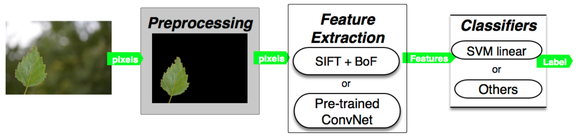
Plant Leaf Recognition

{ Albert Liu and Yangming Wang }@stanford.edu

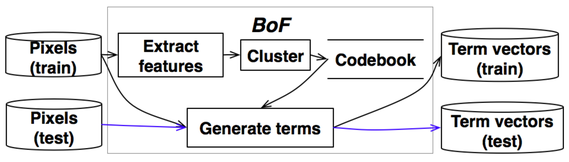
Problem

Fine-grained leaf recognition has important application in weeds identification, species discovery, plant taxonomy, etc. However, the subtle differences between species and the sheer number of categories makes it hard to solve.

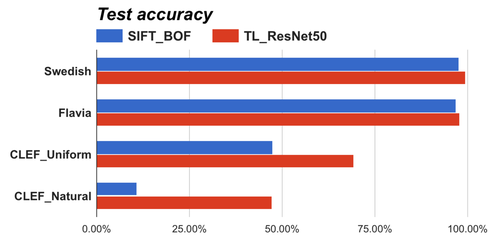
Method

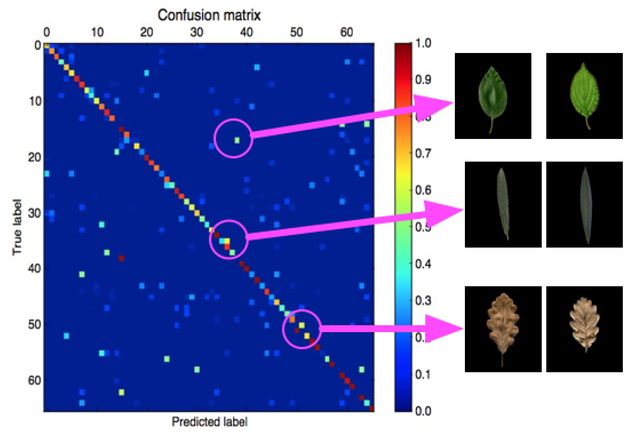


1. Preprocessing Apply CLAHE to reduce lighting condition variation and resize to fit the next layer. Selectively use K-means to remove background heuristically. For challenging dataset, find the convex hull containing the largest N contours and then use GrabCut to segment leaf out.
2. Feature extraction
   - ConvNets.
     Transfer learning approach. Specifically, we take a couple of ConvNets pretrained on ImageNet for ILSVRC object classification task, remove top layers and use it as generic feature extractor. For ResNet50, this is 2048-D feature vector.
   - Traditional SIFT + BoF
     Key points are densely sampled. Size of the codebook (K) is chosen via CV.
3. Classification
   SVM Linear/RBF/Softmax/NN/etc.



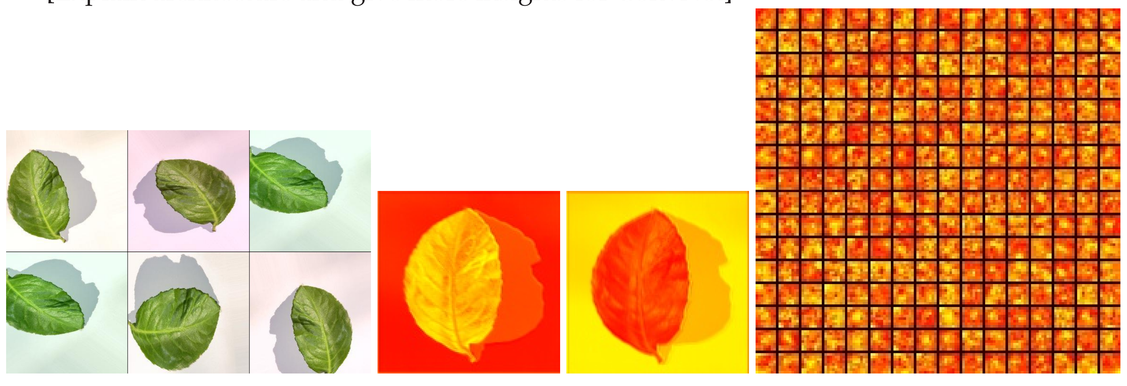
Experimental Results





Transfer Learning - ConvNet

[Explain architecture and give more insights for ConvNet]



Dataset

1. Swedish/Flavia Leaf Dataset: clean images taken in controlled conditions. Use 20 samples per species for training.
2. ImageCLEF Plant: crowd sourced and noisy. Considerable variations on lighting conditions, viewpoints, background clutters and occlusions. Choose species with at least 20 training samples.

Discussions

1. As expected, CNN codes off the shelf yields similar or better accuracy than SIFT+BoF. Particularly traditional method suffers with noisy datasets.
2. Error analysis shows that it helps greatly to reduce noise/variations on data.
3. Looking at the confusion matrix, we believe the main causes for misclassification
   - Very fine differences between species which are hard even for human experts
   - Noisy and plausibly non-representative train data lead to overfitting,
   - Since the ConvNet models are pre-trained for a different task, we speculate these features may not always generalize well for fine-grained classification task

Future works

1. Acquire more data and fine-tune ConvNet to solve overfitting problem
2. Engage advanced techniques for image augmentation
3. Explore state-of-art method to detect and locate leaf for Image CLEF natural data set.