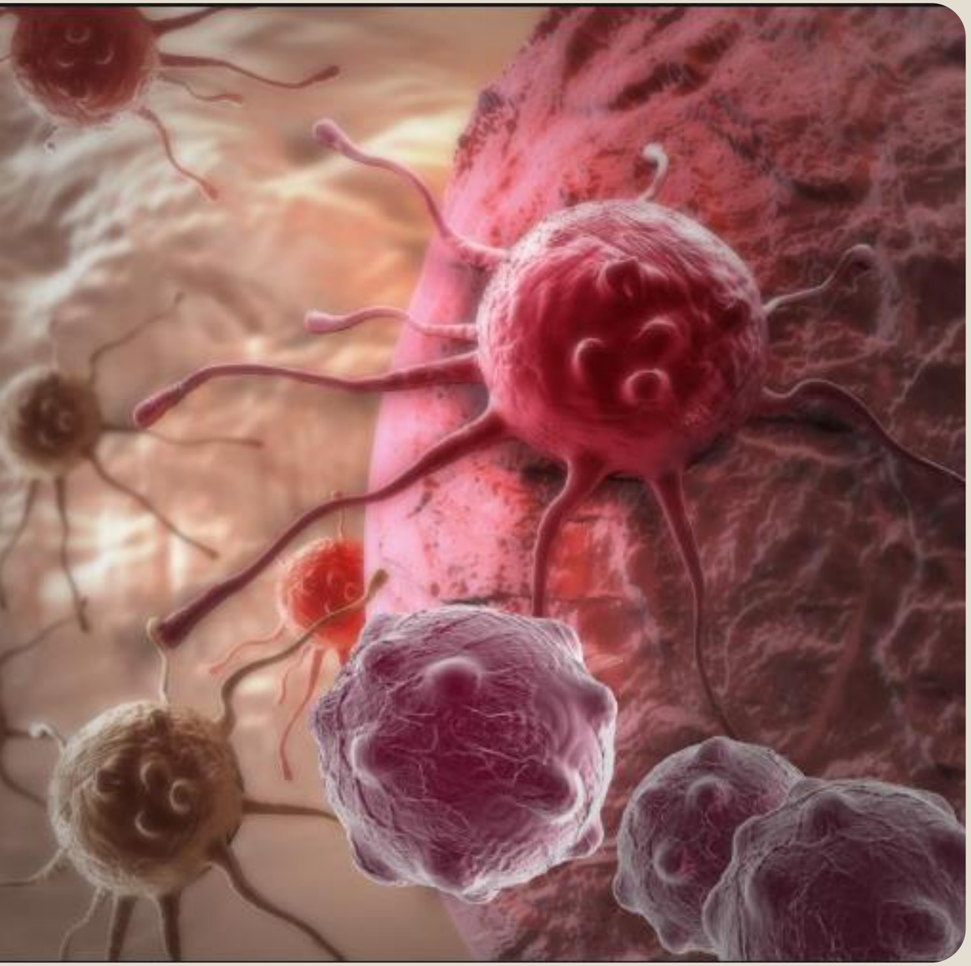

Deep Learning – Brain Tumor Classification

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- Group 1 : Medical Image Classifiers

