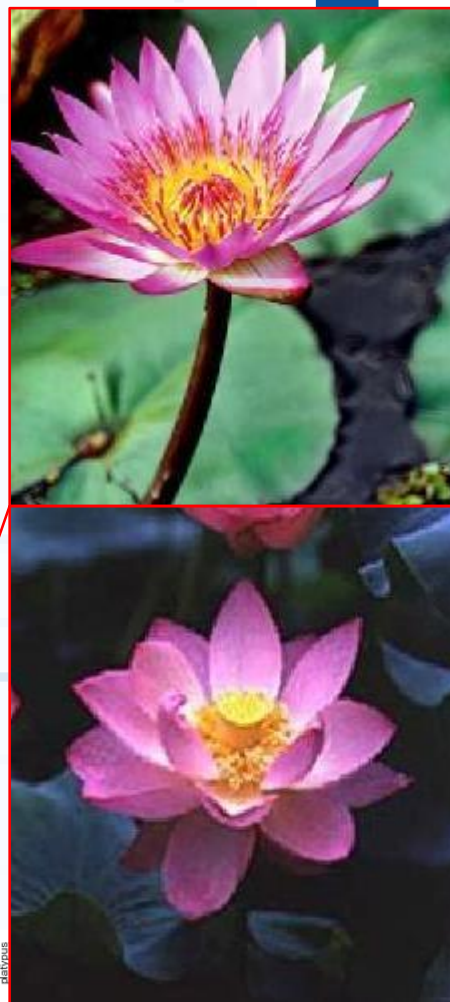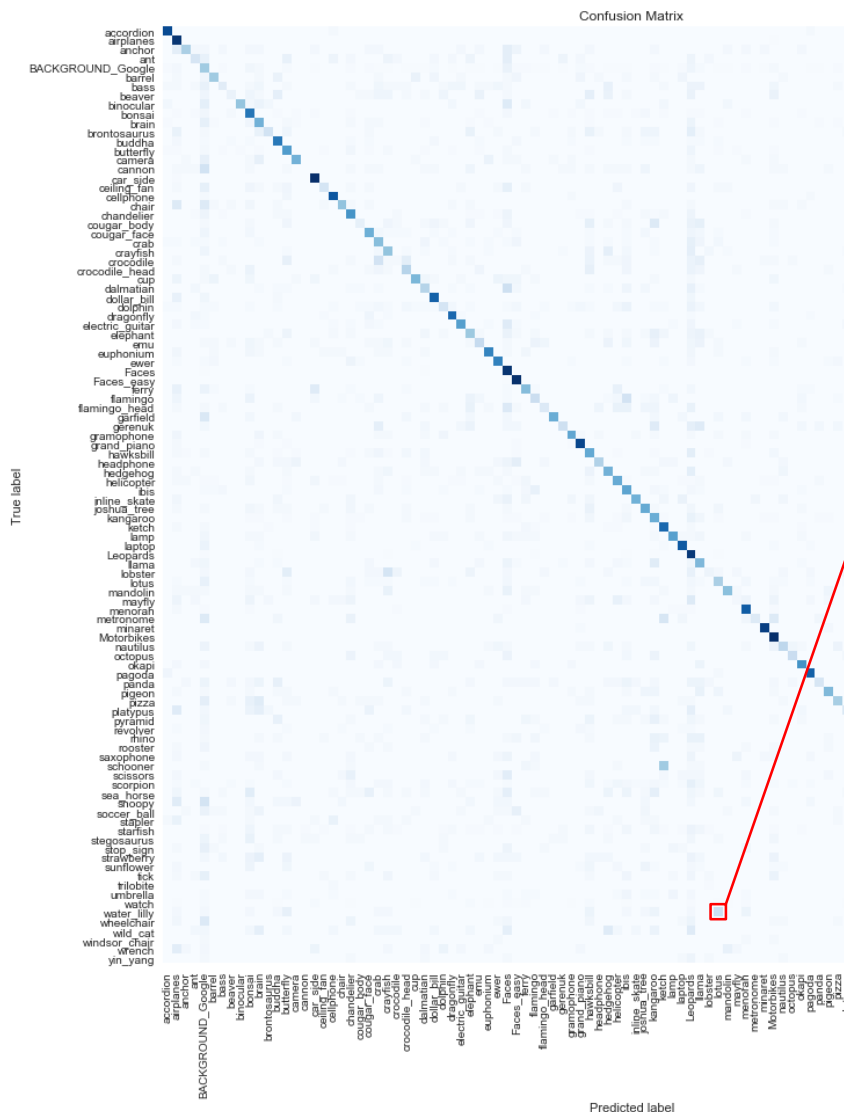Confusion Matrix

Problems

Problems

Possible Improvements

- Use scikit grid search to test all "meaningful" parameter combinations

- Combine multiple classifiers

- Use fine-tuning or additional trainable layers for the transfer learning approach

Thank you for your attention!