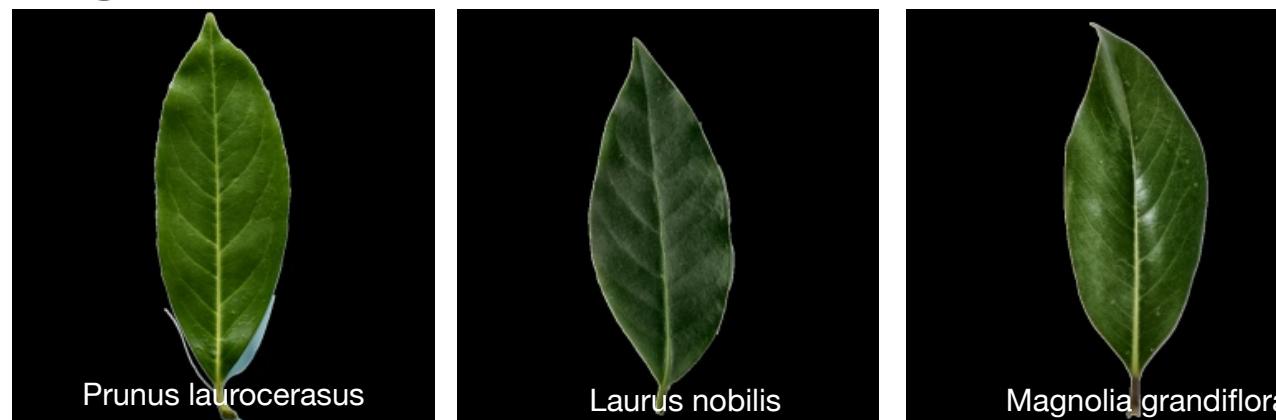


# PLANT LEAF RECOGNITION

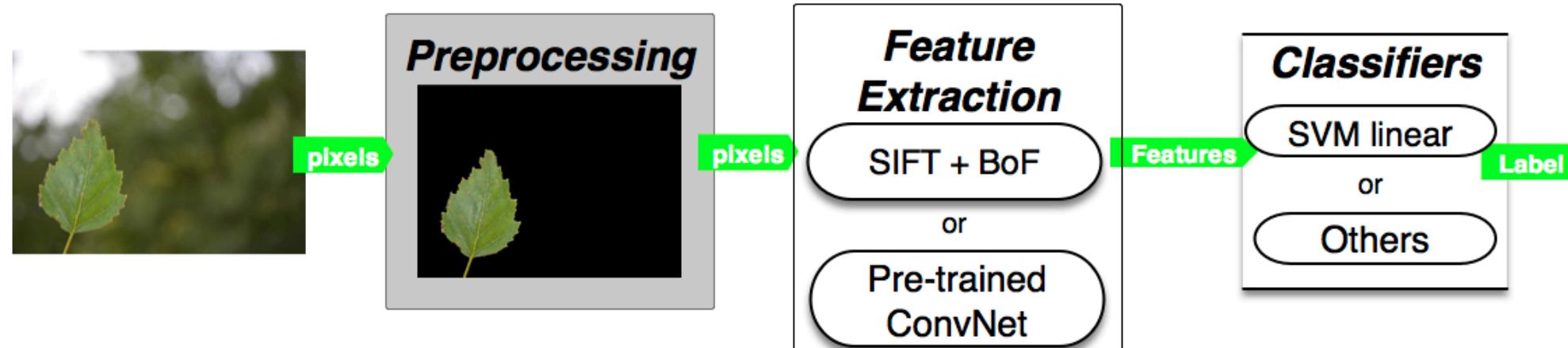
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## PROBLEM

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.

