Fachhochschule Nordwestschweiz

Optimizing Medical Image Classification

Optimization Approach: Classification of Brain Tumor Images Using Convolutional Neural Network (EfficientNet)

Module: Applied Computational Intelligence
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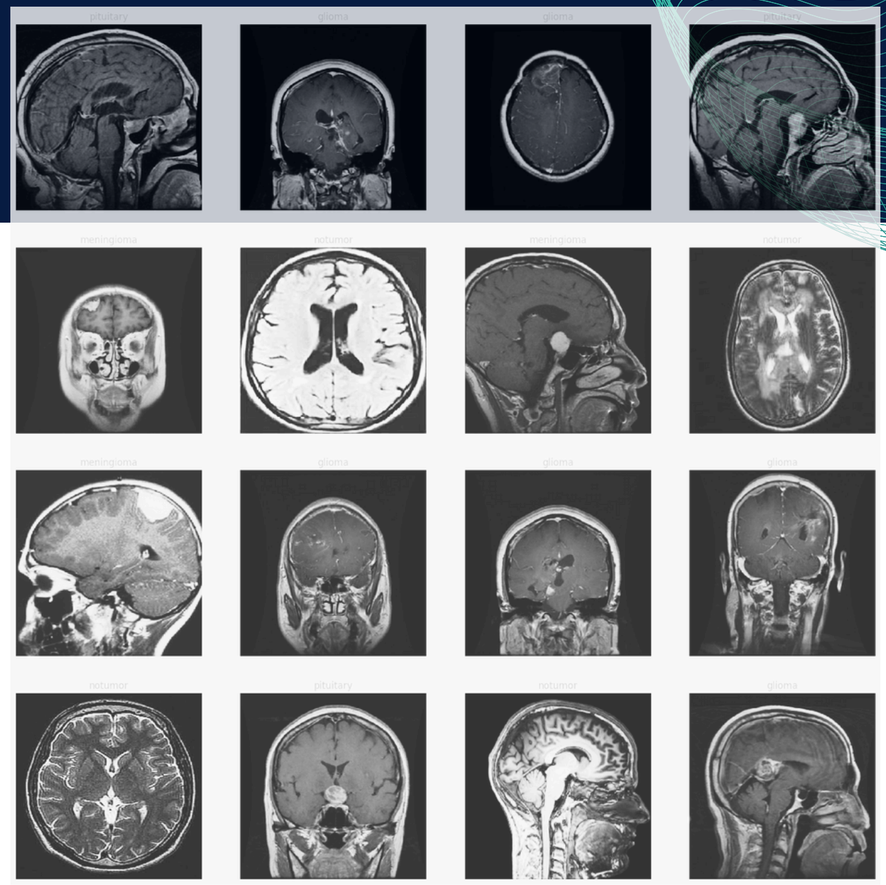
Introduction

Context

Almost 90% of healthcare data consists of medical images. Recent advancements in Convolutional Neural Networks (CNNs) have significantly impacted medical image classification.

Objective

To investigate optimizaiton methids in medical image classification using CNNs, specifically EfficientNet, and optimize the hyperparameters for brain tumor diagnosis using MRI scans.



Research Objectives

Main Goal

Enhance diagnostic accuracy for brain tumor classification.

Specific Objectives:

- Implement EfficientNetB0 for brain tumor classification.
- Use Support Vector Machine (SVM) for multi-class classification.
- Optimize SVM hyperparameters using a Genetic Algorithm (GA).

Methodology - Data Preparation

Dataset:

Kaggle dataset containing 7,023 MRI images of brain tumors (glioma, meningioma, pituitary) and normal brain scans.

Data Split:

- Training set: 5,712 images
- Testing set: 1,311 images

Image Processing:

Images resized to 224x224 pixels, normalized, and augmented using ImageDataGenerator.

