Two stage feature level ensemble of deep CNN models Brain Tumor classificaton

Presentation

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Overview

1. **Introduction**

2. **Methodology**

3. **Results**

Introduction

- Brain tumor is caused by the unnatural and uncontrolled growth of brain cells, its severe consequences is life-threatening.
- Around 400,000 people are affected by brain tumor and 120,000 people have died in the year 2021 all over the world, as re-ported by World Health organization (WHO).
- Manual detection of brain tumors can be tedious, time consuming and erroneous.
- An automated process for precise detection and classification of brain tumors is necessary.

Objectives of the Study

1. **Addressing Limitations of Existing Models**: Overcome the common limitations found in existing brain tumor detection models, lack of generalization capability and robustness.

2. **Exploring Multi-Stage Ensemble Techniques**: Experiment with a multi-stage ensemble technique, which has not been extensively studied in the context of brain tumor classification from MRI scans.

3. **Model Selection and Validation**: Model selection, where the best CNN feature extractors and classifiers are identified and experiments across three different datasets.

4. **Two-Stage Ensemble Model**: Proposes a new two-stage ensemble model that is constructed by evaluating and refining the models in two phases.

5. **Real-Time Verification**: Development of a UI that allows for real-time validation of the proposed model.

Methodology Overview
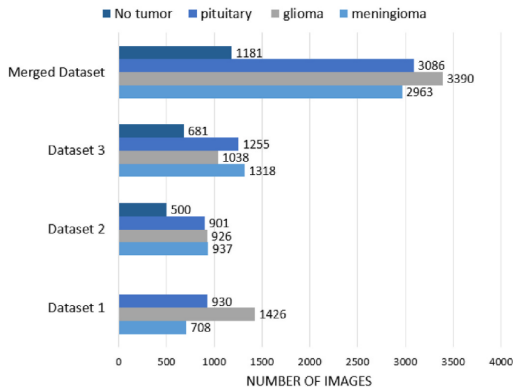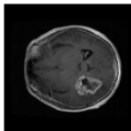
The proposed approach -
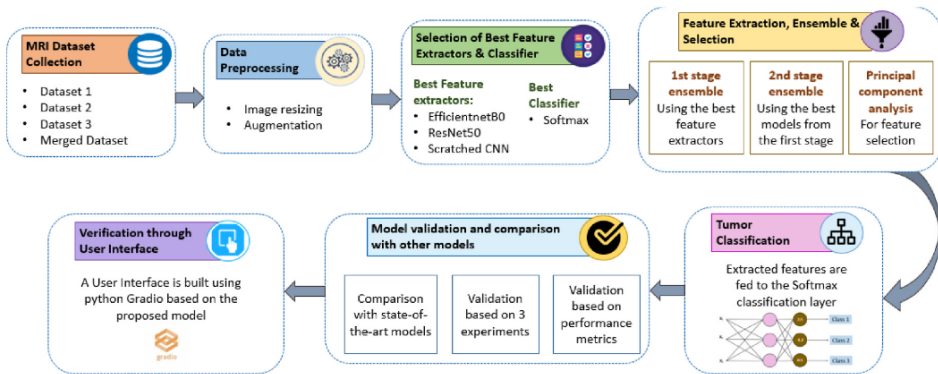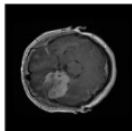
Ensemble of CNN
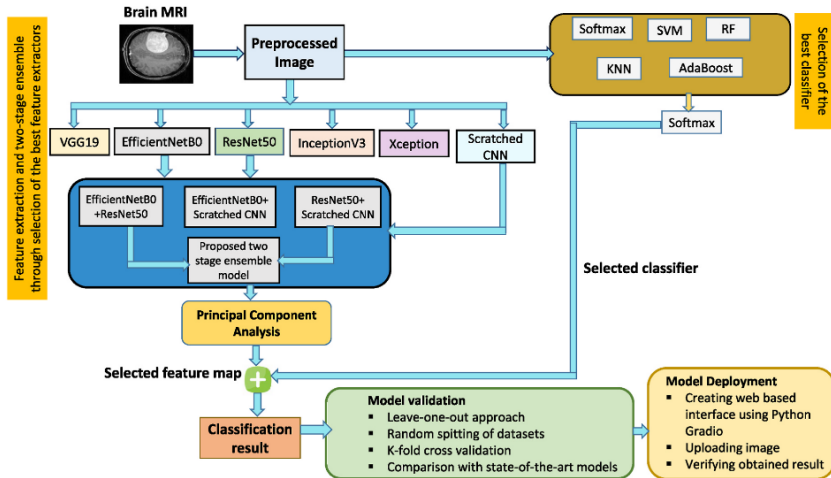
Datasets Used

