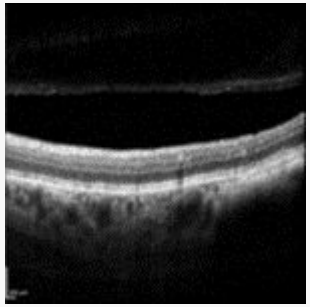
ECE 8803 Fundamentals of Machine Learning

Machine Learning Classification on OCT Images from OLIVES Dataset

Stella Fournier & John Grilo

Introduction

OCT Images from OLIVES



32,337 images with 3 severity classes

Supervised Machine Learning Model

Analysis

- Balanced Accuracy
- ROC curve
- Confusion Matrix
- Performance Metrics

1. K-nearest Neighbors (KNN)
2. Naïve Bayes
3. Convolutional neural network (CNN) with an untrained AlexNet
4. Transfer learning CNN using a pre-trained ResNet

KNN

- Method: Flattened each image pixel value into a 1D array → KNN algorithm
  - Balanced accuracy: 33.91% with k = 15
- Principal Component Analysis (PCA)
  - “Curse of Dimensionality” → extract the most important features based on cumulative variance within the vector
  - **Step 1**: Find best ‘n’ by increasing ‘n’ from 10 to 300 in increments of 10 (Fig. 1)
    - n = 20
  - **Step 2**: Sample of n = 10, 20, 50, and 100 pair with k values of 1 to 30 (Fig. 2)
    - Balanced accuracy = 40.93%

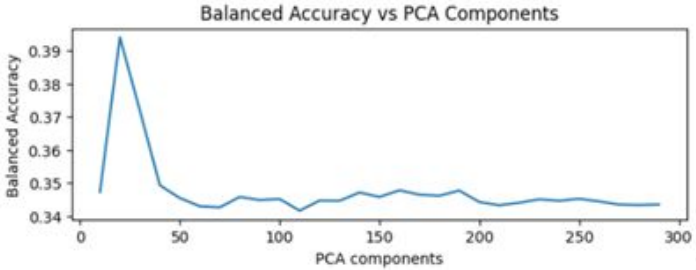


Fig. 1: The number of principal components and their corresponding balanced accuracy with k value equals 15 on training data using KNN.

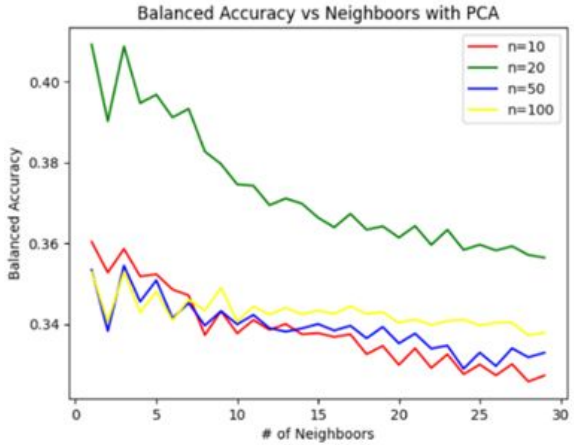


Fig. 2: The number of ‘k’ neighbors and its corresponding balanced accuracy with n PCA components on training data using KNN.

Naïve Bayes

- Method: Flattened each image pixel value into a 1D array → KNN algorithm
  - Balanced accuracy: 46.84%.
- PCA
  - Find best ‘n’ by increasing ‘n’ from 10 to 300 with an increment of 10
    - n = 30
    - Balanced accuracy: 51.22%
    - assumes independence, functions better on high dimensionality data