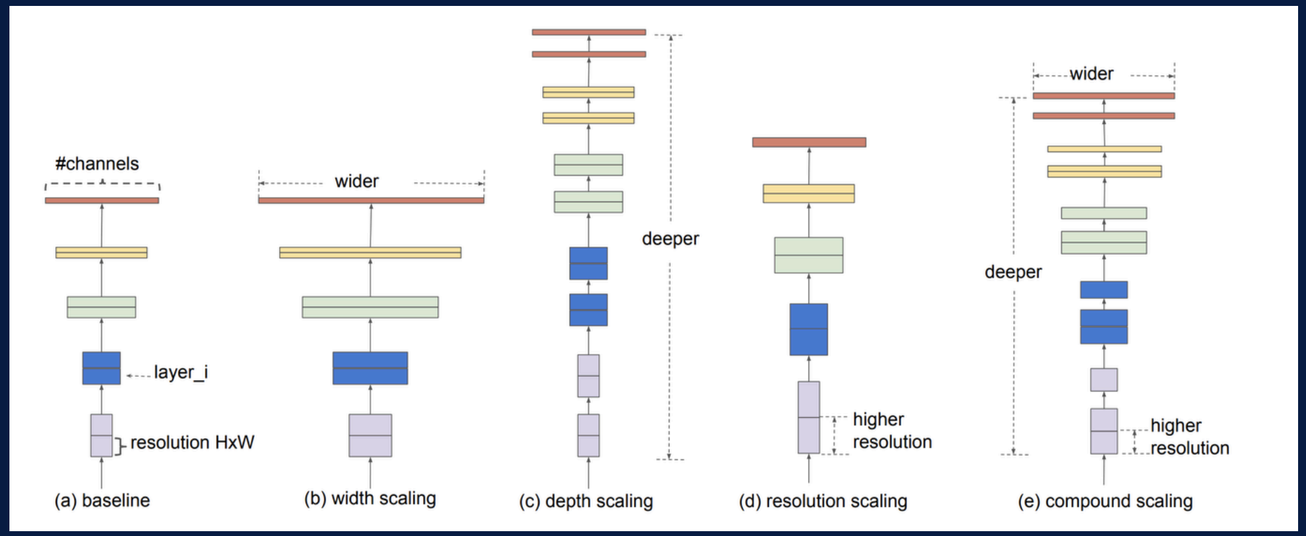
Methodology - EfficientNetB0

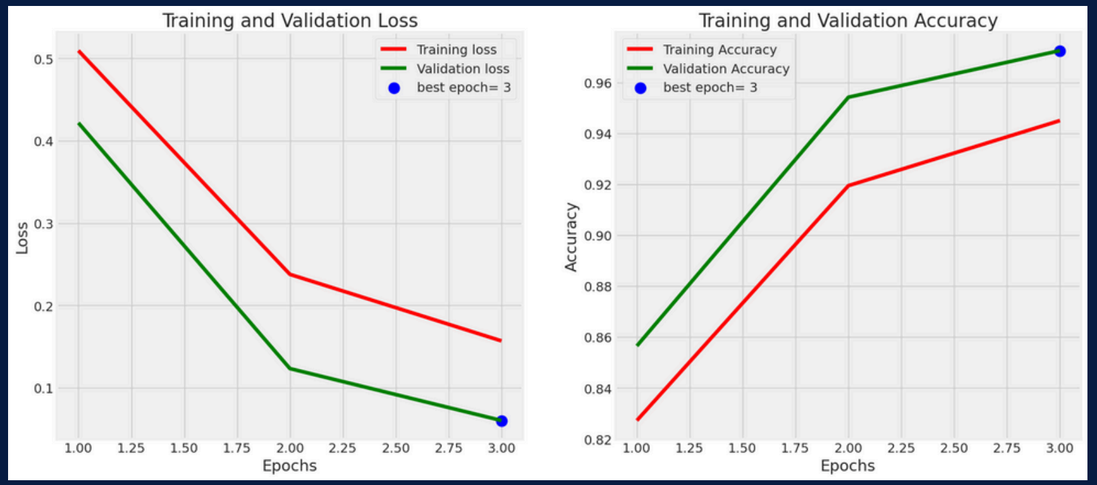
Architecture:

- EfficientNetB0 model
- Layers added: BatchNormalization, Flatten, Dense (256 neurons), Dropout (0.5), Dense (output layer with softmax)

Training:

- **Optimizer:** Adam (learning rate: 0.0001)
- **Loss Function:** Categorical Crossentropy
- **Metrics:** Accuracy
- **Epochs:** 3





Methodology - SVM

Feature Extraction: EfficientNet used to extract features from brain tumor MRI scans.