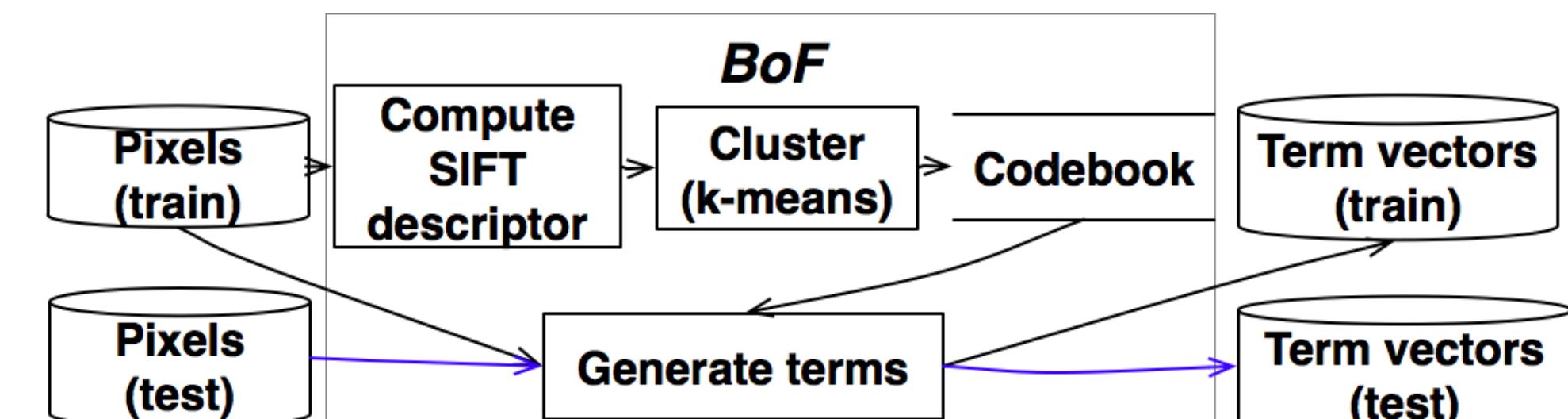
Transfer learning approach. Specifically, we take a couple of ConvNets pretrained on ImageNet for ILSVRC object classification task, remove top layers and use it as generic feature extractor.