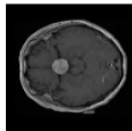The dataset includes T1-weighted contrast-enhanced images (where fat tissue is highlighted).
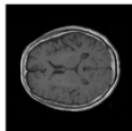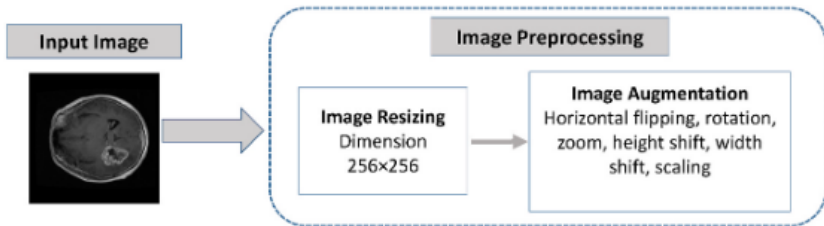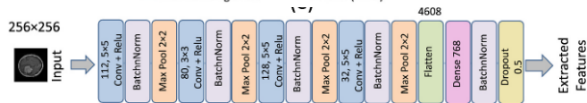
Preprocessing

Glioma   Meningioma   Pituitary   No Tumor

Input Image

Image Preprocessing

Image Resizing
Dimension
256×256

Image Augmentation
Horizontal flipping, rotation, zoom, height shift, width shift, scaling

Model Selection

Custom Models

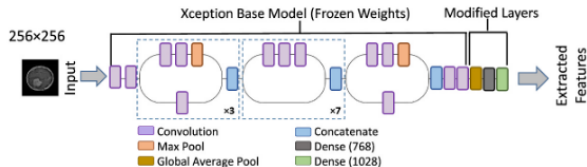1. Vgg19
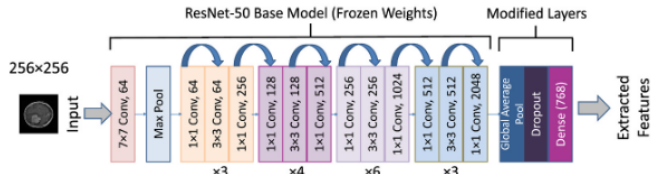2. EfficientNet B0
3. Inception V3

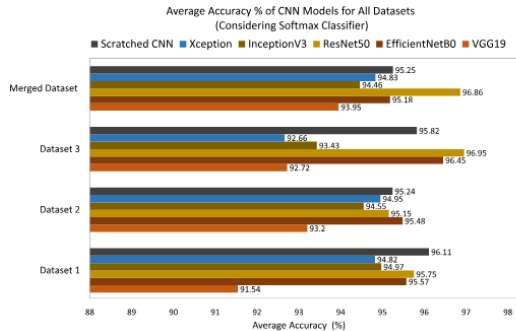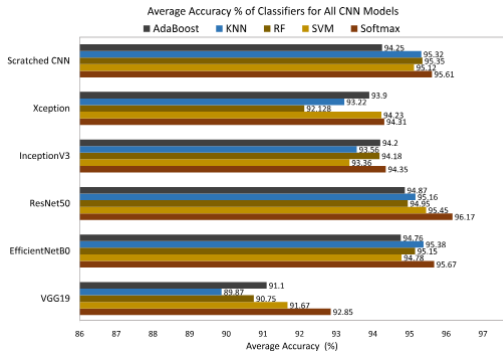# Model Selection

Custom Models

1. ResNet 50
2. Xception
3. Proposed CNN model from scratch

Hyperparameters

hyper-parameter	Search space (min value, max value)	Selected value (optimum)
No of Conv layer	2, 5	4
No of filters in Conv 1	32, 128	112
No of filters in Conv 2	32, 128	80
No of filters in Conv 3	32, 128	128
No of filters in Conv 4	32, 128	32
Kernel size of Conv 1	3, 5	5
Kernel size of Conv 2	3, 5	3
Kernel size of Conv 3	3, 5	5
Kernel size of Conv 4	3, 5	5
Units in Dense layer	32, 1028	768
Initial learning rate	1e-2, 1e-4	1e-2