SVM Set Up:

- **Kernel:** Radial Basis Functioon (RBF)
- **Parameters:** Regularization (C), kernel coefficient (gamma)
- **Hyperparameter Tuning:** GridSearchCV with 5 fold cross validation-

```
SVC
SVC(C=1, class_weight='balanced', gamma=0.001)
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 efficientnetb0_input (InputLayer)  [(None, 224, 224, 3)]     0

 efficientnetb0 (Functional)  (None, 1280)              4049571

 batch_normalization (BatchNormalization)  (None, 1280)              5120

 flatten (Flatten)           (None, 1280)              0

=================================================================
Total params: 4054691 (15.47 MB)
Trainable params: 4010108 (15.30 MB)
Non-trainable params: 44583 (174.16 KB)
_________________________________________________________________
```

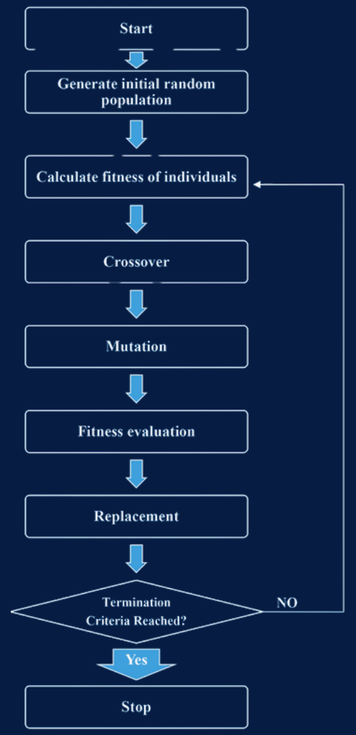
```
Fitting 5 folds for each of 9 candidates, totalling 45 fits
[CV] END .....................C=0.1, gamma=scale, kernel=rbf; total time= 1.2min
[CV] END .....................C=0.1, gamma=scale, kernel=rbf; total time= 1.3min
[CV] END .....................C=0.1, gamma=scale, kernel=rbf; total time= 1.3min
[CV] END .....................C=0.1, gamma=scale, kernel=rbf; total time= 1.3min
[CV] END .....................C=0.1, gamma=scale, kernel=rbf; total time= 1.2min
[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time= 1.5min
[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time= 1.4min
[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time= 1.5min
[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time= 1.4min
[CV] END .....................C=0.1, gamma=0.001, kernel=rbf; total time= 1.5min
[CV] END .....................C=0.1, gamma=0.01, kernel=rbf; total time= 4.8min
[CV] END .....................C=0.1, gamma=0.01, kernel=rbf; total time= 4.9min
[CV] END .....................C=0.1, gamma=0.01, kernel=rbf; total time= 5.0min
[CV] END .....................C=0.1, gamma=0.01, kernel=rbf; total time= 5.0min
```