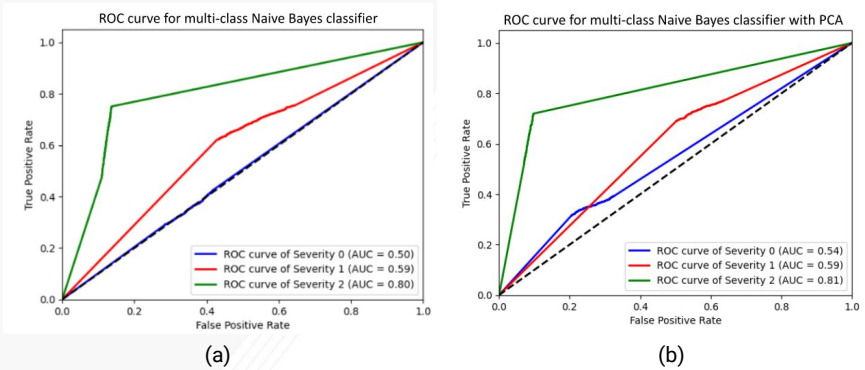


Fig. 3: ROC curves for multi-class Naïve Bayes classifier

	Naïve Bayes	Naïve Bayes with PCA
Recall	[0.2928, 0.6238, 0.4885]	[0.3179, 0.6931, 0.5313]
Precision	[0.3221, 0.5804, 0.5093]	[0.4173, 0.5690, 0.6349]
F1	[0.3067, 0.6014, 0.4987]	[0.3609, 0.6250, 0.5785]

Table 1: Recall, Precision, and F1 Scores for Naïve Bayes with and without PCA. [Class 0, Class 1, Class 2]

CNN with AlexNet

- Method: Learning rate tuning, data augmentation (crop, horizontal flip), and visualization
- Untrained AlexNet balanced accuracy: 35.89%
  - randomly initialized weights, and imbalanced dataset causing overfitting
- Baseline tuning
  - The learning rate curves peaked around lr = 0.0001 (Fig. 4)
- Data Augmentation (Table 2)
- Visualization via saliency mapping (Fig. 5)
  - Show the activations of features
  - Focus on the right parts of the image?

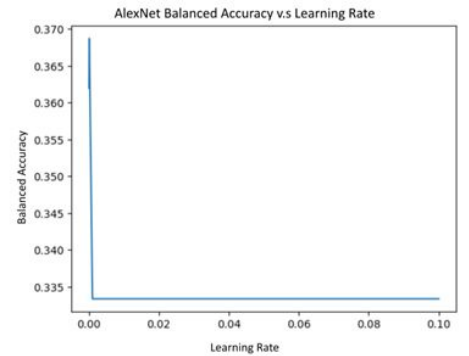


Fig. 4: Balanced Accuracy vs Learning Rate

Data Augmentation	Balanced Accuracy
Original	35.89%
Crop	37.48%
Original + Crop	38.05%
Original + Flip	35.74%
Original + Flip2	42.98%

Table 2: Balanced accuracy for data augmentation for AlexNet model.

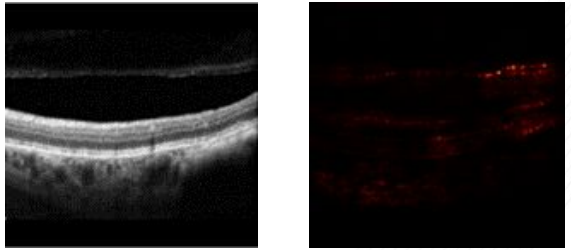


Fig. 5: Cropped trainset image example and its corresponding visualization

Georgia Tech
CREATING THE NEXT

Transfer Learning with ResNet

- Method: Pretrained model, learning rate tuning, data augmentation (crop, horizontal flip), visualization
- ResNet balanced accuracy: 38.76%
- Data Augmentation (Table 3)
- Visualization via saliency mapping (Fig. 7)

Data Augmentation	Balanced Accuracy
Original	38.76%
Crop	35.75%
Original + Crop	39.58%
Original + Flip	34.02%
Original + Flip2	35.76%

Table 3: Balanced accuracy for data augmentation for ResNet model.