Feature Extraction and Selection

Average Accuracy % of Classifiers for All CNN Models

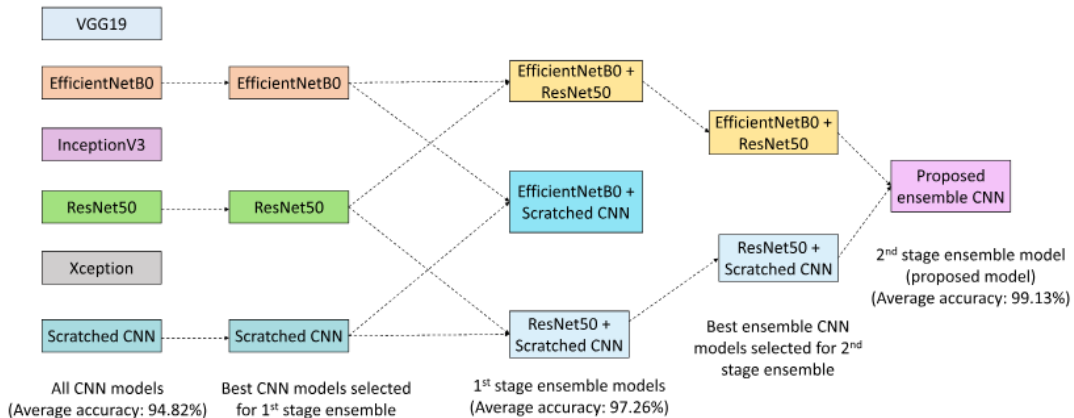Average Accuracy % of CNN Models for All Datasets (Considering Softmax Classifier)
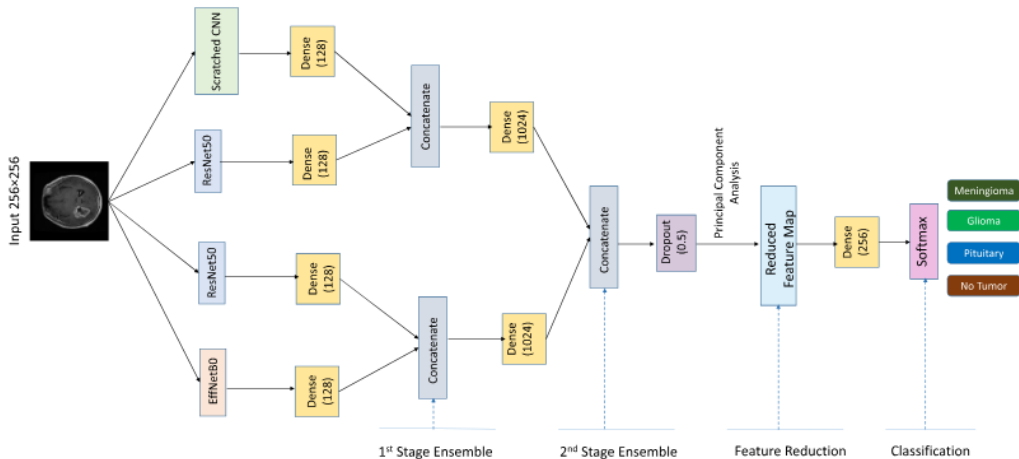
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[1]Softmax obtained the best average accuracy considering all feature extractors.

[2]Proposed Scratched CNN, EfficientNet-B0 and ResNet-50 attained the best accuracy scores considering all datasets.

Ensemble Network

VGG19

EfficientNetB0 → EfficientNetB0

InceptionV3

ResNet50 → ResNet50

Xception

Scratched CNN → Scratched CNN

EfficientNetB0 + ResNet50

EfficientNetB0 + Scratched CNN

ResNet50 + Scratched CNN

EfficientNetB0 + ResNet50

ResNet50 + Scratched CNN

Proposed ensemble CNN

All CNN models
(Average accuracy: 94.82%)

Best CNN models selected
for 1st stage ensemble

1st stage ensemble models
(Average accuracy: 97.26%)

Best ensemble CNN
models selected for 2nd
stage ensemble

2nd stage ensemble model
(proposed model)
(Average accuracy: 99.13%)

2 Stage Ensemble Model

Results

Validation accuracy of the first stage ensemble models.

| Model	Validation Accuracy %			
	Dataset 1	Dataset 2	Dataset 3	Merged Dataset
ResNet50+proposed CNN	**98.53**	96.83	97.71	**97.98**
EfficientNetB0+proposed CNN	96.15	95.72	97.41	97.23
EfficientNetB0+ResNet50	96.22	**97.12**	**98.819**	97.41