Methodology -
Genetic Algorithm

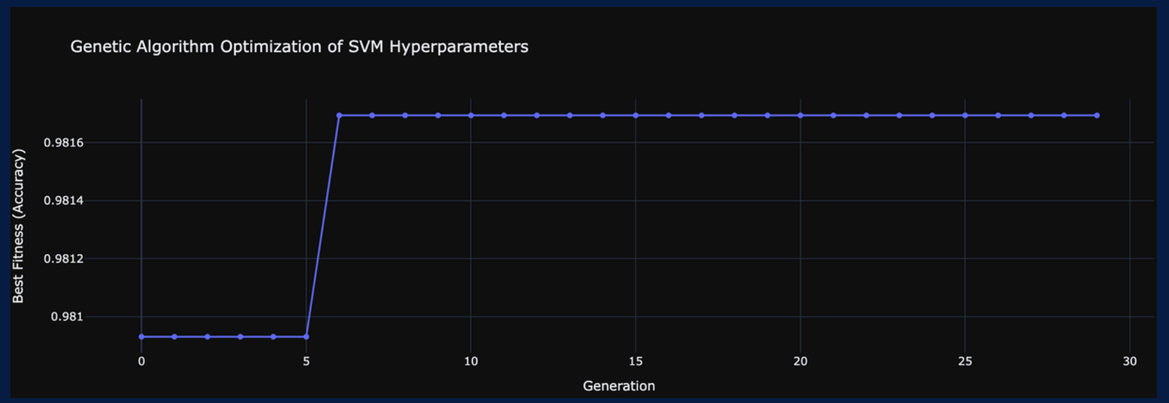
Objective: Optimize SVM Hyperparameters

Genetic Algorythm Set Up:

- Initial population with range values for C (0.1 - 10.0) and gamma (0.0001 - 1.0)
- Fitness Function: SVM accuracy on test data
- Selection: top individuals based on fitness
- Iterations: 30 generations



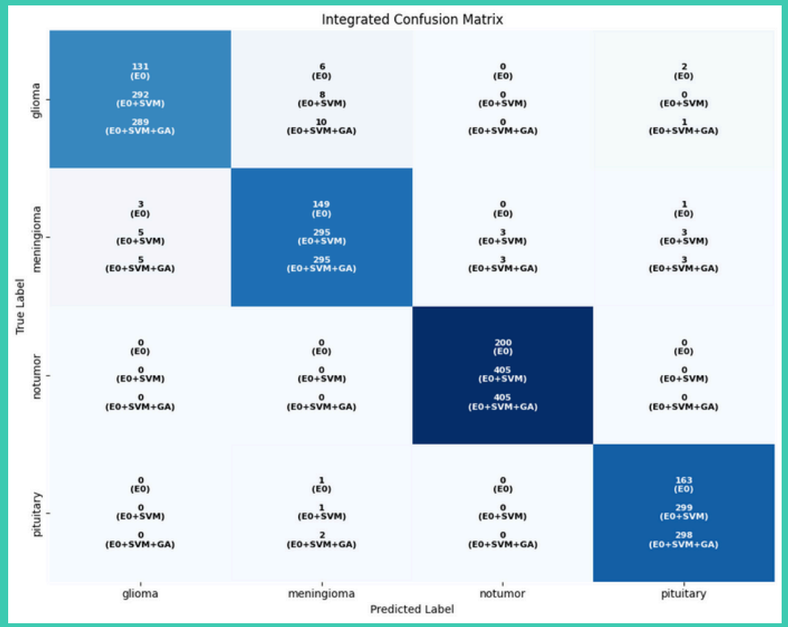

```python
# Defining Genetic Algorithm
ga_instance = pygad.GA(
    num_generations=30,
    num_parents_mating=5,
    fitness_func=fitness_func,
    sol_per_pop=10,
    num_genes=2,
    init_range_low=0.1,
    init_range_high=10.0,
    mutation_percent_genes=50,
    gene_type=float,
    gene_space=[{'low': 0.1, 'high': 10.0}, {'low': 0.0001, 'high': 1.0}],
    on_generation=on_generation
)
```



Results

Model Comparison

Model	Accuracy	Precision	Recall	F1 Score
CNN	98.02%	98.00%	98.00	98.00%
CNN-SVM	98.47%	98.32%	98.27%	98.31%
CNN-SVM-GA	98.17%	98.08%	98.17%	98.15%