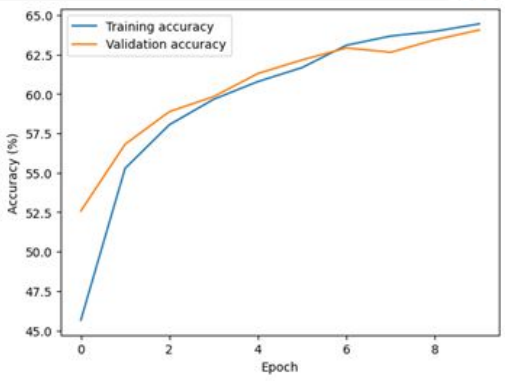


Fig. 6: Train and Validation vs # Epochs

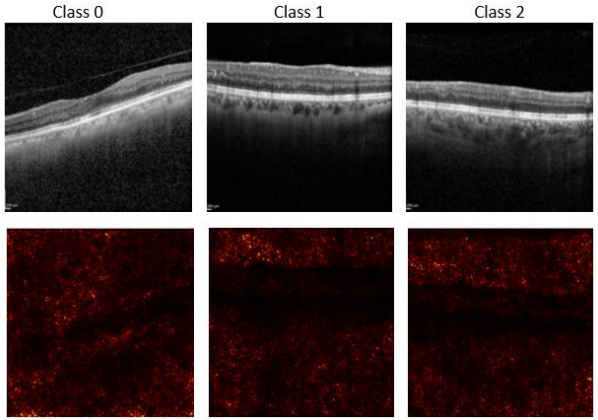
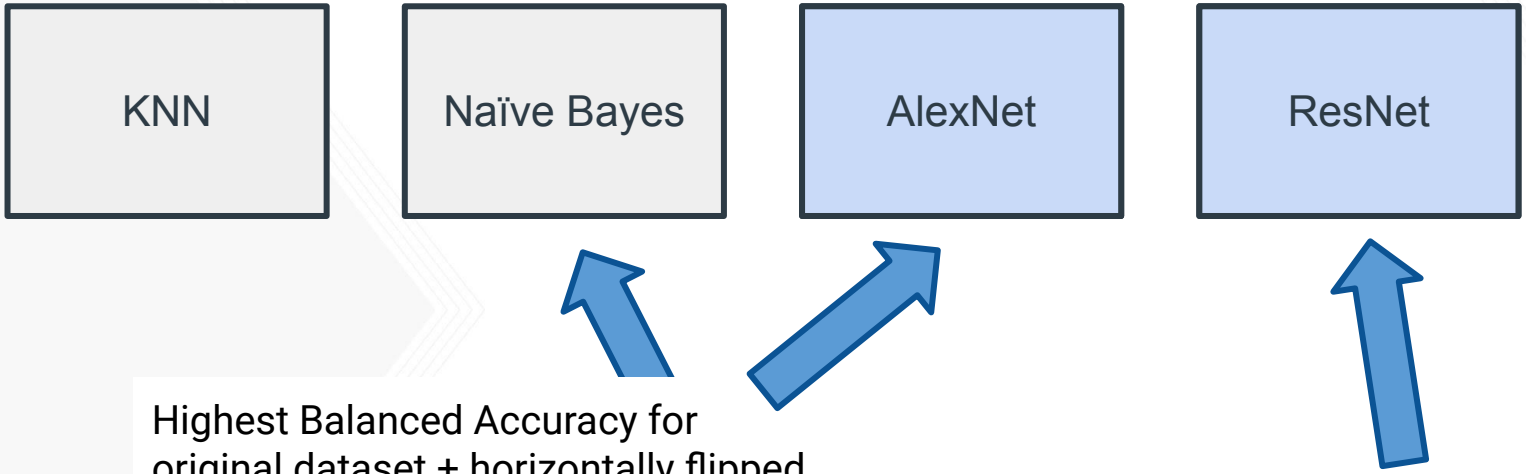


Fig. 7: Original + Flip Severity Class 2 Saliency Mapping

Georgia Tech
CREATING THE NEXT

Conclusion



Highest Balanced Accuracy for original dataset + horizontally flipped class 2: 42.98%

Highest Balanced Accuracy for cropped images + original dataset: 39.58%

➔ Relatively simply
vorks well with high dimensional data
PCA makes it easier to classify

Naïve Bayes > CNN
➔ require large amounts of data and have high learning capacity