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UNC Charlotte

Introduction

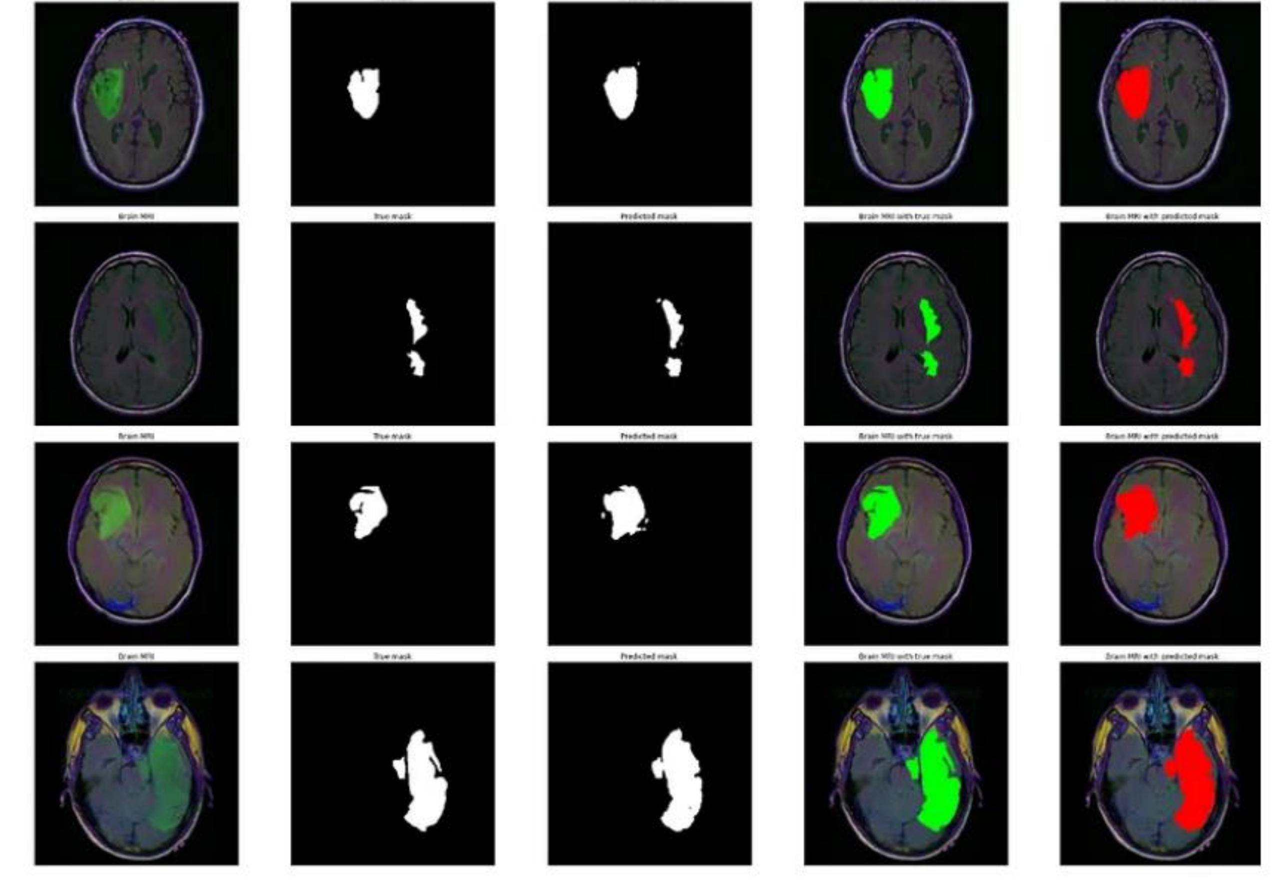
Classifying image tumor cells of 3 different brain tumors – Glioma, Meningioma, Pituitary and no tumor cells

Overall, there are 7022 image files split into training and testing, each of an MRI of the brain

The initial goal is to use transfer learning from pre-trained CNNs such as VGG-16 and RES-NET 50 and use it on our dataset

The final goal is to improve the above model and understand model's application on other datasets to be able to generalize classification

Brain Tumor MRI Dataset | Kaggle



- Pre-process the image as necessary after further examination on IDE, and use image augmentation
- Use VGG-16, RESNET-50 & InceptionV3 [GoogleNet] for transfer learning and examine results to understand if they need to be combined or to choose the best model
- Evaluate on test data and improve the model further from existing research papers by fine-tuning the inner architecture
- Experiment with applying the classification methodology to other images such as detecting Leukemia to build a general classification CNN model