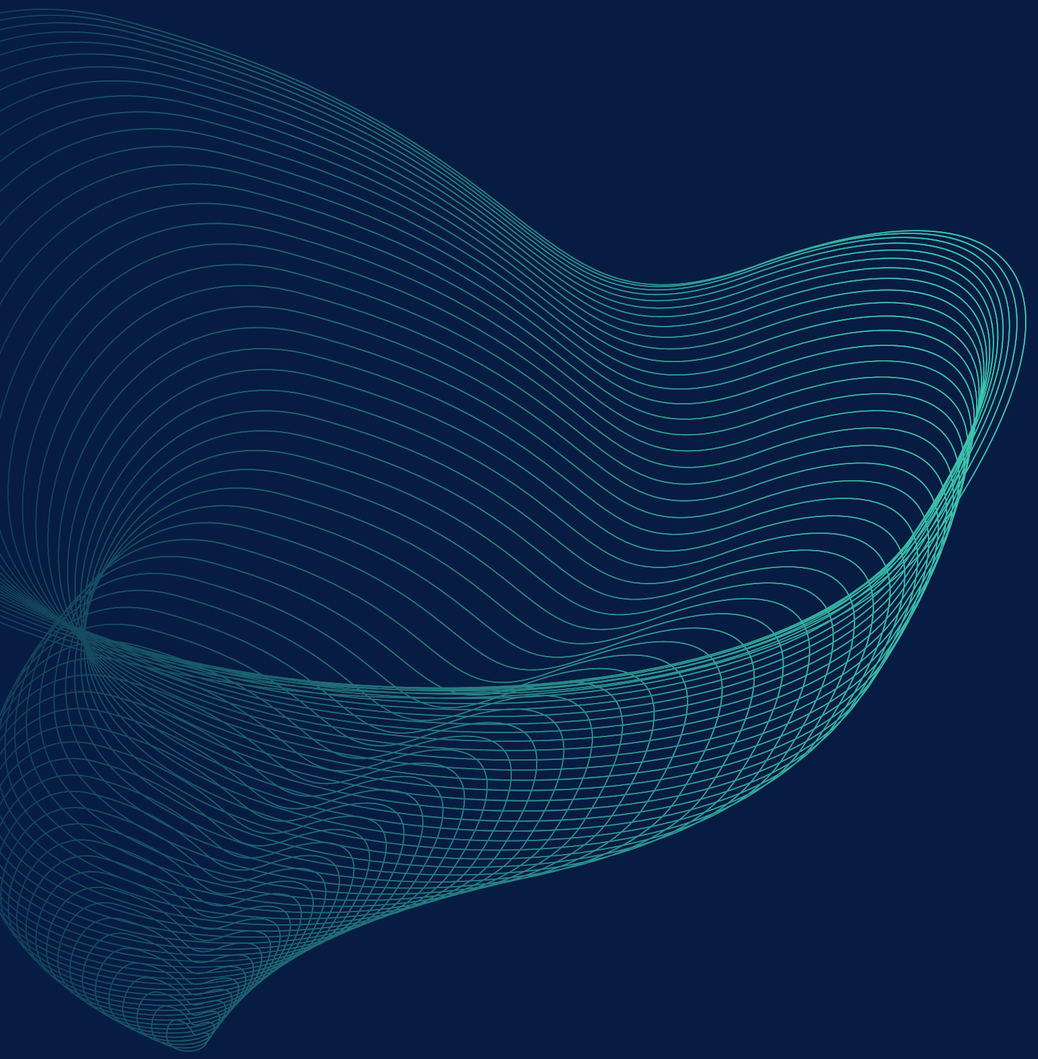
Discusion and Conclusion

Findings

- EfficientNetB0 provides a strong foundation for brain tumor classification.
- SVM improves classification performance.
- Genetic Algorithm offers marginal improvement but potential for further optimization.

Future Work

- Explore other EfficientNet models (B0 to B7).
- Test with larger datasets and different medical imaging tasks.
- Extend SVM hyperparameter search.



Thank You

Work available in GitHub:
https://github.com/DatAlbertW/Applied-Computational-Intelligence

Or by scanninng the **QR Code**

References

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