Impact of 2 stage ensemble

■ 2nd stage ensemble ■ 1st stage ensemble ■ No ensemble
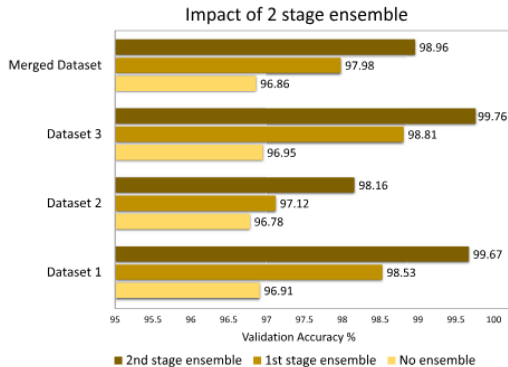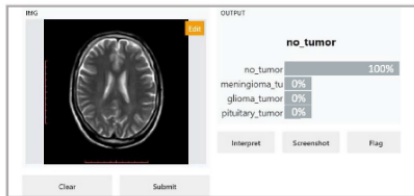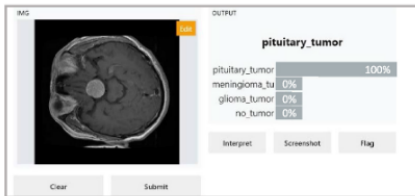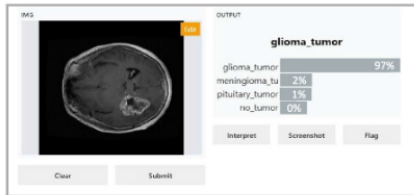
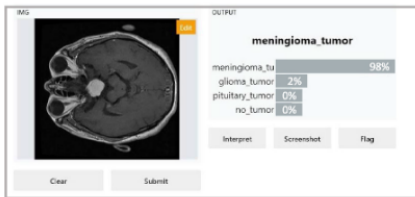# Comparison with Existing Models
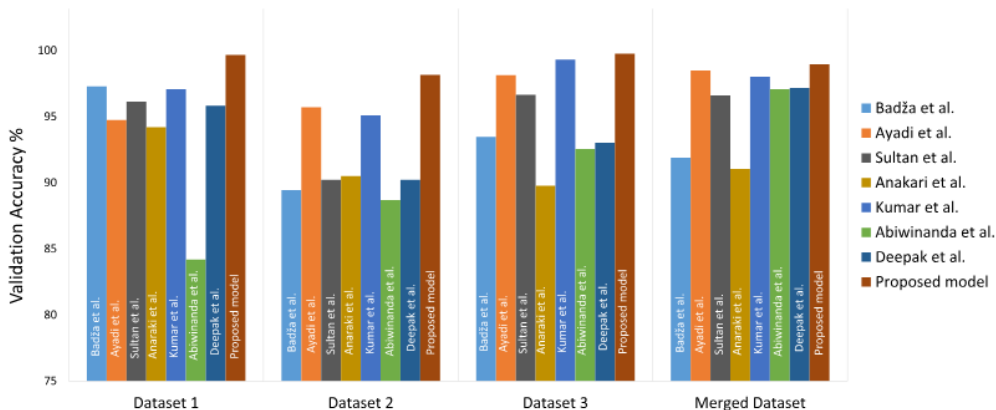
User Interface (UI)

Developed User Interface–
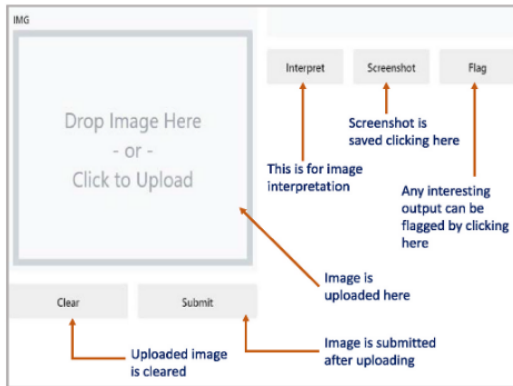
User Interface (UI)

Developed User Interface–

Conclusion

As a result of applying two-stage ensemble, the overall accuracy increases 4.31%. After applying PCA, the average execution time and the number of features reduce by a factor of 6 and 18.71 respectively. Moreover, three experiments conducted on the datasets considering random splitting, 8-fold cross-validation, and different validation set also prove the robustness and generalization capability of the proposed model.

Limitation & Future Work

There are around 120 types of brain tumors but because of data inadequacy, our work was limited to three major types of tumor. We only considered MRI because of its harmless nature but other med- ical imaging techniques, i.e., CT (Computed Tomography) scan, PET (Positron-Emission Tomography) can also be taken under consideration in future work.

The End