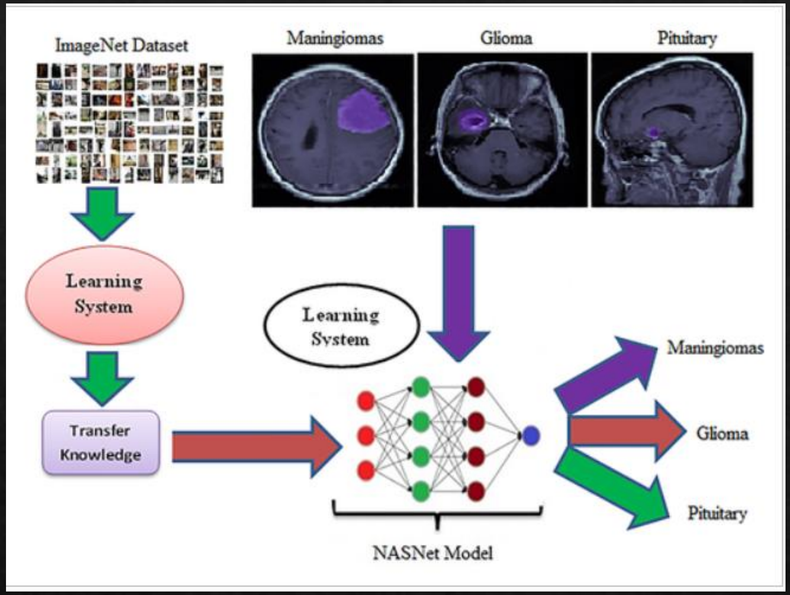
Approach & Steps

Survey Research (I)

A brief summary of a research method which used 2 deep learning models [Multiclass & Binary] with a 23-layer CNN.

- Multiclass (meningioma, glioma, and pituitary)
  - 3064 images
  - 23-layer CNN
  - 97.8% accuracy, 96.5% precision, 96.4% recall
- Binary classification (normal and abnormal)
  - 152 images - 71 normal, 81 abnormal
  - Merged transfer learning based VGG16 with 23-layer CNN to prevent overfitting with smaller dataset
  - 100% accuracy, precision, and recall

Khan, Md Saikat Islam et al. "Accurate brain tumor detection using deep convolutional neural network." Computational and structural biotechnology journal vol. 20 4733-4745. 27 Aug. 2022, doi:10.1016/j.csbj.2022.08.039



Model	Unet
Backbone	ResNet50
Image size	256 × 256
Weight	ImageNet
Optimizer	Adam
Loss	bce_jaccard_loss
Metrics	iou_score
Epochs	80
Random seed	42
Batch size	16

Survey Research (II)

A brief summary of a research method which used Unet model with RESNET-50 as the backbone for brain tumor detection

- Comprises of an encoder and a decoder, where in, the encoder eliminated the global average pooling and fully connected layer from the end of resnet-50
- The decoder consists of 5 blocks, every block containing 2 × 2 up-sampling layer encompassing a convolution layer, Rectified Linear Unit (ReLU) and batch normalization layer
- And for brain tumor classification, a NASNET model was used where an image size of 224*224 was sent to the NASNET model with weights of image-net dataset.
- It worked with an accuracy of 99.6% with no signs of overfitting, and with the ability to generalize data well.