- Traditional SIFT + BoF

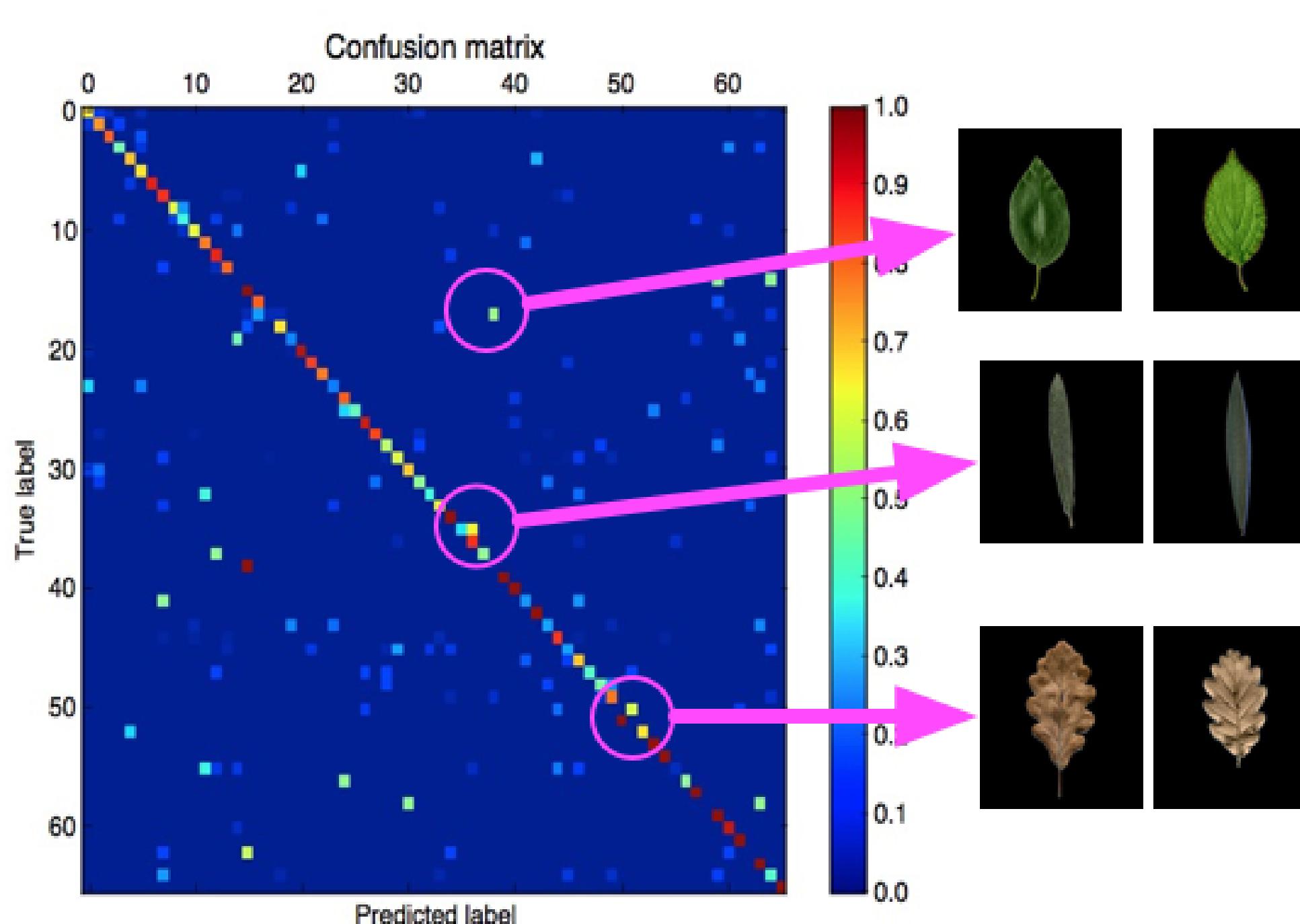
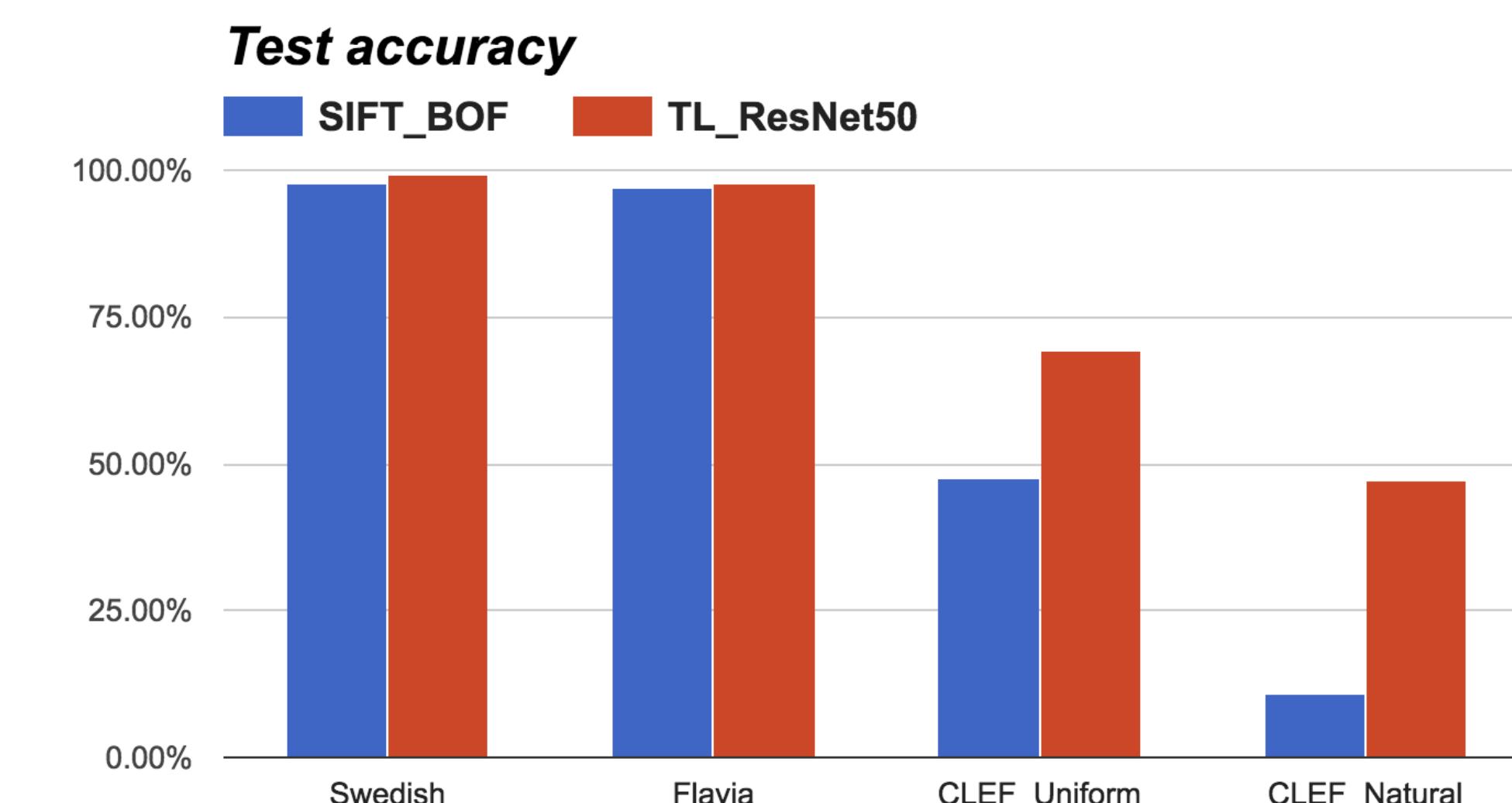
Key points are densely sampled. Size of the codebook ( $K$ ) is fixed at 1000/3000.

### 3. Classification

SVM Linear/RBF/Softmax/MLP/etc.