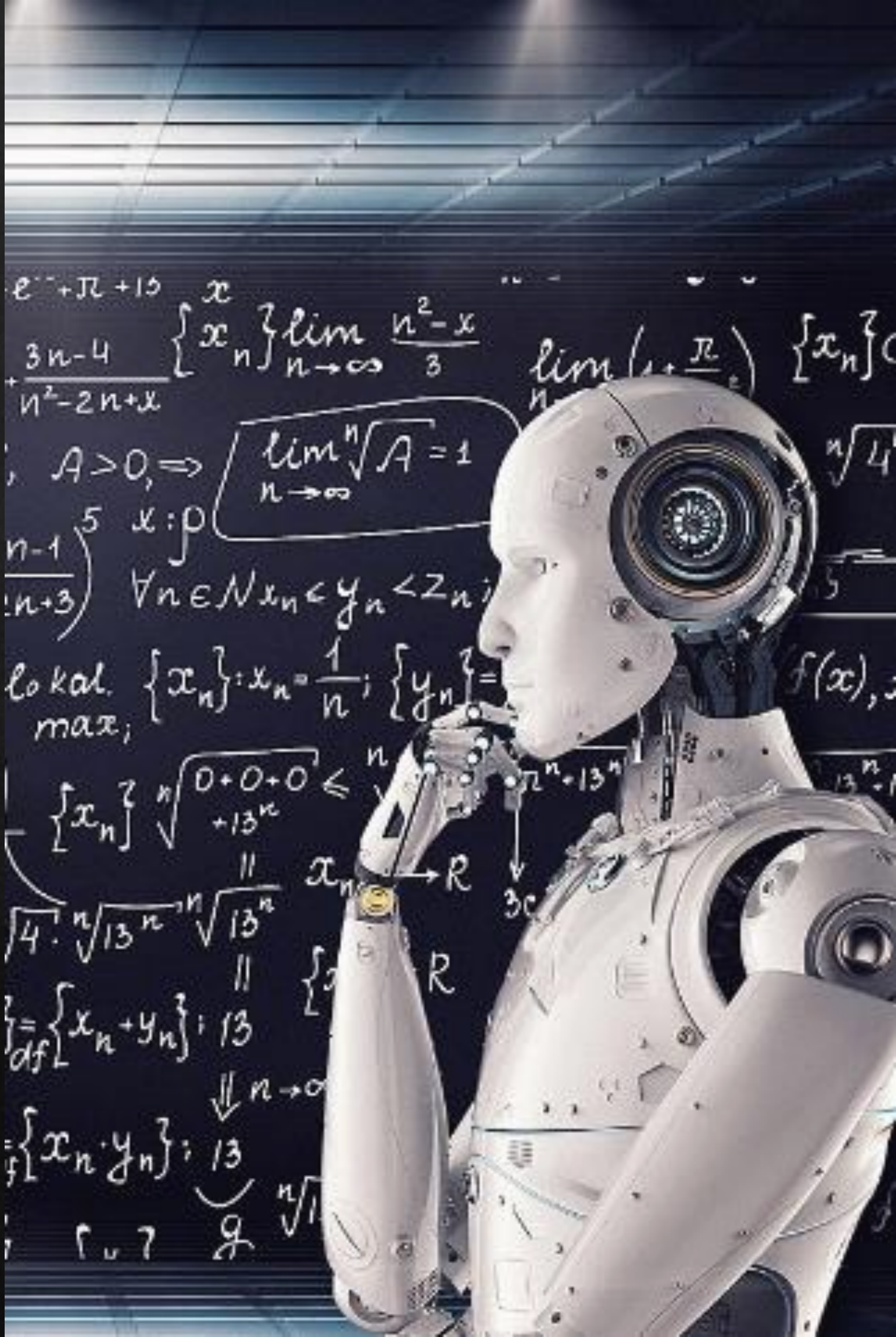
Sadad, Tariq, et al. "Brain tumor detection and multi-classification using advanced deep learning techniques." Microscopy Research and Technique 84.6 (2021): 1296-1308.

Survey Research (III)

Summary of an article which used parallel convolutional layers by going wider rather than going deeper.

- Filters used in parallel convolutional layers are 3x3, 5x5 and 1x1.
- Limitations like overfitting and also updating gradient weights were overcome by using the Inception V3 module.
- 100 images in each category (normal/abnormal) are selected from the database of 130 subjects.
- Comparing accuracy of the Inception V3 performance with the VGG-16.
- Average accuracy of inception architecture is 95.1%, whereas VGG-16 is 92.8%
- Average accuracy of 95.1%, Sensitivity of 96.2%, and Specificity of 94%.

Baloni, Dev, and Shashi Kant Verma. "Detection of hydrocephalus using deep convolutional neural network in medical science." Multimedia Tools and Applications 81.12 (2022): 16171-16193.