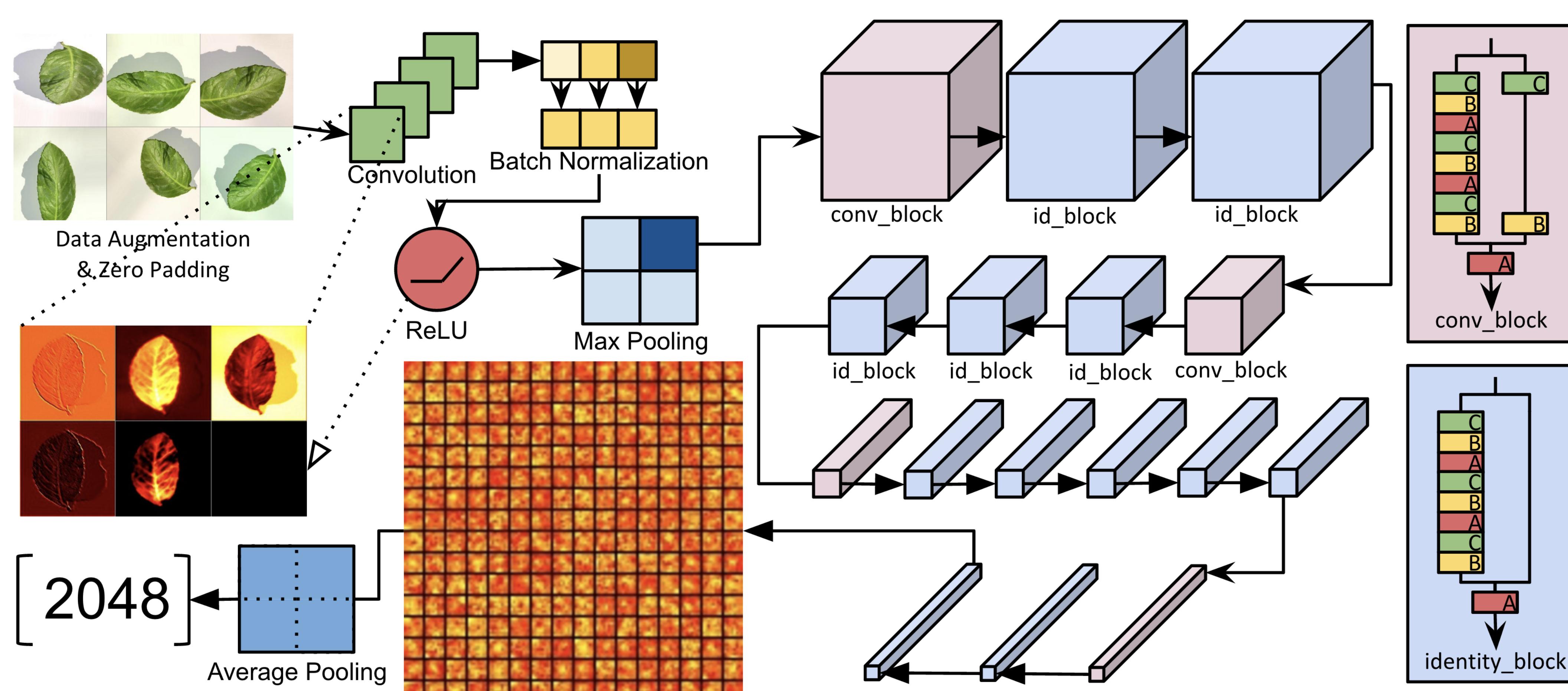


## EXPERIMENTAL RESULTS



## TRANSFER LEARNING - CONVNET

The pre-trained weights of VGG16, VGG19 and ResNet50 are available from open source Keras Framework. After comparing preliminary results, we choose ResNet50 since ResNet50 gives better results and less overfitting. We believe this can be attributed to the fact that ResNet50 is deeper and generates lower dimension feature vector, which is likely due to the use of a more aggressive Average Pooling with a pool size of 7x7.



The ResNet is famous for its deep layers, in our case, 50 layers, with 49 Conv layers and one FC layer on top. Except for the first Conv layer, the rest 48 compose 16 “residual” blocks in 4 stages. The block within each stage has similar architecture, i.e. same input & output shape.

The output of the stage 5 give 2048-D features. Every cell in the grid shown above is a 8x8 filter visualized with heatmap, which will be a scalar after average pooling.

## DATASET

- Swedish/Flavia Leaf Dataset: clean images taken in controlled conditions. Use 20 samples per species for training.
- 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

- As expected, CNN codes off the shelf yields similar or better accuracy, compared to SIFT+BoF. Particularly traditional method suffers with noisy datasets.
- Error analysis shows that it helps greatly to reduce noise/variations on data.
- Looking at the confusion matrix, we believe the main causes for misclassification
  - Very fine differences between species, which is hard even for human experts
  - Noisy and possibly 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.

## FUTURE WORKS

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