Timeline

- 2/15 – 3/08 : Pre-process a subset of the images, and apply transfer learning to research and understand the effect of the pre-trained CNN model on tumor images
- 3/21 – Mid progress report
- 3/09 – 3/31: Experiment further on pre-processing of images [use image augmentation, image-centering, resizing, etc.,] and shift focus towards fine-tuning the layers of CNN model, change the inner final layers, deepen or reduce the network size depending on the evaluation on test data. Finalize the model for classification of brain tumor detection

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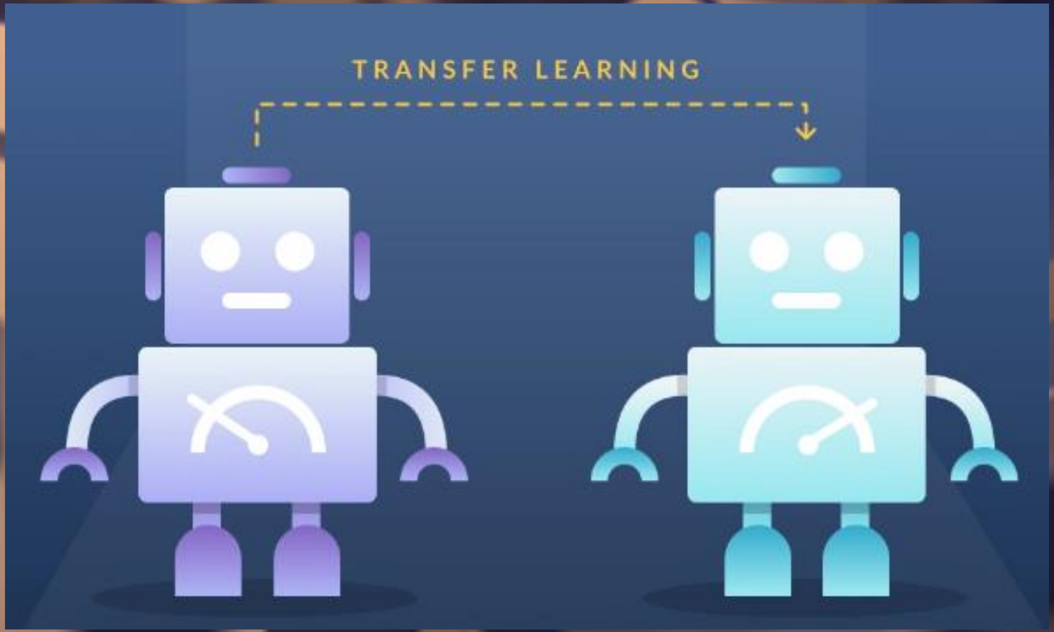
- 4/01 – 4/22 : Generalize the above model to recognize other medical diagnostic imaging such as leukemia cells.
- 4/23 – 4/28 : Finalize the slides for in-class presentation
- 4/29 – 5/4 : Finalize the report

Individual Responsibilities

- Pre-processing of images – Work together and finalize to have a structured blueprint to have common grounds to build further work on, i.e., transfer learning

- Transfer Learning – Each of the team member will pick up one pre-trained CNN model [VGG-16 : Carsten, RESNET-50 : Anulitha, InceptionV3 : Sundari] and apply transfer-learning on the above images, and continue to tune our respective models

- Evaluation – Will jointly work on examining results after individually evaluating on test data, post which we will pick the best performing model to work on other cancer datasets to expand the classification to a general CNN model.



Questions to answer

- Pre-processing steps and how it effects the result. We are aware of a limited number of approaches to pre-processing image data, and mostly have worked with already pre-processed data. We'd like to explore the practices that are out there, and how they effect the model's performance
- Whether or not we can build a generalized CNN model for grayscale tumor/cancer image data
- Whether we can apply the above model to RGB/non-grayscale images

Expectations

- Applications of transfer-learning and their impact on model performance
- Industry level image preprocessing standards
- Customize pre-trained models
- Testing the finalized model on different datasets and evaluating its performance
- Hopefully build a generalized classification model for medical diagnostic images